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FROM THE EDITOR-IN-CHIEF'S DESK

Behind the Scenes: Summer Dedication and Editorial Continuity

As the golden hues of summer fade and the autumn air takes hold, our surgical departments experience the familiar, sharp surge in clinical and operative volume. The end of the summer season typically brings a transition from vacation coverage back to full capacity, accompanied by a marked increase in our surgical workload. Operating theaters are once again running at peak capacity to address elective cases deferred over the summer months, while emergency departments see a steady rise in complex, acute surgical presentations. While this seasonal influx tests our physical endurance, human resources, and institutional logistics, it also invigorates our shared calling.

It serves as a timely reminder of our steadfast commitment to clinical rigor, surgical excellence, and the ongoing advancement of scientific knowledge. Behind the scenes of this comprehensive September 2026 issue lies months of relentless dedication and hard work. Even during the peak of the summer season, our Editorial Board and reviewers worked tirelessly without interruption. Throughout these warm summer months, we maintained our rigorous peer-review processes, carefully evaluated a high volume of manuscript submissions, and meticulously curated the diverse scientific content presented here. We are profoundly grateful to every member of our editorial team and our expert reviewers, whose silent, continuous efforts over the summer made the timely publication of this issue possible.

In this September 2026 issue of the Turkish Journal of Surgery, we are proud to publish an exceptionally rich and diverse selection of clinical, educational, and experimental studies addressing critical challenges across the spectrum of modern surgery: Atlı and Koc conduct a retrospective analysis of 244 patients to evaluate how graft bile duct anatomy and anastomosis techniques (duct-to-duct vs. Roux-en-Y) affect postoperative morbidity and early mortality in living- and deceased-donor liver transplantation. Picchio et al. present a retrospective case-control study of 196 patients, showing that postoperative betamethasone infusion significantly reduces the incidence of biochemical and symptomatic hypocalcemia and early postoperative pain. Oruc et al. examine pre-procedural risk factors among 364 critically ill patients undergoing percutaneous endoscopic gastrostomy and identify active systemic infection, severe hypoalbuminemia, and elevated urea levels as strong independent predictors of in-hospital mortality. Erdogrul et al. evaluate 120 patients with adhesive small bowel obstruction, demonstrating that oral administration of low-osmolar iohexol is safe and significantly accelerates the time to restoration of bowel passage compared with standard conservative management. Ozcinar et al. analyze national survey data from 156 surgical educators across Türkiye, revealing significant gaps between written core curricula and practical implementation and calling for standardized competency-based training models. Sekerci et al. report the results of a nationwide survey of 147 general surgeons, noting that although over 94% of surgeons support incorporating interventional POCUS into the residency core curriculum, structural barriers and a lack of dedicated devices still limit its use in daily practice. In a 1:1 age- and sex-matched study of 696 patients, Gulcek et al. demonstrate that individual complete blood count indices (PLT, PCT, PDW, MPV, RDW) do not discriminate between papillary thyroid carcinoma and benign nodules, suggesting that prior positive literature may reflect demographic confounding. Tali et al. investigate 505 patients undergoing resection for stage II–III colorectal cancer and report that lower preoperative Hemoglobin, Albumin, Lymphocyte, and Platelet (HALP) scores are independently associated with a higher risk of postoperative anastomotic leakage. Yavuz et al. evaluate 83 adult patients with electrical burn injuries and conclude that markers of deep muscle necrosis and systemic inflammation (LDH, ALT, NLR, and HALP score) are far more predictive of limb loss than surface burn area or voltage levels. In a prospective study of 536 trauma patients in India, Yadukrishna et al. validate the rSIG score as a highly effective triage tool for predicting early blood transfusion requirements and in-hospital mortality. Bulut et al. translate and cross-culturally adapt the CCS for 85 patients with a median follow-up of 79 months, establishing the Turkish CCS as a robust, disease-specific instrument for evaluating chronic pain, mesh sensation, and movement limitation after inguinal hernia repair. This issue also features innovative video articles on esophageal reconstruction challenges after sleeve gastrectomy and on Thiersch's procedure for rectal prolapse, a narrative review on artificial intelligence in head and neck surgery, and engaging letters to the editor.

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As we navigate the heightened clinical demands of the autumn season, we express our profound appreciation to our authors for choosing the Turkish Journal of Surgery as their academic home, and to our peer reviewers and editorial team, whose rigorous evaluations uphold our publication's high standards. We trust that the scientific evidence presented in this issue will inform your clinical decisions and ultimately enhance patient care.

As always, thanks to our readers…

Prof. M. Umit UGURLU
TurkJSurg Editor-in-Chief

ORIGINAL ARTICLE
Turk J Surg 2026;42(3):281-288

Impact of bile duct number and anastomosis technique on postoperative morbidity and mortality in living and deceased donor liver transplantation

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ABSTRACT

Objective: This study aims to retrospectively examine the relationship between graft bile duct number (single or multiple) and biliary anastomosis technique (duct-to-duct or Roux-en-Y hepaticojejunostomy) with postoperative morbidity and mortality in living donor liver transplantation (LDLT) and deceased donor liver transplantation (DDLT) patients.

Material and Methods: A retrospective cohort study was conducted on 244 patients who underwent LDLT and DDLT at Ankara Güven Hospital Liver Transplantation Center between January 2013 and January 2025. Patient data including demographic characteristics, preoperative parameters (MELD score, underlying liver disease), surgical variables (bile duct number, anastomosis type, graft type, operation time), and postoperative outcomes were collected systematically. Bile duct anatomy was classified as single or multiple ducts, and anastomosis techniques were categorized as duct-to-duct or Roux-en-Y. Biliary complications were graded according to the International Liver Transplant Society consensus classification and Clavien-Dindo system. Statistical analyses were performed using SPSS 27.0, employing independent-samples t-tests, Mann-Whitney U tests, and chi-square tests.

Results: The mean patient age was 57.8±11.5 years with mean body mass index (BMI) of 27.62±5.67 kg/m^2. The cohort comprised 70.49% males and 29.51% females. Significant gender distribution differences were observed between groups, with higher male ratio in the duct-to-duct group (75.94%) compared to Roux-en-Y group (63.96%; p=0.041). Diabetes mellitus prevalence was notably higher in the Roux-en-Y group (46.85%) versus duct-to-duct group (34.59%; p=0.052). No significant differences were found in age, BMI, or blood group distribution between anastomosis techniques.

Conclusion: Preliminary findings suggest demographic and comorbidity variations between anastomosis technique groups, indicating the need for individualized surgical planning in LDLT and DDLT based on bile duct anatomy and patient characteristics.

Keywords: Bile duct, biliary complication, hepaticojejunostomy, liver transplantation

INTRODUCTION

Liver transplantation is currently the most effective and accepted curative treatment method for fulminant hepatitis, hepatocellular carcinoma, and end-stage chronic liver disease. As the number of patients requiring liver transplantation continues to outpace the availability of deceased donor organs globally, living donor liver transplantation (LDLT) has emerged as an essential alternative (1,2). Compared with deceased liver transplantation (DDLT), LDLT offers advantages such as planned surgery, elimination of waiting time, and reduced cold ischemia time (3). However, LDLT is a technically complex procedure, and factors such as graft weight, adequacy of vascular structures, immunological compatibility, and, especially, biliary tract anatomy play a critical role in its success (1,3).

Biliary tract reconstruction is the most critical point of LDLT and DDLT, and anatomical variations and surgical technique choices at this stage directly affect postoperative morbidity and mortality. The number and configuration of graft bile ducts are among the most important determinants of surgical planning. The presence of a single bile duct facilitates the application of standard anastomosis techniques and is associated with lower complication rates; however, multiple duct variations (two or more ducts) increase technical difficulties and significantly raise the risk of biliary complications (4,5). Different surgical approaches, such as duct-to-duct anastomosis (end-to-end), Roux-en-Y hepaticojejunostomy (Roux-en-Y), double duct-to-duct, and hybrid techniques, are used for biliary reconstruction, each with its own advantages,

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disadvantages, and complication profiles (6). The choice of anastomosis technique is individualized based on factors such as bile duct diameter and number, the recipient's native biliary tract anatomy, and the surgeon's experience (5,6).

Postoperative biliary complications are among the most common causes of morbidity after LDLT and DDLT. Serious clinical conditions such as bile leakage, biliary stricture, cholangitis, secondary sepsis, graft dysfunction, and graft loss negatively affect the quality of life of patients and increase mortality rates by increasing the need for reoperation (7). Although various data exist in the literature regarding the effects of bile duct anatomical variations and anastomosis techniques on clinical outcomes, prospective or large cohort studies that comprehensively and specifically examine this relationship remain limited. Therefore, studies that further clarify the role of different anastomosis techniques, depending on the number of bile ducts, in postoperative outcomes are needed.

The aim of this study is to retrospectively examine the relationship between the number of graft bile ducts (single or multiple) and the preferred biliary anastomosis type (duct-to-duct or Roux-en-Y) and postoperative morbidity and mortality in patients undergoing LDLT and DDLT donor liver transplantation. The findings are expected to contribute to risk analysis in preoperative surgical planning, provide an evidence-based approach to selecting anastomosis techniques, and shed light on strategies to reduce postoperative complications.

MATERIAL and METHODS

This study is a retrospective cohort study encompassing patients who underwent LDLT and DDLT donor liver transplantation at the Ankara Güven Hospital Liver Transplantation Center between January 1, 2013, and January 1, 2025. This study was conducted in accordance with the Helsinki Declaration and received ethical approval from the Sivas Cumhuriyet University Faculty of Medicine Health Sciences Research Ethics Committee (approval number: 2025-06/44, dated: June 2025). Inclusion criteria were: Having undergone LDLT and DDLT donor liver transplantation at our center within the specified time period, having complete records of bile duct anatomy and anastomosis type in electronic medical records and surgical reports, and having a postoperative follow-up period of at least 6 months. Exclusion criteria were: Patients with incomplete or unreliable data, patients under 18 years of age, and patients with a postoperative follow-up period shorter than 6 months.

Study Design and Participants

Patient data were collected through systematic retrospective review of electronic health records, standard surgical reports, and clinical follow-up notes. Standardized data collection forms were used, and all data were double-entered and cross-checked by two independent researchers. The variables collected included demographic data (age, gender, body mass index), preoperative parameters [model for end-stage liver disease (MELD) score, underlying liver disease etiology, comorbidities, biochemical test results], surgical variables (number of bile ducts and anatomical variations, anastomosis type, graft type, operation time, amount of blood transfusion), and postoperative outcomes. Primary outcome parameters were postoperative morbidity and mortality, while secondary outcome parameters included biliary complications (bile leakage, stricture, cholangitis), vascular complications, bleeding, infection, liver failure, postoperative ileus, length of hospital and intensive care unit stay, and graft and patient survival. Bile duct anatomy is classified as "single duct" or "multiple ducts", and the type of anastomosis is classified as "duct-to-duct" or "Roux-en-Y".

The primary objective of this study is to assess the impact of bile duct number and anastomotic technique on postoperative morbidity and mortality. In accordance with the International Liver Transplant Society consensus established at the 2023 BileducTx conference in Innsbruck, biliary complications are categorized by anatomical location: Intrahepatic post-transplant cholangiopathy, hilar post-transplant cholangiopathy, and anastomotic stricture or leakage (8). This classification evaluates complications in five stages, presenting a progressive spectrum of severity from radiological abnormalities (Stage I) to mortality (Stage V) (Table 1). Treatment approaches and intervention methods applied for each stage are described in detail.

Similarly, biliary complications were graded using the Clavien-Dindo classification system, modified according to these consensus definitions. All patients were followed according to our institution's standard liver transplant follow-up protocol, with follow-up beginning on the transplant date and continuing until the last application date, death, or study completion. To protect patient confidentiality, all personally identifiable information was anonymized, and data was stored in an encrypted digital environment in accordance with institutional data security protocols. The obtained data were analyzed by creating main comparison groups.

Biliary Reconstruction Strategy

Biliary reconstruction was performed after the completion of arterial anastomosis. Our standard approach favored duct-to-duct anastomosis in all eligible adult recipients to preserve the physiological sphincter of Oddi mechanism and facilitate future endoscopic access.

The selection criteria for Roux-en-Y included:

1. Recipients with intrinsic biliary diseases (e.g., Primary Sclerosing Cholangitis),

2. Cases where tension-free duct-to-duct anastomosis was not technically feasible,

3. Recipients with multiple graft bile ducts where ductoplasty was not suitable.

Table 1. Classification and treatment approaches of biliary complications after liver transplantation			
Stage	**Definition**	**Clinical situation**	**Treatment approach**
I	Radiological abnormalities	Mild dilation, asymptomatic	Monitoring ("watch and wait" policy)
II	Minimal biliary complications	Bile leakage	Conservative approach (medical treatment, antibiotic therapy)
IIIA	Complications requiring endoscopic/ radiological intervention	Minimally invasive intervention	ERCP + biliary stent, PTBD, balloon dilation
IIIB	Complications requiring surgical revision	Severe biliary strictures	Anastomosis revision, hepaticojejunostomy conversion
IV	Complications requiring re-transplantation	Irreversible graft dysfunction	Re-transplantation
V	Mortality secondary to biliary complications	Sepsis, MOF, cholangitis	
MOF: Multiple organ failure, PTBD: Percutaneous transhepatic biliary drainage, Re-Tx: Re-transplantation, ERCP: Endoscopic retrograde cholangiopancreatography.			

In grafts with multiple bile ducts, ductoplasty was attempted to merge the orifices into a single opening to facilitate duct-to-duct anastomosis, provided the ducts were adjacent. If the distance between the ducts precluded a safe ductoplasty, or if the recipient's bile duct was unsuitable for multiple anastomoses, Roux-en-Y was performed. Therefore, the choice of reconstruction was based on a hierarchical surgical algorithm rather than solely on the number of graft ducts.

Statistical Analysis

Statistical analyses were performed using SPSS version 27.0 (Statistical Package for the Social Sciences, IBM Corporation, Armonk, NY, USA). Continuous variables are presented as mean ± standard deviation, while categorical variables are expressed as frequency and percentage. Independent-samples t-tests and Mann-Whitney U tests were employed to compare continuous variables between groups. Chi-square and likelihood ratio tests were utilized to evaluate associations among categorical variables.

RESULTS

When the demographic characteristics of the 244 patients included in the study were compared according to the anastomosis technique, the mean age of the patients was determined to be 57.8±11.5 years (median: 61.32 years, range: 1.42-75.39 years), and the mean body mass index (BMI) value was 27.62±5.67 kg/m^2 (median: 27.02 kg/m^2, range: 16.44-48.27 kg/m^2). The mean age was 56.58±13.26 years in the Roux-en-Y group, while it was 58.83±9.73 years in the duct-to-duct anastomosis group, and no statistically significant difference was found between the groups (t=-1.485; p=0.139). Similarly, the groups showed a homogeneous distribution of BMI values (26.92±5.61 vs. 28.2±5.68 kg/m^2; t=-1.766; p=0.079). However, a notable difference was observed in the gender distribution, with 70.49% (n=172) of the study cohort male and 29.51% (n=72) female. The male ratio was 63.96% in the Roux-en-Y group, increasing to 75.94% in the duct-to-duct group; this difference was statistically significant (χ^2=4.172; p=0.041). When the blood group distribution was examined, blood group A was the most common (45.9%), followed by blood group 0 (29.1%), and there was no significant difference between the groups (X^2=1.012; p=0.798). When evaluated in terms of comorbidities, the prevalence of diabetes mellitus was found to be significantly higher in the Roux-en-Y group (46.85%; n=52) compared to the duct-to-duct group (34.59%; n=46), and this difference was very close to the threshold of statistical significance (X^2=3.784; p=0.052). These findings suggest that gender, and especially the presence of diabetes, may be potential factors influencing the choice of anastomosis technique, and that their effects on postoperative outcomes should be evaluated using multivariate analyses (Table 2).

When the comparative analysis of the clinical and biochemical characteristics of the patients was evaluated (Table 3), the mean MELD score was 19.8±6.32 (median: 20, range: 6-40), and there was no statistically significant difference between the groups (Roux-en-Y: 19.41±6.41 vs. duct-to-duct: 20.13±6.25; t=-0.880; p=0.380). Alpha-foetoprotein (AFP) levels also showed a homogeneous distribution in both groups (mean 48.03±113.08 ng/mL; Z=0.133; p=0.894). In terms of surgical parameters, there are striking and statistically significant differences: the total operation time was significantly longer in the Roux-en-Y group (550.12±119.53 minutes; median: 544 min) compared to the duct-to-duct group (470.38±99.49 minutes; median: 468 min) (t=5.687; p<0.001). The amount of erythrocyte suspension administered during surgery was also significantly higher in the Roux-en-Y group (average 5.33±4.79 units; median: 4) compared to the duct-to-duct group (3.22±3.62 units; median: 2) (Z=-4.513; p<0.001), indicating that Roux-en-Y anastomosis is a more invasive procedure and leads to greater blood loss. The length of stay in the intensive care unit was also significantly longer in the Roux-en-Y group (2.39±3.39 vs. 2.15±3.7 days; Z=-2.274; p=0.023).

Table 2. Recipient demographics						
		All patients (n=244)	**Duct-to-duct (n=133)**	**Roux-en-Y (n=111)**	**t**	**p**
Age (y)		57.8±11.5	58.83±9.73	56.58±13.26	-1.485*	0.139
BMI (kg/m^2)		27.62±5.67	28.2±5.68	26.92±5.61	-1.766*	0.079
		n (%)	n (%)	n (%)	X^2	p
Male sex (%)	Male	172 (70)	101 (75)	71 (63)	**4.172****	**0.041**
	Female	72 (29)	32 (24)	40 (36)		
Blood group	0	71 (29.1)	37 (27.82)	34 (30.63)	1.012**	0.798
	A	112 (45.9)	60 (45.11)	52 (46.85)		
	B	44 (18.03)	25 (18.8)	(17.12)		
	AB	17 (6.97)	11 (8.27)	6 (5.41)		
DM	No	146 (59.84)	87 (65.41)	59 (53.15)	3.784**	0.052
	Yes	98 (40.16)	46 (34.59)	52 (46.85)		

Data are presented as mean ± standard deviation or number (%), *: Independent samples t-test; n: number; %: Distribution percentage, **: Chi-square test, p: Significance (<0.05), BMI: Body mass index, Duct-to-duct: Duct-to-duct biliary anastomosis, Roux-en-Y: Roux-en-Y hepaticojejunostomy, BMI: Body mass index, DM: Diabetes mellitus.

Table 3. Comparison of clinical and biochemical characteristics by group						
		All patients	**Duct-to-duct**	**Roux-en-Y**	**t/Z**	**p**
		(n=244)	**(n=133)**	**(n=111)**		
MELD score		19.8±6.32	20.13±6.25	19.41±6.41	-0.880*	0.380
AFP		48.03±113.08	46.62±111.01	50.5±119	0.133*	0.894
Total surgery time(min)		506.66±115.87	470.38±99.49	550.12±119.53	**5.687***	**<0.001**
Transfusion E (U)		4.18±4.32	3.22±3.62	5.33±4.79	**-4.513****	**<0.001**
Transfusion FFP (U)		3.87±3.24	3.52±2.75	4.28±3.71	1.773*	0.078
Transfusion PLT (U)		1.33±2.96	1.16±2.34	1.53±3.55	0.955*	0.341
Hospital stay (d)		16.61±11.66	15.79±11.13	17.60±12.25	-1.521**	0.128
ICU stay (d)		2.26±3.56	2.15±3.7	2.39±3.39	**-2.274****	**0.023**
Graft weight (g)		946.78±267.19	979.77±272.55	907.24±256.28	**-2.127***	**0.034**
GRWR		1.26±0.37	1.25±0.36	1.28±0.37	0.761*	0.448
					X^2/LR	p
Cirrhosis etiology	Cryptogenic	42 (17.21)	21 (15.79)	21 (18.92)	**16.080*****	**0.003**
	HBV	87 (35.66)	59 (44.36)	28 (25.23)		
	HCV	15 (6.15)	11 (8.27)	4 (3.6)		
	Alcohol	19 (7.79)	10 (7.52)	9 (8.11)		
	Others	81 (33.2)	32 (24.06)	49 (44.14)		
Ascitis	No	111 (45.49)	60 (45.11)	51 (45.95)	0.839***	0.657
	Treatment-responsive	52 (21.31)	26 (19.55)	26 (23.42)		
	Treatment-resistant	81 (33.2)	47 (35.34)	34 (30.63)		
Encephalopathy	No	192 (78.69)	106 (79.7)	86 (77.48)	0.444****	0.822
	Treatment-responsive	45 (18.44)	24 (18.05)	21 (18.92)		
	Treatment-resistant	7 (2.87)	3 (2.26)	4 (3.6)		

Data are presented as mean ± standard deviation or number (%), *: Independent samples t-test, **: Mann-Whitney U test, n: Number, %: Percentage, ***: Chi-square test, ****: LR: Likelihood ratio, p: Significance (<0.05), Duct-to-duct: Duct-to-duct biliary anastomosis, Roux-en-Y: Roux-en-Y hepaticojejunostomy, MELD: Model for end-stage liver disease, AFP: Alpha-foetoprotein, E: Erythrocyte, FFP: Fresh frozen plasma, PLT: Platelet, ICU: Intensive care unit, GRWR: Graft-to-recipient weight ratio, HBV: Hepatitis B virus, HCV: Hepatitis C virus.

Interestingly, the graft weight used was significantly heavier in the duct-to-duct group (979.77±272.55 grams) compared to the Roux-en-Y group (907.24±256.28 grams) (t=-2.127; p=0.034). When the etiology of cirrhosis was evaluated, HBV was the most frequent cause (35.66%), followed by cryptogenic causes (17.21%), and a statistically significant difference was found in the etiology distribution between the groups (X^2=16.080; p=0.003); the prevalence of HBV was particularly high in the duct-to-duct group (44.36% vs. 25.23%). Regarding transplant type, 91.39% of patients received transplants from living donors and 8.61% from cadaveric donors, with a similar distribution between the groups (χ^2=2.653; p=0.103). These findings indicate that Roux-en-Y is a technically more challenging and invasive procedure, requiring longer operating times and more blood transfusions.

When the comparative analysis of the preoperative biochemical parameters of the patients according to the anastomosis technique was examined (Table 4), the mean serum total bilirubin level was 4.3±6.23 mg/dL (median: 2.18 mg/dL, range: 0.3-44.46 mg/dL), serum albumin 3.15±0.61 g/L (median: 3.05 g/L), serum creatinine 0.9±0.48 mg/dL (median: 0.77 mg/dL), AFP 48.03±113.08 ng/mL (median: 8.45 ng/mL), gamma-glutamyltransferase (GGT) 54.38±41.04 U/L (median: 43 U/L), international normalized ratio (INR) 1.59±0.55 (median: 1.5) and serum sodium 135.66±5.03 mEq/L (median: 136 mEq/L) was measured. Remarkably, there were no statistically significant differences between the Roux-en-Y and duct-to-duct groups in terms of all biochemical values (p-values: Bilirubin p=0.304, albumin p=0.555, creatinine p=0.597, AFP p=0.894, GGT p=0.420, INR p=0.681, sodium p=0.587, respectively). The fact that the maximum bilirubin value reached 44.46 mg/dL, INR 5.93, and creatinine 4 mg/dL indicates the presence of patients with severe hepatic insufficiency, coagulopathy, and hepatorenal syndrome in the cohort. This comprehensive biochemical homogeneity indicates that the choice of surgical technique was independent of the patient's preoperative liver function, coagulation status, renal function, and electrolyte balance. The fact that both groups have comparable baseline characteristics is methodologically important for minimizing confounding in the comparative analysis of postoperative outcomes and for allowing a clearer assessment of the true impact of anastomosis technique on outcomes.

Table 5 presents the distribution of patients' postoperative complications by anastomosis technique, stratified by time interval (<3 months vs. >3 months), according to the Clavien-Dindo classification. Analysis of patients' postoperative complications according to the Clavien-Dindo classification in the early (first 3 months) and late (after 3 months) periods revealed significant findings. In the early postoperative period, Grade 1 complications were observed in 110 patients, and there was no significant difference between the groups (Roux-en-Y: 40% vs. duct-to-duct: 60%; X^2=2.436; p=0.119). Grade 2 (27 patients), Grade 3A (35 patients), and Grade 4B (2 patients) complications were also detected at similar rates (p=0.179, p=0.977, p=0.898, respectively). Grade 3B complications occurred in 42 patients and were numerically higher in the Roux-en-Y group (54.76% vs. 45.24%), but this difference was not statistically significant (χ^2=1.758; p=0.185). A critical finding was early mortality (Grade 5), occurring in 28 patients, which was significantly higher in the Roux-en-Y group (64.29%, n=18 vs. 35.71%, n=10), and this difference was statistically significant (X^2=4.505; p=0.034). Regarding late postoperative complications, Grade 1 complications occurred in 149 patients, Grade 2 in 12, Grade 3A in 34, and Grade 3B in 11; no statistically significant differences were found between the groups. Late mortality, excluding early deaths, occurred in 10 patients and was equally distributed in both groups (n=5 in each group; X^2=0.206; p=0.650). However, in the total mortality analysis including early mortality, 38 patients were lost, and this was significantly higher in the Roux-en-Y group (60.53%, n=23 vs. 39.47%, n=15; X^2=4.103; p=0.043). These findings demonstrate that although both anastomosis techniques have similar minor and major complication rates, Roux-en-Y is associated with statistically significantly higher mortality, particularly in the early period and in terms of overall survival, compared to duct-to-duct anastomosis, and strongly support the preference for duct-to-duct anastomosis in anatomically suitable patients.

Table 4. Comparison of preoperative biochemical characteristics according to groups

	All patients (n=244)	Duct-to-Duct (n=133)	Roux-en-Y (n=111)	t/Z	p
Bilirubin (mg/dL)	4.3±6.23	3.88±5.73	4.81±6.77	-1.028**	0.304
Albumin (g/L)	3.15±0.61	3.17±0.62	3.13±0.61	-0.591*	0.555
Creatinine (mg/dL)	0.9±0.48	0.91±0.49	0.88±0.46	-0.529*	0.597
AFP	48.03±113.08	46.62±111.01	50.5±119	0.133*	0.894
Preop_GGT	54.38±41.04	58.05±40.17	51.02±41.97	-0.810*	0.420
INR	1.59±0.55	1.6±0.55	1.57±0.55	-0.411*	0.681
Na	135.66±5.03	135.5±4.85	135.86±5.24	0.544*	0.587

Data are presented as mean ± standard deviation or number (%), *: Independent samples t-test, **: Mann-Whitney U test, n: Number, p: Significance (<0.05), Duct-to-duct: Duct-to-duct biliary anastomosis, Roux-en-Y: Roux-en-Y hepaticojejunostomy, AFP: Alpha-foetoprotein, GGT: Gamma-glutamyltransferase, INR: International normalized ratio, Na: Sodium.

Table 5. Treatment and the number of complications according to Clavien-Dindo						
Grades (no. of patients)		Complication types	Duct-to-Duct	Roux-en-Y	X²/LR	p
			n (%)	n (%)		
Clavien-Dindo (<3 month)	I (n=110)	Mild dilation, asymptomatic	66	44	2.436*	0.119
	II (n=27)	Bile leakage	18	9	1.810*	0.179
	IIIA (n=35)	Minimally invasive intervention	19	16	0.001*	0.977
	IIIB (n=42)	Severe biliary strictures	19	23	1.758*	0.185
	IV (n=2)	Irreversible graft dysfunction	1	1	0.016**	0.898
	V (n=28)	Sepsis, MOF, cholangitis	10	18	**4.505***	**0.034**
Clavien-Dindo (>3 month)	I (n=149)	Mild dilation, asymptomatic	88	61	3.198*	0.074
	II (n=12)	Bile leakage	7	5	0.074*	0.456
	IIIA (n=34)	Minimally invasive intervention	15	19	1.720*	0.190
	IIIB (n=11)	Severe biliary strictures	8	3	1.542*	0.214
	V (n=38)	Sepsis, MOF, cholangitis	15	23	**4.103***	**0.043**

Data are presented as mean n: Number, %: Percentage, *: Chi-square test, **LR: Likelihood Ratio; p: Significance (<0.05), MOF: Multiple organ failure, Duct-to-duct: Duct-to-duct biliary anastomosis, Roux-en-Y: Roux-en-Y hepaticojejunostomy.

DISCUSSION

This retrospective cohort study presents a comprehensive analysis systematically evaluating the impact of bile duct anatomy and anastomosis technique selection on postoperative outcomes in 244 living and deceased donor liver transplant patients over a 12-year period. Although biliary anatomy differs between LDLT and DDLT, the surgical principles for anastomosis selection remain consistent in our center. Our findings reaffirm the critical importance of biliary reconstruction, considered the "Achilles' heel" of LDLT, for graft survival and patient outcomes. The complex interplay between bile duct number and anastomosis technique plays a decisive role in postoperative morbidity and mortality, highlighting the importance of preoperative surgical planning (1,3-5). Our finding that the presence of multiple bile ducts increases technical difficulty and significantly increases the risk of biliary complications supports and extends existing literature. The application of the current International Liver Transplant Society consensus classification in our study enabled standardized assessment of biliary complications and increased the comparability of our results with the international literature. These findings offer significant contributions to clinical practice in risk stratification, selection of anastomosis techniques, and postoperative complication management.

The demographic data obtained in our study reflect the general profile of LDLT patients and reveal the potential influence of certain factors on the choice of anastomosis technique. The mean age of 57.8±11.5 years and BMI of 27.62±5.67 kg/m^2 are consistent with other LDLT cohorts in the literature (9). Notably, the high proportion of male patients in our study population (70.49%) and, especially, the increase to 75.94% in the duct-to-duct anastomosis group (p=0.041) suggest that gender may play a role in the choice of anastomosis technique. Based on the literature, this situation may stem from the natural anatomy of the biliary tract in male patients being more suitable for duct-to-duct anastomosis, or from an unconscious preference in the surgical decision-making process (10). The significantly higher prevalence of diabetes mellitus in the Roux-en-Y group (46.85% vs. 34.59%; p=0.052) suggests that hepaticojejunostomy, considered safer, may have been preferred in patients with metabolic comorbidities due to the risk of biliary complications. This finding is consistent with the study by Antolovic et al. (11), which reported an increased risk of bile leakage in diabetic patients.

Although the number of graft bile ducts is a predisposing factor that dictates the surgical strategy, our findings suggest that the type of biliary reconstruction (duct-to-duct vs. Roux-en-Y) significantly influences postoperative outcomes. Therefore, the choice of anastomosis technique, tailored to the anatomical variation, is crucial for minimizing complications. The simpler anastomosis and the applicability of standard surgical techniques in the presence of a single bile duct result in lower complication rates. In contrast, in multi-duct anatomy, modifications such as separate reconstruction of each duct or duct merging are required, increasing technical difficulty and the risk of complications (4). As reported by Lee et al. (10), the presence of multiple bile ducts increases the risk of biliary complications by 2 times. The spectrum of biliary complications observed in our study, when evaluated according to the International Liver Transplantation Society consensus classification, shows that Stage II, III, and V complications are the most frequent categories. These findings highlight the critical importance of detailed preoperative imaging and surgical planning in patients with multi-duct anatomy.

The choice between duct-to-duct anastomosis and hepaticojejunostomy is among the most debated topics in LDLT (12,13). Our study demonstrated successful outcomes with both techniques across various clinical scenarios, underscoring the need for individualized selection based on patient-specific factors. Duct-to-duct anastomosis offers advantages such as preserving physiological bile flow, maintaining Oddi sphincter function, and shorter operation time, but it carries risks of bile leakage and anastomotic stricture (12,14). Hepaticojejunostomy, on the other hand, is preferred, particularly in cases of multiple ducts, small-diameter ducts, or recipient biliary tract pathologies, and is reported to have a lower risk of anastomotic stricture. However, the risk of ascending cholangitis due to enteral connection and a longer operation time are disadvantages (15). The higher prevalence of diabetes mellitus in the Roux-en-Y group in our study suggests that this technique, with a better safety profile, was preferred in high-risk patients.

The use of the 2023 Innsbruck BileducTx consensus classification has significantly standardized the assessment of biliary complications (8). This five-stage classification system offers a progressive approach based on the severity of complications and the level of intervention required, enabling rationalization of treatment decisions. In our study, most Stage I (radiological abnormalities) patients showed spontaneous resolution and could be managed with close monitoring alone. While Stage II complications were successfully controlled with conservative medical treatment, Stage III-A patients benefited from endoscopic or radiological interventions. Endoscopic retrograde cholangiopancreatography-assisted biliary tract stent placement and percutaneous transhepatic biliary drainage application demonstrated the effectiveness of minimally invasive approaches. The need for surgical revision in Stage III-B patients reflected technical failure or complex anatomical conditions. As reported in the literature, early diagnosis and appropriate intervention can minimize Stage IV (re-transplantation) and Stage V (mortality) rates (8,16). In our study, the parallel use of the modified Clavien-Dindo classification provided additional insight into the objective assessment of complication severity.

The most important strength of our study is its cohort size, encompassing 244 patients over a broad 12-year period, and reflecting data from an experienced center like Ankara Güven Hospital. The use of standardized data collection forms, cross-checking by two independent researchers, and application of the current international consensus classification enhance the methodological quality of the study. Furthermore, evaluating the combined effect of bile duct number and anastomosis technique is a significant contribution that fills a gap in the literature. However, limitations of the study include missing data in some variables due to the retrospective design, the inability to fully control selection bias, and heterogeneity in surgical technique preferences among surgeons. While the single-center experience may limit the generalizability of the results, the application of a standardized surgical protocol and follow-up algorithm strengthens internal validity. Prospective, multicenter studies evaluating long-term outcomes and graft survival are needed.

Our study findings highlight the need for detailed preoperative planning of biliary reconstruction in LDLT and the importance of individualizing the choice of anastomosis technique according to patient-specific factors. Considering the increased risk of complications in patients with multiple bile duct anatomy, evaluation by an experienced surgical team is recommended. In patients with metabolic comorbidities such as diabetes mellitus, a more cautious approach is needed regarding the risk of biliary complications, and it was concluded that the hepaticojejunostomy technique may be preferred in these patients, taking into account its safety profile. Close biliary monitoring in the early postoperative period, regular laboratory follow-up, and aggressive imaging strategies when necessary are critical for the early diagnosis and intervention of complications. In conclusion, the success of biliary reconstruction in LDLT can be optimized by integrating accurate assessment of anatomical factors, selection of an appropriate surgical technique, and close postoperative monitoring.

Study Limitations

Several inherent limitations warrant consideration when interpreting these findings. First, the retrospective design precludes establishment of definitive causal relationships between bile duct configuration, anastomotic technique selection, and postoperative outcomes. Selection bias may have influenced surgical decision-making, as anastomotic methods were determined by individual anatomical variations, surgeon expertise, and clinical circumstances rather than randomization. Furthermore, this single-center study was conducted at a high-volume liver transplantation institution, potentially limiting generalizability to centers with varying levels of surgical experience, diverse patient demographics, or differing resource constraints. Finally, evolution in surgical techniques, immunosuppressive regimens, and perioperative management protocols over the 12-year study period may have introduced temporal confounding that could influence outcome comparisons

Furthermore, despite comprehensive data collection efforts, certain variables that could potentially influence postoperative morbidity and mortality—such as donor-specific characteristics, detailed graft quality parameters, specific immunosuppression regimens, and long-term functional outcomes—were not fully captured in our analysis. The relatively short median follow-up period may not adequately reflect late biliary complications,

which can develop months or years after transplantation. Sample size limitations, particularly when stratifying by both bile duct number and anastomosis type, may have reduced statistical power to detect clinically meaningful differences in certain subgroup analyses. Additionally, the classification of biliary complications, while based on established international consensus criteria, involves some degree of subjective clinical judgment that could introduce measurement variability. These limitations underscore the need for prospective, multicenter randomized controlled trials with longer follow-up periods to validate our findings and establish evidence-based guidelines for biliary reconstruction strategy selection.

CONCLUSION

This retrospective study demonstrates that bile duct anatomy significantly influences surgical technique selection in LDLT and DDLT. Duct-to-duct anastomosis is predominantly preferred for single bile duct configurations, whereas hepaticojejunostomy becomes the preferred approach when multiple bile ducts are present. Our findings underscore that optimal biliary reconstruction strategy requires comprehensive assessment integrating three key factors: anatomical variations of the biliary tract, individual patient characteristics, and technical surgical considerations. This holistic approach is essential for minimizing biliary complications and enhancing long-term transplantation outcomes. Future prospective studies with larger cohorts are warranted to establish standardized protocols that can guide surgical decision-making and further improve patient prognosis in LDLT and DDLT.

Ethics

Ethics Committee Approval: This study was conducted in accordance with the Helsinki Declaration and received ethical approval from the Sivas Cumhuriyet University Faculty of Medicine Health Sciences Research Ethics Committee (approval number: 2025-06/44, dated: June 2025).

Informed Consent: Patient consent was waived due to the retrospective nature of this study.

Footnotes

Author Contributions

Surgical and Medical Practices - M.A., S.K.; Concept - M.A., S.K.; Design - M.A., S.K.; Data Collection or Processing - M.A., S.K.; Analysis or Interpretation - M.A., S.K.; Literature Search - M.A., S.K.; Writing - M.A., S.K.

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REFERENCES

1. *Gadour E. Lesson learnt from 60 years of liver transplantation: advancements, challenges, and future directions. World J Transplant. 2025;15:93253.*
2. *Yankol Y, Mecit N, Kanmaz T, Kalayoğlu M, Acarlı K. Complications and outcomes of 890 living liver donor hepatectomies at a single center: risks of saving loved one's life. Turk J Surg. 2020;36:192-201.*
3. *Liu H, Ashwat E, Humar A. Current status of living donor liver transplantation: impact, advantages, and challenges. Curr Gastroenterol Rep. 2023;25:225-231.*
4. *Hassouneh R, Beran A, Rosenheck M, Sosio J, Olchawa N, Kubal C, et al. Risk factors for biliary strictures and leaks after living-donor liver transplantation: a systematic review and meta-analysis. J Gastrointest Surg. 2024;28:1870-1882.*
5. *Elkomos BE, Abdelaal A. Do we need to use a stent in biliary reconstruction to decrease the incidence of biliary complications in liver transplantation? A systematic review and meta-analysis. J Gastrointest Surg. 2023;27:180-196.*
6. *Valenzuela-Fuenzalida JJ, Avalos-Díaz C, Droguett-Utreras A, Guerra-Loyola J, Nova-Baeza P, Orellana-Donoso M, et al. Clinical implications of aberrant anatomy of the common hepatic duct in liver surgery: a systematic review and meta-analysis. Surgical and Radiologic Anatomy. 2024;46:2023-2047.*
7. *Dirican A, Ara C, Kutluturk K, Ozsoy M, Ates M, Baskiran A, et al. Donor postoperative biliary complications after living-donor liver transplant. Exp Clin Transplant. 2015;13:516-523.*
8. *Esser H, de Jong IEM, Roos FM, Bogensperger C, Brunner SM, Cardini B, et al. Consensus classification of biliary complications after liver transplantation: guidelines from the BileducTx meeting. Br J Surg. 2025;112:znae321*
9. *Arikan T, Emek E, Bozkurt B, Mammadov E, Ceyhan O, Sahin T, et al. Does multiple bile duct anastomosis in living donor liver transplantation affect the postoperative biliary complications? Transplant Proc. 2019;51:2473-2477.*
10. *Lee DH, Kim D, Choi ST, Park YH. The impact of the multiple bile ducts on postoperative biliary complications in patients undergoing living donor liver transplantation. Transplant Proc. 2023;55:934-939:*
11. *Antolovic D, Koch M, Galindo L, Wolff S, Music E, Kienle P, et al. Hepaticojejunostomy--analysis of risk factors for postoperative bile leaks and surgical complications. J Gastrointest Surg. 2007;11:555-561.*
12. *Hou TY, Komorowski AL, Lin TS, Lin YC, Sng YP, Yeh CH, et al. The outcomes and biliary complications of a staged biliary reconstruction in living donor liver transplantation: a propensity score matched analysis. HPB (Oxford). 2024;26:928-937.*
13. *Liu CL, Lo CM, Fan ST. What is the best technique for right hemiliver living donor liver transplantation? With or without the middle hepatic vein? Duct-to-duct biliary anastomosis or Roux-en-Y hepaticojejunostomy? J Hepatol. 2005;43:17-22.*
14. *Sibulesky L, Heckman MG, Perry DK, Taner CB, Willingham DL, Nguyen JH. A single-center experience with biliary reconstruction in retransplantation: duct-to-duct or Roux-en-Y choledochojejunostomy. Liver Transpl. 2011;17:710-716.*
15. *Jung DH, Ikegami T, Balci D, Bhangui P. Biliary reconstruction and complications in living donor liver transplantation. Int J Surg. 2020;82S:138-144.*
16. *Neuberger J. Long-term care of the adult liver transplant recipient. J Clin Exp Hepatol. 2022;12:1547-1556.*

ORIGINAL ARTICLE
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Betamethasone to prevent hypocalcemia and other complications after total thyroidectomy: A retrospective case-control study

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ABSTRACT

Objective: Hypocalcemia (HC) is a common complication after thyroid surgery. This retrospective case-control study aimed to evaluate the efficacy of postoperative betamethasone infusion in reducing the incidence of HC following thyroid surgery, with recurrent laryngeal nerve palsy and other complications as secondary outcomes.

Material and Methods: A total of 196 patients who underwent total or completion thyroidectomy were retrospectively analyzed. Patients were divided into groups receiving postoperative betamethasone infusion or no glucocorticoid treatment. Postoperative data on HC incidence (at least one serum calcium measurement below 8.0 mg/dL), symptomatic HC (HC associate with numbness of the extremities, facial paresthesia, muscular spasms, and Chvostek's or Trousseau's signs), pain, recurrent laryngeal nerve palsy, voice dysfunction, sore-throat and dysphagia were collected and analyzed. Additionally, demographic and clinical characteristics were assessed, including preoperative assessments, intraoperative techniques, and postoperative recovery parameters.

Results: The study found a significantly lower incidence of HC and symptomatic HC in the betamethasone group compared to the control (32.0% vs. 49.5%, p=0.013; 11.3% vs. 25.3%, p=0.012, respectively). Betamethasone-treated patients also reported lower postoperative pain scores (p=0.002).

Conclusion: Betamethasone infusion post-thyroidectomy demonstrated efficacy in reducing HC and symptomatic hypoparathyroidism, with minimal impact on other complications. The findings suggest the potential of glucocorticoids as a therapeutic option in thyroid surgery to enhance postoperative outcomes and patient recovery.

Keywords: Endocrine surgery, parathyroid, thyroid surgery

INTRODUCTION

Total thyroidectomy is an effective therapy for both benign and malignant diseases of the thyroid gland. Although thyroid surgery is considered a safe procedure, it can cause serious postoperative complications.

Hypocalcemia (HC) and recurrent laryngeal nerve (RLN) palsy are serious complications after thyroidectomy. Biochemical HC represents the most frequent complication with rates ranging from 15.7% to 76.7% in a recent systematic review (1). HC can often cause a prolonged postoperative recovery with increased hospital care cost, so that preventing this complication is very important (2). Even when the procedure is expertly performed, surgical trauma remains a recognized cause of HC because the parathyroid glands may be unintentionally traumatized or devascularized. This damage triggers an inflammatory reaction that compromises parathyroid physiology (3).

Glucocorticoids are anti-inflammatory drugs that may improve surgical outcomes and reduce complications by modifying perioperative inflammatory responses (4). However, the literature reports limited and conflicting information regarding the optimal timing of their use in thyroid surgery. Some studies suggest that a single preoperative dose of dexamethasone may reduce the occurrence of postoperative HC, although results are often conflicting in different studies (5-7). One recent meta-

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analysis found no effect on the incidence of permanent HC, although transient biochemical HC reduction with or without related symptoms was observed in the early recovery (8). Similarly, another meta-analysis found no significant impact of intraoperative glucocorticoid administration on reducing RLN palsy, while evidence of effect on subjective voice impairment was insufficient (9).

Our research group previously published a study demonstrating that postoperative infusion of betamethasone at the end of thyroidectomy reduces the risk of postoperative HC (10). The present study further explores this issue by analysing the same database but with a significantly larger group of patients. It also assesses RLN palsy and other common complications as secondary outcomes.

MATERIAL and METHODS

This was a retrospective case-control study that used data from a prospective database. It included adult patients who underwent total or completion thyroidectomy consecutively between January 2018 and December 2023. The surgeries were performed in the Surgical Department of the University La Sapienza of Rome, Polo Pontino at the "A. Fiorini" Hospital in Terracina. The study was approved by the local bioethics committees, and preoperative informed consent was obtained from all patients upon hospital admission. Ethics committee approval for the study was obtained from the Lazio 2 Ethics Committee of ASL Roma 2 on February 9, 2022, under protocol no: 0031401/2022. This research was conducted without specific funding from any public, private, or non-profit organizations. It enrolled patients regardless of whether they had a malignant or benign condition requiring surgery. A diagnosis of thyroid cancer was confirmed if the final pathology report showed cancer of any size.

From January 2018 to June 2019, patients received 4 mg of intravenous betamethasone (Bentelan, Alfasigma SpA) 2 hours after surgery and 1.5 mg of intravenous betamethasone on postoperative days 1, 2, and 3 (beta group); from July 2019 to June 2020, no glucocorticoids were injected (no-beta group). From July 2020 to December 2023, betamethasone was administered using an alternating method, i.e., injection in one patient and no infusion in the subsequent patient.

We collected the following prospective data: Gender, age, body mass index (BMI), presence of co-morbidities, indication to surgery, American Society of Anesthesiology (ASA) score, type of operation, operating time, recovery after surgery, pathologic examination, presence of any parathyroid gland in the specimen; moreover, the number of parathyroid glands remaining *in situ* (PGRIS) score was calculated using the formula: 4 minus parathyroid glands found in the specimen. All subjects underwent flexible laryngoscopic examinations of the vocal cords preoperatively.

All surgeries were carried out under general anesthesia with orotracheal intubation and were completed by an experienced surgeon with more than 50 certified thyroidectomies. A standard open procedure was used to perform a total thyroidectomy. Surgeons identified and exposed the RLN and its branches, meticulously following its course to its point of entry into the larynx. They also located the parathyroid glands when feasible; no autotransplantation of damaged glands were performed. Additionally, two suction drains were inserted in each patient.

Plasma levels of parathyroid hormone (PTH) (reference range: 15-65 pg/mL), total calcium (reference range: 8.4-10.4 mg/dL), serum albumin, and C-reactive protein (CRP) (reference range: 0-0.5 mg/dL) were measured preoperatively and on the first, second, and third postoperative days.

The primary outcome was HC, defined as at least one serum calcium measurement below 8.0 mg/dL.

Secondary outcomes were as follows:

1. Symptomatic HC (SHC), defined as the presence of the following signs and symptoms, along with HC: numbness of the extremities, facial paresthesia, muscular spasms, and Chvostek's or Trousseau's signs.

2. Biochemical hypoparathyroidism (hPT) defined as a low intact PTH level, below the lower limit of the reference range, accompanied by HC.

3. Biochemical hPT with symptoms, defined as biochemical hPT amidst symptoms and/or signs of HC.

4. Differences in serum calcium levels.

5. Differences in serum PTH.

6. Differences in serum CRP.

7. Differences in pain 24 hours after surgery, assessed with a numeric rating scale (NRS), ranging from 0 (no pain) to 10 (worst imaginable pain).

8. Differences in common postoperative complications, such as voice dysfunction, sore-throat and dysphagia.

9. Difference in postoperative hospital stay (days).

Patients who developed HC were given oral calcium supplements along with a vitamin D analogue. For those with severe HC symptoms or when oral treatment was ineffective, 10% calcium gluconate was administered intravenously. All patients received an intravenous infusion of 1g of paracetamol three times a day after surgery.

Patients were discharged from the hospital once their serum calcium level was above 8.0 mg/dL. A 30-day follow-up was conducted for all patients to monitor for any morbidity.

Statistical Analysis

MedCalc® Release 14.8.1 was used for the statistical analysis of the data. The characteristics of the patients were reported as mean and 95% confidence interval (CI) for continuous parametric variables, as median and interquartile range (IQR) for continuous non-parametric variables, and as number (percentage) of patients for categorical variables. Student's t-test test was used to compare continuous parametric variables and Mann-Whitney U test was used to compare continuous non-parametric variables; for categorical variables, the two-sided chi-square and Fisher's exact test were used as appropriate. The association between HC and dichotomic variables was analysed by means of both univariate and multivariate analysis. An odds ratio (OR) greater than one, reported with 95% CI and p-values indicates a higher chance of the event occurring in one study group compared with the other. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 196 patients were analysed, divided into a betamethasone group (97 pts) and a control group (99 pts).

The two groups were similar with respect to their demographic and clinical characteristics, although the no-beta group had a higher prevalence of PIGRIS scores 1 and 2, which was not statistically significant. None of the patients were on calcium or vitamin D supplementation before surgery (Table 1).

HC

HC occurred in 80 pts (40.8%), and symptoms were reported in 36 pts (18.4%). The occurrence of HC was significantly lower in the beta group compared with the no-beta group [31 pts (32.0%) vs. 49 pts (49.5%); p=0.013]. The difference was confirmed when SHC was considered: 11 pts (11.3%) in the beta group and 25 pts (25.3%) in the no-beta group (p=0.012). HC required intravenous administration of 10% calcium gluconate in 62 (31.6%) patients: 20 (20.6%) in the beta group and in 42 (42.4%) in the no-beta group (p=0.001). At discharge, the persistence of HC was similar between the two study groups [19 pts (19.6%) vs. 27 pts (27.3%); p=0.205]. Median (IQR) postoperative hospital stay was 3 (3-5) overall and 3 (3-5) in both the beta and no-beta groups (p=0.568).

Biochemical hPT was present in 51 pts (26.0%) of the entire series and occurred together with symptoms in 30 cases (15.3%). The two study groups were similar with respect to biochemical hPT alone [21 pts (21.6%) vs. 30 pts (30.3%); p=0.168]. In contrast, a significant difference was found when considering the percentage of patients with biochemical hPT associated with symptoms and/or signs of HC in the beta group vs. the no-beta group [9 pts (9.3%) vs. 21 pts (21.2%), respectively; p=0.021].

Serum calcium, PTH, and CRP levels during recovery in the two study groups are reported in Figures 1-3, respectively. In the beta group, serum calcium levels were significantly higher on the first postoperative day [8.5 (8.4-8.6) mg/dL vs. 8.2 (8.1-8.3) mg/dL in the no-beta group; p<0.000] and on postoperative day 2 [8.5 (8.4-8.7) mg/dL vs. 8.2 (8.1-8.3) mg/dL in the no-beta group; p<0.000]. Serum PTH was similar in the two groups. In the beta group, serum CRP levels were significantly lower on postoperative day 2 [0.7 (0.5-1.0) mg/dL vs. 2.0 (1.5-2.6) mg/dL in the no-beta group; p=0.002] and postoperative day 3 [0.5 (0.3-0.6) mg/dL vs. 2.3 (1.3-3.2) mg/dL in the no-beta group; p=0.039]. One day after surgery, serum albumin levels were 3.9 (3.8-4.0) g/dL; they were 3.9 (3.8-4.0) g/dL in the beta group and 3.8 (3.7-4.0) g/dL in the no-beta group (p=0.067).

Predictors of HC Symptoms

Both univariate and multivariate analyses assessing predictors of SHC are reported in Table 2. In univariate analysis, betamethasone treatment significantly decreased the risk of SHC occurrence [OR=0.38 (0.17 to 0.82); p=0.014], while a PIGRIS score <3 was associated with an increased risk of SHC occurrence [OR=3.17 (1.51 to 6.67); p=0.002]. In multivariate analysis, the only factor that significantly decreased the risk of developing SHC was betamethasone treatment [OR=0.23 (0.07 to 0.78); p=0.019], whereas a PIGRIS score <3 was significantly associated with SHC occurrence [OR=5.01 (1.42 to 17.65); p=0.012].

The same evaluation was performed to assess the predictors of hPT (Table 3). A PIGRIS score <3 was the only independent factor significantly associated with a higher incidence of hPT [OR=2.53 (1.23 to 5.18); p=0.011].

Other Common Complications

Other common complications occurring within the 30-day postoperative follow-up period are reported in Table 4. The NRS score for pain was 2 (2-3), with a significant decrease in the beta group [2 (1-3) in the beta group vs. 3 (2-4) in the no-beta group; p=0.002]. After surgery, dysphonia was present in 85 pts (43.4%) and persisted in 65 pts (33.2%) during follow-up; RLN palsy was documented in 9 pts (4.6%) by laryngoscopy; sore throat was present in 49 pts (25.0%); and dysphagia occurred in 12 pts (6.1%). No statistically significant difference was observed between the two study groups. No surgical site infections occurred during follow-up.

Table 1. Demographic and clinical characteristics of the study group				
Characteristics	**Total (n=196)**	**Beta group (n=97)**	**No beta group (n=99)**	**p**
Gender, female	42 (21.4)	27 (27.8)	15 (15.2)	**0.031**
Age, years	56.6 (54.77 to 58.52)	58.8 (56.13 to 61.57)	54.5 (51.91 to 57.19)	**0.021**
Age >50 years	130 (66.3)	68 (70.1)	62 (62.6)	0.269
BMI, kg/m^2	27.4 (26.61 to 28.12)	27.2 (26.21 to 28.29)	27.5 (26.36 to 28.59)	0.768
BMI >30	49 (25.0)	25 (25.8)	24 (24.2)	0.805
Co-morbidities	151 (80.4)	78 (77.5)	73 (73.7)	0.268
Preoperative diagnosis				
Multinodular goitre	161 (82.1)	76 (78.4)	85 (85.9)	
Toxic multinodular goitre	17 (8.7)	7 (7.2)	10 (10.1)	0.445
Grave's disease	4 (2.0)	1 (1.0)	3 (3.0)	
Other*	14 (7.1)	9 (9.3)	5 (5.0)	
Hyperthyroidism	25 (12.7)	11 (11.3)	14 (14.1)	0.557
PTH, pg/mL	79.1 (75.01 to 83.24)	76.6 (70.45 to 82.72)	81.4 (75.84 to 87.03)	0.246
Serum calcium, mg/dL	9.3 (9.24 to 9.45)	9.4 (9.22 to 9.58)	9.3 (9.18 to 9.41)	0.351
C-reactive protein, mg/dL	0.3 (0.20 to 0.37)	0.3 (0.20-0.41)	0.3 (0.24-0.39)	0.847
ASA				**0.030**
I	32 (16.3)	12 (12.4)	20 (20.2)	
II	142 (72.4)	70 (72.2)	72 (72.7)	
III	22 (11.2)	15 (15.5)	7 (7.1)	
Operation				
Total thyroidectomy	188 (95.9)	93 (95.9)	95 (95.9)	0.998
Completion thyroidectomy	8 (4.1)	4 (4.1)	4 (4.1)	
Duration of surgery, min.	75.0 (72.78 to 77.24)	76.9 (73.85 to 79.98)	73.1 (69.9 to 76.38)	0.0946
Postoperative recovery, days	3 (3-3)	3 (3-3)	3 (3-3)	0.568
Final pathology				
Benign	193 (98.7)	95 (97.9)	98 (100)	0.196
Malignant	3 (1.3)	2 (2.1)	1 (1.0)	
Thyroid tissue weight, gr	49 (35-89)	47 (35-91)	51 (36-87)	0.749
PIGRIS score				
1	2 (1.0)	-	2 (2.0)	0.458
2	16 (8.2)	6 (6.2)	10 (10.1)	
3	52 (26.5)	27 (27.8)	30 (30.3)	
4	126 (64.3)	64 (66.0)	57 (57.6)	

Data are presented as number (percentage) or mean (95% confidence interval). Beta: Betamethasone, *: Indeterminate or suspicious nodule 11 pts, PIGRIS: Parathyroid glands remaining *in situ*, BMI: Body mass index, ASA: American Society of Anesthesiologists, PTH: Parathyroid hormone.

DISCUSSION

The use of glucocorticoids during the perioperative period is common due to their various benefits, including reduction of postoperative nausea and vomiting, analgesic effects and a significant improvement of the quality of recovery (11). However, concerns regarding their side effects, such as potential immunosuppression that could lead to complications, including infections and impaired wound healing, limit their use. Two recent meta-analyses reported the safety of glucocorticoids in patients submitted to surgery, though they also highlighted biases that warrant caution (12,13). While most studies describe the administration of a single preoperative dose of the glucocorticoid dexamethasone, we chose to prescribe betamethasone postoperatively. Our decision stems from studies indicating that glucocorticoids taper the

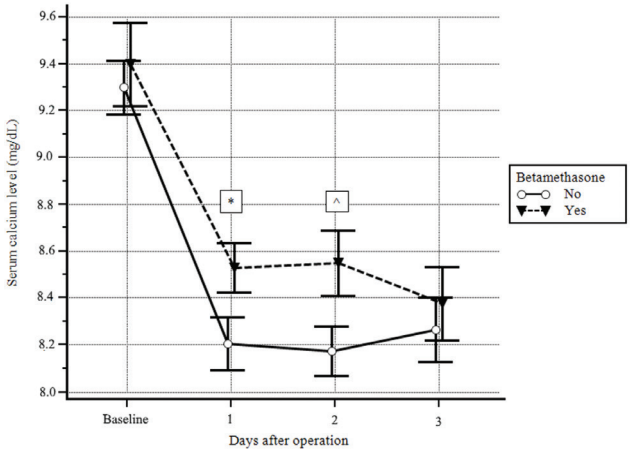

Figure 1. Differences in serum calcium levels between patients who received or did not receive betamethasone. In the betamethasone group, serum calcium levels were significantly higher on post-operative day 1 (*p<0.000) and on day 2 (^p<0.001).

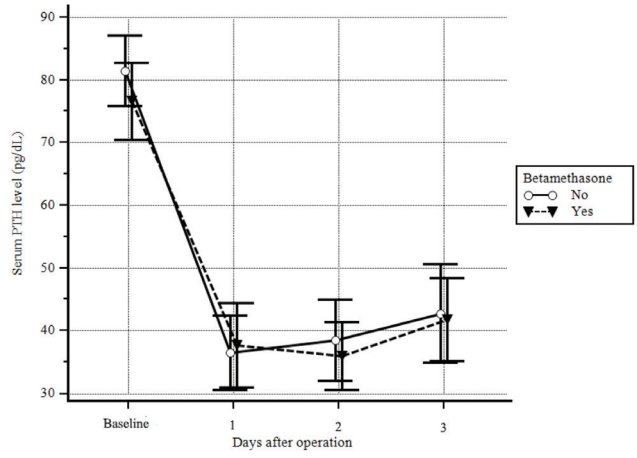

Figure 2. Differences in serum parathyroid hormone (PTH) levels between patients who received or did not receive betamethasone. No significant difference was observed between the two study groups.

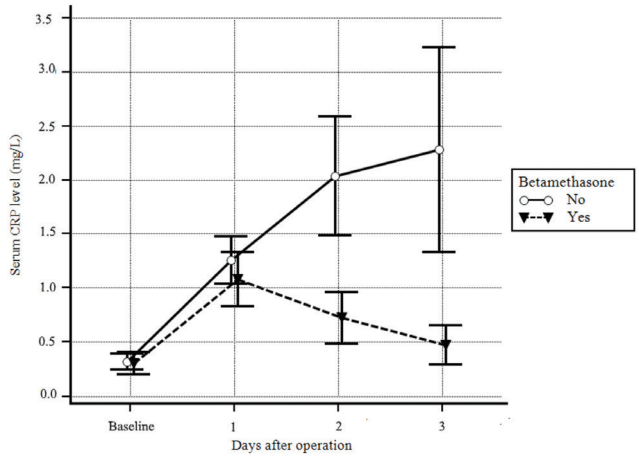

Figure 3. Differences in serum C-reactive protein (CRP) levels were assessed between patients who received betamethasone and those who did not. In the betamethasone group, CRP levels were significantly lower on post-operative day 2 (*≤0.002) and on day 3 (^p<0.039).

immune response, when inflammation is absent, but stimulate immunological response when inflammation occurs (4). The anti-inflammatory effect of glucocorticoids in the postoperative phase is confirmed by our results, which show a significant decrease in CRP levels in the beta group after thyroidectomy. The intraoperative administration of glucocorticoids does not impact the incidence of surgical site infection, as reported in two large randomized trials (14,15). Thyroid surgery is considered a clean procedure with a very low rate of surgical site infection, and the lack of surgical site infections in our study support the safety of glucocorticoids, in spite of their anti-inflammatory properties.

After thyroidectomy HC may stem from various events, including the accidental removal or trauma of the parathyroid glands, which can lead to devascularization and damage (1); another potential cause includes postoperative alkalosis-induced HC from hyperventilation due to pain, and dilution HC (16).

Surgical trauma is a major cause of HC after thyroidectomy; therefore, reducing trauma-related inflammation is a potentially effective way to manage it. However, there is a lack of studies confirming this relationship. There are only three randomized studies that compare patients treated with preoperative dexamethasone injection vs. placebo before thyroidectomy (5-7). The trial of Kolahdouzan et al. (5), showed a lower rate of postoperative symptomatic HC in patients treated with dexamethasone before total thyroidectomy, although there was no statistical significance. In the study of Dhahri et al. (6), a single preoperative dose of dexamethasone significantly reduced postoperative HC and symptomatic HC. In the trial of Latif et al. (7), dexamethasone prophylaxis before sub-total thyroidectomy was effective in reducing postoperative HC. A Chinese retrospective study on patients, who underwent thyroid surgery for papillary carcinoma, showed that the incidence of hPT after surgery was lower in subjects submitted not only to intraoperative but also to postoperative administration of glucocorticoids (17). The present study demonstrated that both biochemical HC and SHC levels were significantly reduced when betamethasone was administered postoperatively. Biochemical hPT was similar in the two study groups, with a significant decrease in the beta group when it was associated with symptoms and/or signs of HC, suggesting that parathyroid gland function was potentially unaffected and that the finding may reflect the subjective nature of symptoms. Although postoperative hospital stay was similar in the two study groups, there was a a significantly increased need to administer an intravenous infusion of calcium to correct HC

Table 2. Predictors of SHC						
Characteristics	**SHC** (n=36)	**No SHC** (n=160)	**Univariate OR** (95% CI)	**p**	**Multivariate OR** (95% CI)	**p**
Gender, male	8 (22.2)	28 (77.8)	1.06 (0.44 to 2.53)	0.898	0.979 (0.23 to 3.98)	0.967
BMI >30	6 (16.7)	43 (26.9)	0.54 (0.21 to 1.39)	0.206	0.72 (0.15 to 3.34)	0.676
Age >50 years	21 (58.3)	109 (68.1)	0.65 (0.31 to 1.37)	0.263	2.07 (0.30 to 14.12)	0.458
Co-morbidities	25 (77.8)	126 (80.7)	0.61 (0.27 to 1.37)	0.233	0.36 (0.06 to 2.06)	0.254
Preoperative diagnosis						
Multinodular goitre	28 (77.8)	133 (83.1)	Reference		Reference	
Other	8 (22.2)	27 (16.9)	1.40 (0.58 to 3.42)	0.451	1.32 (0.26 to 6.78)	0.741
ASA						
I-II	19 (11.9)	141 (88.1)	Reference		Reference	
III	3 (8.3)	33 (91.7)	0.67 (0.19 to 2.41)	0.545	0.97 (0.26 to 3.62)	0.961
Betamethasone	11 (30.6)	86 (53.7)	0.38 (0.17 to 0.82)	**0.014**	0.23 (0.07 to 0.78)	**0.019**
Final pathology						
Benign	34 (94.4)	150 (93.7)	Reference		Reference	
Malignant	2 (5.6)	10 (6.2)	0.88 (0.18 to 4.21)	0.875	1.66 (0.24 to 11.45)	0.605
PIGRIS						
≥3	15 (41.7)	111 (69.4)	Reference		Reference	
<3	21 (58.3)	49 (30.6)	3.17 (1.51 to 6.67)	**0.002**	5.01 (1.42 to 17.65)	**0.012**

Data are presented as number (percentage), unless otherwise specified. SHC: Symptomatic hypocalcemia, OR: Odds ratios, PIGRIS: Parathyroid glands remaining *in situ*, BMI: Body mass index, ASA: American Society of Anesthesiologists.

Table 3. Predictors of hPT						
Characteristics	**hPT** (n=51)	**No hPT** (n=145)	**Univariate OR** (95% CI)	**p**	**Multivariate OR** (95% CI)	**p**
Gender, male	9 (17.6)	33 (22.8)	0.72 (0.32 to 1.65)	0.445	0.86 (0.36 to 2.06)	0.742
BMI >30	8 (15.7)	41 (28.3)	0.47 (0.20 to 1.09)	0.079	0.48 (0.19 to 1.16)	0.102
Age >50 years	28 (54.9)	102 (70.3)	0.51 (0.27 to 0.99)	**0.047**	0.73 (0.32 to 1.62)	0.440
Co-morbidities	33 (64.7)	118 (81.4)	0.42 (0.21 to 0.85)	**0.017**	0.45 (0.19 to 1.09)	0.078
Preoperative diagnosis						
Multinodular goitre	42 (82.3)	119 (82.1)	Reference		Reference	
Other	9 (17.7)	26 (17.9)	0.98 (0.42 to 2.26)	0.964	0.85 (0.35 to 2.08)	0.720
ASA						
I-II	48 (94.1)	126 (86.9)	Reference		Reference	
III	3 (5.9)	19 (13.1)	0.41 (0.12 to 1.46)	0.171	0.55 (0.14 to 2.09)	0.380
Betamethasone	21 (41.2)	76 (52.4)	0.64 (0.33 to 1.21)	0.169	0.84 (0.42 to 1.68)	0.617
Final pathology						
Benign	50 (98.0)	137 (94.5)	Reference		Reference	
Malignant	1 (2.0)	8 (5.5)	0.34 (0.04 to 2.81)	0.318	0.38 (0.04 to 3.28)	0.377
PIGRIS						
≥3	26 (51.0)	100 (69.0)	Reference		Reference	
<3	25 (49.0)	45 (31.0)	2.14 (1.11 to 4.10)	**0.023**	2.53 (1.23 to 5.18)	**0.011**

Data are presented as number (percentage), unless otherwise specified. OR: Odds ratios, PIGRIS: Parathyroid glands remaining *in situ*, hPT: Hypoparathyroidism, CI: Confidence interval, ASA: American Society of Anesthesiologists, BMI: Body mass index.

Table 4. Complications in the study groups				
Variable	**Total** (n=196)	**Beta group** (n=97)	**No beta group** (n=99)	**p**
Dysphonia				
At hospital discharge	85 (43.4)	44 (45.3)	41 (41.4)	0.788
At 30-day follow-up	65 (33.2)	30 (30.1)	35 (35.3)	0.439
RLN palsy	9 (4.6)	3 (3.1)	6 (6.1)	0.318
Sore throat	49 (25.0)	25 (25.8)	24 (24.2)	0.619
Dysphagia	12 (6.1)	7 (7.2)	5 (5.1)	0.541
Pain, NSR score	2 (2 to 3)	2 (1 to 3)	3 (2 to 4)	**0.002**

Data are presented as number (percentage) or mean (95% confidence interval). Beta: Betamethasone, RLN: Recurrent laryngeal nerve, NRS: Numeric rating scale.

during recovery in the no-beta group. Moreover, treatment with betamethasone was significantly associated with a reduction in SHC after surgery in both univariate and multivariate analyses.

Our study confirms that PIGRIS score is a factor significantly related to postoperative SHC and hPT, as it is well documented in the literature (18). Due to the quite large number of patients, the higher but not significant prevalence of PIGRIS score 1 and 2 in the no-beta group does not affect the validity of the results.

It is common for patients to experience voice dysfunction after thyroidectomy. While RLN palsy is a known cause of dysphonia, a complete transection of the RLN is rare. Instead, the primary cause of functional impairment of the RLN is typically the trauma consequent to the manipulation of the nerve during the operation (19). Another possible cause, not related to surgery, is the trauma caused by the tracheal intubation (20). Based on these observations, glucocorticoids were proposed during the perioperative period to decrease inflammation caused by surgical trauma and thereby preserve RLN function. Six randomized studies have been published that examine the effect of preoperative injection of dexamethasone before surgery on voice outcomes (6,7,21-24). Temporary improvement of the voice after preoperative dexamethasone infusion was described in four trials (6,21,23,24). The studies by Latif et al. (7) and Feroci et al. (22) found no effect of dexamethasone on this complication. Similarly, the present study showed that glucocorticoids do not influence voice outcomes when administered postoperatively.

Glucocorticoids are also effective in minimizing sore throat after tracheal intubation (25). The occurrence of sore throat is particularly frequent in thyroid surgeries performed under general anesthesia (26). A randomized trial indicated that dexamethasone, administered preoperatively could reduce this complication (27). However, our results do not confirm the effectiveness of glucocorticoids infused postoperatively in preventing this common side effect after thyroidectomy.

Dysphagia is also a frequent occurrence (28,29). When there is no RLN transection, swallowing difficulties seem to be primarily linked to surgical trauma (30). One retrospective study showed that perioperative dexamethasone could influence dysphagia in the early postoperative phase (31). Our study found a tendency toward reduced swallowing complaints in the beta group, although this difference was not statistically significant when compared with the no-beta group.

Perioperative glucocorticoids have been extensively used to alleviate postoperative pain across various surgical procedures, offering considerable benefits (32). In the context of thyroid surgery, some trials showed that glucocorticoids significantly reduce pain after the operation, even when pain was not the primary outcome of the study (22,23,33). One trial, that specifically had postoperative pain as its primary outcome, found that two different preoperative doses of dexamethasone were not effective to reduce pain or to spare opioids with respect to placebo (34). Our results support the efficacy of glucocorticoids in reducing postoperative pain following thyroidectomy.

Study Limitations

The main limitation of this study is the retrospective analysis of the data. Moreover, the administration or non-administration of betamethasone was performed without any previously defined protocol. However, because a single experienced surgeon performed all operations, two potential biases were avoided: Variation in expertise (the surgeon was already experienced at the beginning of the study) and variation in surgical technique (he did not change it during the study period). Furthermore, all postoperative symptoms were reported subjectively by patients, without objective measurements. Serum calcium levels after surgery may be affected by several factors such fluid administration, alkalosis, and serum albumin levels: Another limitation of our study is that we only assessed albumin levels after surgery. Although we suggested that betamethasone after thyroid surgery may preserve parathyroid function due to its anti-inflammatory effect, the conflicting results of our study, showing that biochemical hPT was unaffected, with only a reduction in hPT with symptoms, do not clearly support this mechanism.

CONCLUSION

The present study supports the use of betamethasone at the end of thyroidectomy to decrease the incidence of both biochemical HC and SHC. Postoperatively, pain is significantly reduced, while voice dysfunction, sore-throat and dysphagia are unaffected after betamethasone infusion. Further prospective, randomized trials are needed to assess the effectiveness of glucocorticoids in reducing complications after total thyroidectomy.

Ethics

Ethics Committee Approval: Ethics committee approval for the study was obtained from the Lazio 2 Ethics Committee of ASL Roma 2 on February 9, 2022, under protocol no: 0031401/2022.

Informed Consent: The study was approved by the local bioethics committees, and preoperative informed consent was obtained from all patients upon hospital admission.

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Footnotes

Author Contributions

Surgical and Medical Practices - R.M., A.D.C., E.S.; Concept - M.P., A.D.C., E.S.; Design - M.P., E.S.; Data Collection or Processing - M.P., R.M., A.R.D.F.; Analysis or Interpretation - M.P., R.M., A.S.D.U.; Literature Search - M.P., A.R.D.F., M.S.; Writing - M.P., A.S.D.U.

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REFERENCES

1. *Hong PK, Pathak A, Shirali AS. Predictors of postoperative complications following thyroidectomy: a systematic review. Surg Pract Sci. 2024;18:100252.*
2. *Casey C, Hopkins D. The role of preoperative vitamin D and calcium in preventing post-thyroidectomy hypocalcaemia: a systematic review. Eur Arch Otorhinolaryngol. 2023;280:1555-1563.*
3. *Maheshwari M, Khan IA. Risk factors for transient and permanent hypoparathyroidism following thyroidectomy: a comprehensive review. Cureus. 2024;16:e66551.*
4. *Bain CR, Myles PS, Corcoran T, Dieleman JM. Postoperative systemic inflammatory dysregulation and corticosteroids: a narrative review. Anaesthesia. 2023;78:356-370.*
5. *Kolahdouzan M, Iraj B, Eslamian M, Harandizadeh M, Meamar R. Preventive effect of dexamethasone therapy on the transient hypoparathyroidism through total thyroidectomy. Iran J Otorhinolaryngol. 2019;31:73-80.*
6. *Dhahri AA, Ahmad R, Rao A, Bhatti D, Ahmad SH, Ghufran S, et al. Use of prophylactic steroids to prevent hypocalcemia and voice dysfunction in patients undergoing thyroidectomy: a randomized clinical trial. JAMA Otolaryngol Head Neck Surg. 2021;147:866-870.*
7. *Latif AA, Mohamed T, Lotfy A, Ahmed A. Dexamethazone prophylaxis before near total thyroidectomy to reduce vocal dysfunction: a randomized clinical trial, The Egyptian Journal of Hospital Medicine. 2020;81:1789-1795.*
8. *Zheng XG, Wang MZ, Wang F, He D. The impact of glucocorticoid treatment on hypocalcemia following thyroid surgery: a systematic review and meta-analysis. Endocr Res. 2024;49:77-85.*
9. *Noel JE, Kligerman MP, Megwalu UC. Intraoperative corticosteroids for voice outcomes among patients undergoing thyroidectomy: a systematic review and meta-analysis. Otolaryngol Head Neck Surg. 2018;159:811-816.*
10. *Picchio M, Di Filippo AR, Spaziani M, Orelli S, Bellagamba R, Guttoriello G, et al. Betamethasone to prevent symptomatic hypocalcaemia and other complications after total thyroidectomy: a case-control study. J Endocr Surg. 2021;21:61-69.*
11. *Bansal T, Singhal S, Taxak S, Bajwa SJS. Dexamethasone in anesthesia practice: a narrative review. J Anaesthesiol Clin Pharmacol. 2024;40:3-8.*
12. *Toner AJ, Ganeshanathan V, Chan MT, Ho KM, Corcoran TB. Safety of perioperative glucocorticoids in elective noncardiac surgery: a systematic review and meta-analysis. Anesthesiology. 2017;126:234-248.*
13. *Polderman JA, Farhang-Razi V, Van Dieren S, Kranke P, DeVries JH, Hollmann MW, et al. Adverse side effects of dexamethasone in surgical patients. Cochrane Database Syst Rev. 2018;8:CD011940. Update in: Cochrane Database Syst Rev. 2018;11:CD011940.*
14. *Corcoran TB, Myles PS, Forbes AB, Cheng AC, Bach LA, O'Loughlin E, et al.; PADDI Investigators; Australian and New Zealand College of Anaesthetists Clinical Trials Network; Australasian Society for Infectious Diseases Clinical Research Network. Dexamethasone and surgical-site infection. N Engl J Med. 2021;384:1731-1741.*
15. *Kurz A, Fleischmann E, Sessler DI, Buggy DJ, Apfel C, Akça O; Factorial Trial Investigators. Effects of supplemental oxygen and dexamethasone on surgical site infection: a factorial randomized trial‡. Br J Anaesth. 2015;115:434-443.*
16. *Ozemir IA, Buldanli MZ, Yener O, Leblebici M, Eren T, Baysal H, et al. Factors affecting postoperative hypocalcemia after thyroid surgery: importance of incidental parathyroidectomy. North Clin Istanb. 2016;3:9-14.*
17. *Li JH, Chen XH. [Effect of perioperative application of glucocorticoid on postoperative hypoparathyroidism and hypocalcemia in patients with total thyroidectomy plus central compartment dissection]. Zhonghua Er Bi Yan Hou Tou Jing Wai Ke Za Zhi. 2020;55:249-253. Chinese.*
18. *Sitges-Serra A. The PGRIS and parathyroid splinting concepts for the analysis and prognosis of protracted hypoparathyroidism. Gland Surg. 2017;6(Suppl 1):S86-S93.*
19. *Gambardella C, Polistena A, Sanguinetti A, Patrone R, Napolitano S, Esposito D, et al. Unintentional recurrent laryngeal nerve injuries following thyroidectomy: is it the surgeon who pays the bill? Int J Surg. 2017;41(Suppl 1):S55-S59.*
20. *Anwar M, Hussain KA, Anwar P. Vocal cord paralysis after tracheal intubation: an overview of the etiology and associated risk factors. Int Arch Otorhinolaryngol. 2025;29:1-7.*
21. *Worni M, Schudel HH, Seifert E, Inglin R, Hagemann M, Vorburger SA, et al. Randomized controlled trial on single dose steroid before thyroidectomy for benign disease to improve postoperative nausea, pain, and vocal function. Ann Surg. 2008;248:1060-1066.*
22. *Feroci F, Rettori M, Borrelli A, Lenzi E, Ottaviano A, Scatizzi M. Dexamethasone prophylaxis before thyroidectomy to reduce postoperative nausea, pain, and vocal dysfunction: a randomized clinical controlled trial. Head Neck. 2011;33:840-846.*
23. *Nasiri S, Shafag S, Khorgami Z, Sodagari N, Aminian A, Hedayat A. Does corticosteroid have any beneficial effect on voice change after thyroidectomy? Am Surg. 2013;79:1258-1262.*
24. *Wang LF, Lee KW, Kuo WR, Wu CW, Lu SP, Chiang FY. The efficacy of intraoperative corticosteroids in recurrent laryngeal nerve palsy after thyroid surgery. World J Surg. 2006;30:299-303.*
25. *Jiang Y, Chen R, Xu S, Li J, Yu F, Kong L, et al. The impact of prophylactic dexamethasone on postoperative sore throat: an updated systematic review and meta-analysis. J Pain Res. 2018;11:2463-2475.*

26. *Gong Y, Xu X, Wang J, Che L, Wang W, Yi J. Laryngeal mask airway reduces incidence of post-operative sore throat after thyroid surgery compared with endotracheal tube: a single-blinded randomized controlled trial. BMC Anesthesiol. 2020;20:16.*
27. *Yang C, Jung SM, Bae YK, Park SJ. The effect of ketorolac and dexamethasone on the incidence of sore throat in women after thyroidectomy: a prospective double-blinded randomized trial. Korean J Anesthesiol. 2017;70:64-71.*
28. *Krekeler BN, Wendt E, Macdonald C, Orne J, Francis DO, Sippel R, et al. Patient-reported dysphagia after thyroidectomy: a qualitative study. JAMA Otolaryngol Head Neck Surg. 2018;144:342-348.*
29. *Vardaxi C, Tsetsos N, Koliastasi A, Poutoglidis A, Sapalidis K, Triaridis S, et al. Swallowing disorders after thyroidectomy: a systematic review and meta-analysis. Eur Arch Otorhinolaryngol. 2022;279:4213-4227.*
30. *Park YM, Oh KH, Cho JG, Baek SK, Kwon SY, Jung KY, et al. Changes in voice- and swallowing-related symptoms after thyroidectomy: one-year follow-up study. Ann Otol Rhinol Laryngol. 2018;127:171-177.*
31. *Exarchos ST, Lachanas VA, Tsiouvaka S, Tsea M, Hajiioannou JK, Skoulakis CE, et al. The impact of perioperative dexamethasone on swallowing impairment score after thyroidectomy: a retrospective study of 118 total thyroidectomies. Clin Otolaryngol. 2016;41:615-618.*
32. *Mitchell C, Cheuk SJ, O'Donnell CM, Bampoe S, Walker D. What is the impact of dexamethasone on postoperative pain in adults undergoing general anaesthesia for elective abdominal surgery: a systematic review and meta-analysis. Perioper Med (Lond). 2022;11:13.*
33. *Zhou H, Xu H, Zhang J, Wang W, Wang Y, Hu Z. Combination of dexamethasone and tropisetron before thyroidectomy to alleviate postoperative nausea, vomiting, and pain: randomized controlled trial. World J Surg. 2012;36:1217-1224.*
34. *Doksrød S, Sagen Ø, Nøstdahl T, Ræder J. Dexamethasone does not reduce pain or analgesic consumption after thyroid surgery; a prospective, randomized trial. Acta Anaesthesiol Scand. 2012;56:513-519.*

ORIGINAL ARTICLE
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Pre-procedural predictors of in-hospital mortality in ICU patients undergoing endoscopic PEG placement

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ABSTRACT

Objective: Percutaneous endoscopic gastrostomy (PEG) is widely used to provide long-term enteral nutrition in patients unable to maintain oral intake. However, PEG placement is already considered a high-risk intervention in the intensive care unit (ICU), where short-term mortality is substantial. This study aimed to identify predictors of in-hospital mortality in ICU patients undergoing PEG.

Material and Methods: A retrospective cohort study was conducted at a single tertiary center from 2019 to 2024, including all consecutive adult ICU patients who underwent endoscopic PEG. Demographic, clinical, laboratory, and procedural data were analyzed. The primary outcome was in-hospital mortality. Univariate and multivariate logistic regression analyses were used to identify independent predictors.

Results: A total of 364 ICU patients underwent PEG, of whom 125 (34.3%) died during the index hospitalization. Among non-survivors, 56 (44.8%) died within the first 14 days after PEG placement. Non-survivors showed lower albumin levels (24.4 vs. 28.2 g/L; p<0.001), higher urea concentrations (57.1 vs. 40.6 mg/dL; p<0.001), higher neutrophil-lymphocyte ratio (6.44 vs. 4.81; p=0.002), and more frequent infection at the time of PEG (88% vs. 58.6%; p<0.001). Prolonged mechanical ventilation (>14 days) was more common among non-survivors (23.2% vs. 11.7%; p=0.005). In the multivariate model, active infection [odds ratio (OR) 3.62; p<0.001], lower albumin (OR 0.90 per g/L; p<0.001), and higher urea (OR 1.02; p=0.05) independently predicted in-hospital mortality, whereas prolonged intubation showed a strong trend but did not reach significance (OR 1.85; p=0.06).

Conclusion: ICU patients with active infection, severe hypoalbuminemia, and elevated urea levels have a markedly increased risk of in-hospital mortality after PEG placement. Prolonged mechanical ventilation appears to characterize a clinically more fragile ICU population rather than serving as an independent predictor of mortality. Incorporating these objective markers into pre-procedural assessments may improve patient selection and support decision-making in the ICU.

Keywords: Gastrointestinal surgery, intensive care unit, percutaneous endoscopic gastrostomy

INTRODUCTION

Percutaneous endoscopic gastrostomy (PEG) is a commonly used procedure for providing long-term enteral nutrition to patients who cannot maintain adequate oral intake (1). In the critical care setting, PEG is frequently used for individuals with prolonged mechanical ventilation, severe neurologic impairment, or persistent dysphagia (2). Although the procedure is technically successful and often necessary for nutritional support, short-term mortality in critically ill patients remains high, with reported in-hospital mortality rates between ten and twenty five percent (3).

This substantial mortality risk raises critical clinical dilemmas. In some critically ill patients, PEG placement may occur during the advanced stages of systemic illness when the physiological reserve is severely compromised. In such cases, the procedure may not meaningfully alter the short-term clinical trajectory (4). This pattern underscores the need to better identify, prior to intervention, patients at particularly high risk of early in-hospital mortality following PEG placement.

This need is particularly urgent when PEG is performed late in the illness trajectory of high-risk intensive care unit (ICU) patients, such as those with multiorgan failure or ongoing systemic infection. Although several individual risk factors for poor outcomes in different populations have been identified, and ICU admission itself is associated with a twofold increase in mortality following PEG (5), comprehensive models integrating clinical and laboratory variables to stratify early mortality risk specifically within ICU populations remain limited (6).

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Therefore, the primary aim of this study was to identify pre-procedural clinical and laboratory markers associated with in-hospital mortality following PEG placement in ICU patients. By characterizing high-risk physiologic profiles, we sought to identify patients at substantial risk of death during index hospitalization, in whom the intended benefits of long-term enteral access may not be realized.

MATERIAL and METHODS

Study Design and Patient Population

This retrospective cohort study was conducted at a single tertiary care hospital between 2019 and 2024. All consecutive adult patients who underwent endoscopic PEG placement during ICU admission were evaluated. The majority of PEG placements occurred in patients admitted for non-surgical indications, predominantly severe neurologic conditions and prolonged ventilatory dependence; postoperative cases following major surgery were rare. Only PEG procedures performed by the general surgery department were included; gastrostomy procedures performed by other specialties or via radiologic or surgical techniques were excluded from the study. The primary outcome of the study was in-hospital mortality, defined as death from any cause during index hospitalization.

Patient Selection and Data Collection

Electronic medical records were reviewed to identify eligible patients. Demographic characteristics, body mass index (BMI), comorbidities, admission characteristics, indications for PEG, medication use (including antiplatelet and anticoagulant therapy), and prior surgeries were recorded. Laboratory parameters [hemoglobin, white blood cell count, platelets, neutrophil-to-lymphocyte ratio (NLR), albumin, liver enzymes, renal function markers, electrolytes, C-reactive protein (CRP), and international normalized ratio (INR)] were obtained from blood tests performed within 24 hours before the PEG procedure.

Definitions

Infection during PEG placement was defined as an active, culture-confirmed infection from any source (blood, sputum, urine, tracheal aspirate, or wound samples) requiring systemic antibiotic therapy at the time of PEG placement; infections with documented resolution or negative follow-up cultures before the procedure were not classified as active. Because standardized sepsis severity scores (e.g., SOFA or APACHE II) were not consistently available in this retrospective cohort, the infection status reflected treated infection rather than graded sepsis or septic shock. Prolonged mechanical ventilation or tracheostomy was defined as invasive mechanical ventilation or tracheostomy lasting >14 days, and this classification was used when prolonged ventilatory dependence was the primary indication for PEG. Multisystem disorder on admission referred to the presence of two or more acute organ dysfunctions at the time of hospital admission. In-hospital mortality was defined as death from any cause during index hospitalization.

Statistical Analysis

Statistical analyses were performed using R (version 4.1.1). Continuous variables were assessed for normality using the Shapiro-Wilk test and visual inspection of the distribution plots. Normally distributed variables are presented as mean ± standard deviation and compared between survivors and non-survivors using the independent samples t-test, while non-normally distributed data are reported as median and interquartile range and compared using the Mann-Whitney U test. Categorical variables were summarized as frequencies and percentages and analyzed using either the chi-square test or Fisher's exact test, depending on the expected cell counts.

Correlation analyses (Pearson or Spearman coefficients according to distribution) were performed to evaluate the relationships among continuous predictors and to assess potential collinearity before multivariable modeling. Variables with a p-value <0.10 in univariate comparisons, along with those considered clinically relevant, were entered into a binary logistic regression model to identify independent predictors of in-hospital mortality. The final multivariable model was derived using a backward stepwise elimination approach based on the lowest Akaike Information Criterion. Adjusted odds ratios (ORs) with 95% confidence intervals (CIs) were calculated for each predictor. Multicollinearity was assessed using correlation matrices and variance inflation factors, and highly collinear variables were not included in the same model. The discriminative performance of the multivariate model was evaluated using receiver operating characteristic (ROC) analysis. All statistical tests were two-sided, and statistical significance was set at $p<0.05$.

Ethical Review

This retrospective study was conducted in accordance with the ethical standards of the Declaration of Helsinki. The study protocol was approved by the Institutional Review Board of the Ankara Bilkent City Hospital (number: 433, date: 07.08.2024). The requirement for informed consent was waived owing to the use of anonymized clinical data and the observational, retrospective design of the study.

Artificial Intelligence (AI) Use Statement

During the preparation of this manuscript, ChatGPT (OpenAI, GPT-5) was used solely for language editing and improvement of clarity. No AI tool was used for data collection, data analysis, interpretation of results, or generation of scientific conclusions.

All authors critically reviewed and verified the content and take full responsibility for the accuracy, integrity, and originality of the manuscript. The use of AI complied with ethical standards regarding confidentiality and data protection.

RESULTS

Study Population

A total of 364 patients underwent PEG placement, of whom 125 (34.3%) died during index hospitalization. Baseline demographics, including age and sex distribution, were similar between survivors and non-survivors. However, patients who died had a significantly higher BMI (25.15±4.79 vs. 26.76±4.73 kg/m^2; p=0.010) than those who survived. Several comorbid conditions were more frequent among non-survivors, including multisystem disorder on admission (61.2% vs. 45.4%; p=0.009), active chemotherapy (16.8% vs. 7.5%; p=0.01), diabetes mellitus (32.0% vs. 21.8%; p=0.030), heart failure (8.8% vs. 2.1%; p=0.003), and antiplatelet use (15.2% vs. 8.4%; p=0.045) (Table 1).

Laboratory Parameters

Non-survivors demonstrated a more severe inflammatory and metabolic profile than survivors. They had lower hemoglobin (9.0 vs. 9.7 g/dL; p<0.001), higher NLR (6.44 vs. 4.81; p=0.002), lower albumin (24.4 vs. 28.2 g/L; p<0.001), and higher urea (57.1 vs. 40.6 mg/dL; p<0.001) levels. INR and CRP levels were also significantly elevated in patients who died. ALP levels were higher in the mortality group (p=0.01) (Table 2).

PEG Related Characteristics

The indications for PEG differed between the groups. Patients who died were more likely to have prolonged intubation as the primary indication (23.2% vs. 11.7%, p=0.005), whereas survivors were more often referred for chronic oral intake disorders.

Table 1. Baseline demographics and comorbidities of PEG patients stratified by in-hospital mortality

Variable	Total (n=364)	Survived (n=239)	Exitus (n=125)	p-value
Age, years, mean ± SD	76±17	76±17	76±17	0.89
Male sex, n (%)	186 (51.1)	122 (51.0)	64 (51.2)	0.54
BMI, kg/m^2, mean ± SD	25.74±4.82	25.15±4.79	26.76±4.73	**0.01**
Glasgow Coma Scale <8, n (%)	110 (30.2)	75 (31.4)	35 (28.0)	0.50
Admission from emergency department, n (%)	308 (84.6)	205 (85.8)	103 (82.4)	0.39
Multisystem disorder on admission, n (%)	156 (50.6)	93 (45.4)	63 (61.2)	**0.009**
Cancer (any type), n (%)	66 (18.1)	39 (16.3)	27 (21.6)	0.21
Active chemotherapy, n (%)	39 (10.7)	18 (7.5)	21 (16.8)	**0.01**
Prior abdominal surgery, n (%)	36 (9.9)	20 (8.4)	16 (12.8)	0.17
Prior head/neck-esophageal surgery, n (%)	6 (1.6)	5 (2.1)	1 (0.8)	0.35
Previous PEG, n (%)	10 (2.7)	9 (3.8)	1 (0.8)	0.10
Hypertension, n (%)	180 (49.5)	113 (47.3)	67 (53.6)	0.25
Diabetes mellitus, n (%)	92 (25.3)	52 (21.8)	40 (32.0)	**0.030**
Coronary artery disease, n (%)	41 (11.3)	26 (10.9)	15 (12.0)	0.74
Prior stroke, n (%)	57 (15.7)	42 (17.6)	15 (12.0)	0.16
Atrial fibrillation, n (%)	21 (5.8)	13 (5.4)	8 (6.4)	0.70
COPD, n (%)	34 (9.3)	22 (9.2)	12 (9.6)	0.90
Heart failure, n (%)	16 (4.4)	5 (2.1)	11 (8.8)	**0.003**
Chronic kidney disease, n (%)	14 (3.8)	8 (3.3)	6 (4.8)	0.49
Dementia, n (%)	87 (23.9)	56 (23.4)	31 (24.8)	0.77
Parkinson's disease, n (%)	38 (10.4)	20 (8.4)	18 (14.4)	0.07
Epilepsy, n (%)	13 (3.6)	9 (3.8)	4 (3.2)	0.78
Hypothyroidism, n (%)	12 (3.3)	6 (2.5)	6 (4.8)	0.24
Anticoagulant use, n (%)	53 (14.6)	37 (15.5)	16 (12.8)	0.49
Antiplatelet use, n (%)	39 (10.7)	20 (8.4)	19 (15.2)	**0.04**
Steroid use, n (%)	5 (1.4)	3 (1.3)	2 (1.6)	0.56

BMI: Body mass index, COPD: Chronic obstructive pulmonary disease, PEG: Percutaneous endoscopic gastrostomy, SD: Standard deviation.

Infection during PEG intervention was markedly more common in non-survivors than in survivors (88% vs. 58.6%; p<0.001). ICU length of stay was significantly longer among patients who died (median 45 vs. 40 days; p=0.03). The overall hospital stay did not differ significantly (Table 3). Among the 125 patients who died during the index hospitalization, 37 (29.6%) died within the first 7 days after PEG placement, 19 (15.2%) between days 8 and 14, and the remaining 69 (55.2%) after 14 days. When non-survivors were stratified according to time from PEG to death (≤14 days vs. >14 days), the prevalence of infection, as well as albumin and urea levels at the time of PEG placement, did not differ significantly between early and late deaths (all p>0.05).

Predictors of In-hospital Mortality

The univariate and multivariate analyses identifying predictors of in-hospital mortality among ICU patients undergoing PEG placement are summarized in Table 4. In univariate logistic regression, infection during PEG intervention showed one of the strongest associations, corresponding to a 5.18-fold increase in the mortality risk (p<0.001). Active chemotherapy (OR 4.08, p=0.010) and heart failure (OR 4.51, p=0.006) were also strongly associated with increased mortality rates. Prolonged intubation as an indication for PEG conferred a 2.71-fold increased risk of death (p<0.001). Diabetes mellitus (OR 1.69, p=0.030) and antiplatelet use (OR 1.96, p=0.040) were additional comorbidity-related predictors.

Laboratory variables demonstrated significant prognostic value: lower hemoglobin (OR 0.74 per g/dL), higher NLR (OR 1.03), reduced albumin (OR 0.88 per g/L), elevated urea (OR 1.02), higher INR (OR 13.2), and increased CRP levels (OR 1.01) were all associated with increased mortality in the univariate analysis.

In the multivariate model, three predictors remained significant. Lower albumin levels were strongly associated with mortality, with each 1 g/L decrease increasing the risk by approximately 10% (OR 0.90, p<0.001). Elevated urea level also independently predicted mortality (OR 1.02, p=0.05). Infection during the PEG procedure remained the most important independent predictor, increasing the odds of in-hospital death by more than three-fold (OR 3.62, p<0.001). Although prolonged intubation as an indication for PEG showed a trend toward significance, it did not retain statistical significance after adjustment (OR 1.85, p=0.06).

In the multivariate model, the area under the ROC curve was 0.761. Using a probability cut-off value of 0.50, the model demonstrated a sensitivity of 41.9% and specificity of 86.8% for predicting in-hospital mortality, with an overall classification accuracy of 71.3%.

DISCUSSION

This study of critically ill patients undergoing PEG in the ICU demonstrated a markedly high in-hospital mortality rate of 34.3 percent. This elevated rate likely reflects our study's specific

Table 2. Laboratory parameters in PEG patients stratified by in-hospital mortality

Variables	Total (n=364)	Survived (n=239)	Exitus (n=125)	p-value
Hemoglobin, g/dL, median (IQR)	9.3 (8.3-10.8)	9.7 (8.6-11.4)	9.0 (8-10)	**<0.001**
WBC, $\times10^9$/L, median (IQR)	8.07 (6.19-11)	7.8 (6.01-10.66)	8.6 (6.35-11.6)	0.12
Platelets, $\times10^9$/L, median (IQR)	274 (207-384)	283 (217-398)	261 (195-353)	0.06
NLR, median (IQR)	5.18 (3.08-9.07)	4.81 (2.8-8.6)	6.44 (3.75-10.89)	**0.002**
Albumin, g/L, median (IQR)	26.83 (22.55-31.20)	28.2 (24.48-33)	24.4 (21.75-28)	**<0.001**
ALT, U/L, median (IQR)	21 (14-35)	22 (14-36)	20 (13-33)	0.28
AST, U/L, median (IQR)	29 (19-42)	28 (18-42)	30 (19-42)	0.55
ALP, U/L, median (IQR)	96.5 (74-136)	93 (72-127)	106 (80-147)	**0.01**
GGT, U/L, median (IQR)	28.5 (17.5-57.5)	29 (18-55)	27 (16-61)	0.71
Creatinine, mg/dL, median (IQR)	0.60 (0.42-0.93)	0.59 (0.43-0.83)	0.62 (0.40-1.10)	0.15
Urea, mg/dL, median (IQR)	44.47 (29.96-68.48)	40.6 (25.6-59.9)	57.1 (36.3-98.4)	**<0.001**
INR, median (IQR)	1.20 (1.1-1.3)	1.18 (1.08-1.21)	1.20 (1.1-1.36)	**<0.001**
CRP, mg/L, median (IQR)	40 (10-90)	34 (10-70)	54 (15-119)	**0.003**
Sodium, mmol/L, mean ± SD	140.55±6.98	139.4±6.13	141.7±8.25	0.1
Potassium, mmol/L, mean ± SD	3.87±0.63	3.87±0.54	3.89±0.78	0.34
Chloride, mmol/L, mean ± SD	105.58±7.01	104.88±6.00	106.89±8.46	0.05
Magnesium, mg/dL, mean ± SD	1.72±0.32	1.74±0.31	1.69±0.33	0.19

ALP: Alkaline phosphatase, ALT: Alanine aminotransferase, AST: Aspartate aminotransferase, CRP: C-reactive protein, GGT: Gamma-glutamyl transferase, INR: International normalized ratio, IQR: Interquartile range, NLR: Neutrophil-to-lymphocyte ratio, SD: Standard deviation, WBC: White blood cell count.

focus on a high-risk inpatient cohort, as all patients were actively receiving ICU-level care at the time of the procedure, a population with greater baseline illness severity and physiological instability than those in other clinical settings. This rate significantly exceeds the previously reported ICU-specific mortality (30-day mortality of 14.8% in one surgical ICU cohort), likely reflecting differences in case mix, baseline illness severity, and the evaluation of in-hospital rather than 30-day mortality (7). While ICU status has already been described as "an indication to discourage physicians for PEG," our analysis identified a specific, higher-risk subgroup within this population (5). Non-survivors exhibited a distinct clinical profile characterized by a greater

Table 3. PEG procedure characteristics and clinical outcomes stratified by in-hospital mortality

Variables	Total (n=364)	Survived (n=239)	Exitus (n=125)	p-value
PEG indication, n (%) Neurological disorders Prolonged intubation Oral intake deficiency	 117 (32.1) 57 (15.7) 190 (52.2)	 74 (31) 28 (11.7) 137 (57.3)	 43 (34.4) 29 (23.2) 53 (42.4)	**0.005**
Infection during PEG intervention n (%)	250 (68.7)	140 (58.6)	110 (88)	**<0.001**
Time from admission to PEG, days, median (IQR)	25 (14-37)	23 (13-37)	26 (17-38)	0.18
Time from admission to PEG categorical, n (%) 0-15 days 15-30 days 31-45 days	 94 (25.8) 154 (42.3) 116 (31.9)	 67 (28) 101 (42.3) 71 (29.7)	 27 (21.6) 53 (42.4) 45 (36)	0.31
Peg to in hospital death, n (%) ≤7 days 8-14 days ≥15 days	 37 (10.2) 19 (5.2) 69 (19)		 37 (29.6) 19 (15.2) 69 (55.2)	
Multiple PEG attempt, n (%)	21 (5.8)	13 (5.4)	8 (6.4)	0.7
PEG complication, n, (%)	12 (3.3)	7 (2.9)	5 (4)	0.75
ICU stay, days, median (IQR)	43 (25-68)	40 (21-66)	45 (33-71)	**0.03**
Length of hospital stay, days, median (IQR)	45 (26-71)	41 (22-70)	46 (35-72)	0.08

ICU: Intensive care unit, IQR: Interquartile range, PEG: Percutaneous endoscopic gastrostomy.

Table 4. Univariate and multivariate logistic regression for in-hospital mortality after PEG placement

Variable	Univariate OR (95% CI)	p-value	Multivariate OR (95% CI)	p-value
Glasgow Coma Scale, <8	1.17 (0.70-1.89)	0.5	—	—
BMI, kg/m^2	1.07 (1.01-1.13)	**0.017**	—	—
Active chemotherapy	4.08 (1.35-12.3)	**0.010**	—	—
Diabetes mellitus	1.69 (1.04-2.75)	**0.030**	—	—
Heart failure	4.51 (1.53-13.3)	**0.006**	—	—
Antiplatelet use	1.96 (1.00-3.83)	**0.040**	—	—
Hemoglobin, g/dL	0.74 (0.65-0.85)	**<0.001**	—	—
NLR	1.03 (1.00-1.06)	**0.03**	—	—
Albumin, g/L	**0.88 (0.84-0.92)**	**<0.001**	**0.90 (0.86-0.95)**	**<0.001**
ALP, U/L	1.00 (1.00-1.00)	0.08	—	—
Urea, mg/dL	**1.02 (1.01-1.04)**	**<0.001**	**1.02 (1.01-1.03)**	**0.05**
INR	**13.2 (3.47-50.2)**	**<0.001**	—	—
CRP, mg/L	**1.01 (1.00-1.01)**	**<0.001**	—	—
Prolonged intubation	2.71 (1.48-4.94)	**<0.001**	1.85 (0.96-3.57)	0.06
Infection during PEG intervention	**5.18 (2.85-9.42)**	**<0.001**	**3.62 (1.93-6.80)**	**<0.001**

ALP: Alkaline phosphatase, BMI: Body mass index, CI: Confidence interval, CRP: C-reactive protein, GCS: Glasgow Coma Scale, INR: International normalized ratio, NLR: Neutrophil-to-lymphocyte ratio, OR: Odds ratio, PEG: Percutaneous endoscopic gastrostomy.

systemic illness burden, more pronounced inflammatory and metabolic derangements, and a significantly higher incidence of infection at the time of the procedure. These findings emphasize the importance of objective risk stratification when considering PEG placement in critically ill patients.

The presence of active infection during PEG intervention emerged as the most powerful independent predictor of in-hospital mortality in our cohort, increasing the odds of death by more than threefold. This finding is consistent with the previous literature, underscoring infection as a decisive prognostic marker. Studies have reported that aspiration pneumonia is associated with a 13.6-fold increase in 90-day mortality (8), while early PEG-site infection correlates with a 30-day mortality rate as high as 68% (9). This relationship is further quantified by inflammatory biomarkers; for instance, a CRP level ≥5 mg/dL is associated with a 3-fold increase in 30-day mortality (10). Our results confirm this evidence by demonstrating that any active systemic infection at the time of the procedure serves as a potent indicator of the severe underlying illness. Notably, when non-survivors were stratified according to the time from PEG to death, the infection rates did not differ significantly between early and late deaths, suggesting that infection does not merely identify patients undergoing PEG during imminent terminal deterioration. This suggests that performing an elective procedure, such as PEG, during a state of systemic inflammatory response may reflect the burden of acute physiological instability rather than a direct procedural effect. Consequently, active infection and systemic inflammation should prompt careful clinical reassessment of PEG timing and the overall goals of care.

Severe hypoalbuminemia emerged as a strong, independent predictor of in-hospital mortality in our cohort, reinforcing its role as a key prognostic marker. As an indicator of both nutritional status and systemic inflammation, albumin reflects the overall physiological reserve. Consistent with prior studies, levels below approximately 2.7 g/dL have been linked to more than double the 30 day mortality risk (9). Additionally, each 1 g/dL increase in albumin was associated with an 81 percent reduction in six-month mortality after PEG (8). This risk increases further when hypoalbuminemia is combined with systemic inflammation, such as elevated CRP levels, identifying patients with extreme frailty and catabolic stress (11). Mortality in such cases can exceed 70 percent, with a more than sevenfold increase in risk (9). In ICU patients, marked hypoalbuminemia, particularly when accompanied by infection or other signs of systemic illness, should be interpreted as a marker of increased mortality risk at the time of PEG decision-making and may warrant careful clinical consideration of the overall prognosis.

Elevated urea was also an important predictor of in-hospital mortality in our cohort, highlighting its prognostic role in patients with metabolic and renal dysfunction. This finding is consistent with previous studies in which elevated pre-procedural urea levels were independently associated with a four-fold increase in 30 day mortality (11,12). In critical illness, an elevated BUN concentration often reflects renal impairment, dehydration, and increased catabolic protein breakdown, all of which are indicative of severe physiological stress and multi-organ dysfunction (13). Consequently, a high urea level in a candidate for PEG may reflect reduced metabolic reserve at the time of decision-making. Together with the existing evidence, our results suggest that an elevated BUN level is associated with an increased risk of early mortality and warrants careful clinical consideration within the broader context of the patient's overall condition.

Our analysis identified several factors that were strongly associated with mortality in the univariate analysis but did not retain independent significance in the final model. For example, elevated CRP levels are well-established predictors of early mortality in many PEG studies (10,12). However, in our intensive care cohort, its effect was likely absorbed by the closely related presence of active infection and profound hypoalbuminemia, both of which are central components of the systemic inflammatory response. A prolonged INR, which marked the most critically ill patients in our sample, similarly reflects severe hepatic dysfunction or coagulopathy but did not provide additional prognostic information once the core markers of acute physiological derangement were included. The indication for PEG placement also played an important role; the need for prolonged mechanical ventilation demonstrated a strong unadjusted association with mortality and narrowly missed significance after adjustment, suggesting that the observed risk may be related to the concurrent burden of infection, organ failure, and malnutrition (14). This overall pattern, in which traditional risk factors, such as comorbidities, inflammatory markers, and coagulation abnormalities, lose their predictive strength once broader indicators of acute severity are considered, has been described in other critically ill populations (2,7). This reinforces that in the intensive care setting, the overall severity of illness driven by infection, poor nutrition, and metabolic stress may be more influential in predicting outcomes than any single diagnosis or laboratory value. Importantly, these findings should be interpreted as associations reflecting underlying vulnerability rather than evidence that PEG placement itself contributes causally to mortality.

Although our model demonstrated acceptable discrimination, its modest sensitivity indicates that it should be interpreted as identifying high-risk clinical profiles rather than excluding patients from PEG based solely on the predicted probability. Prior studies have attempted to define non-beneficial PEG placement using broad clinical categories such as advanced dementia, persistent vegetative state, or death within 30 days

of the procedure, identifying roughly ten percent of cases as potentially unnecessary in a general patient cohort (6,15). These observations highlight that clearer selection criteria can meaningfully improve outcomes, as demonstrated by the reduction in 30-day PEG mortality in England from 13.2 percent to 5.3 percent following the adoption of more refined national guidelines (16). Our study provides evidence that may help extend the principle of structured risk assessment to the high-risk ICU population. By incorporating the key variables identified in this study, clinicians may better recognize patients at a substantially increased risk of in-hospital mortality.

This study has several strengths, including a relatively large cohort focused exclusively on critically ill ICU patients undergoing endoscopic PEG. Detailed clinical, laboratory, and physiological data collected at the time of the procedure enabled a structured evaluation of factors independently associated with in-hospital mortality.

Study Limitations

Important limitations should be acknowledged. The retrospective single-center design introduces potential residual confounding and limits its generalizability. Although selected laboratory parameters were analyzed as proxies of physiological instability, standardized severity-of-illness scores were not consistently available, and we could not definitively distinguish between localized infection and septic shock at the time of PEG placement. Standardized nutritional risk assessments were not routinely documented. While the timing from ICU admission to PEG was evaluated, a detailed assessment of dynamic clinical stability at the time of procedural decision-making was not possible. Because only patients who ultimately underwent endoscopic PEG were included, selection bias related to institutional referral patterns and procedural thresholds cannot be excluded. Furthermore, the exclusion of surgical and radiologic gastrostomy cases limits the generalizability of these findings to endoscopic PEG. Finally, although the multivariable model demonstrated acceptable discrimination, it was not externally validated and should be interpreted as identifying high-risk clinical profiles rather than serving as a stand-alone prediction tool. Despite these limitations, this study identified objective markers associated with early in-hospital mortality and supports the need for structured risk stratification in critically ill patients considered for PEG. Prospective multicenter validation is required.

CONCLUSION

This study identified a distinct high-risk profile associated with in-hospital mortality among critically ill patients undergoing PEG, primarily characterized by active infection, severe hypoalbuminemia, and elevated urea levels, while prolonged intubation characterized a clinically more fragile subgroup. These objective markers may support structured risk stratification and more informed patient selection in intensive care settings.

Ethics

Ethics Committee Approval: The study protocol was approved by the Institutional Review Board of the Ankara Bilkent City Hospital (number: 433, date: 07.08.2024).

Informed Consent: The requirement for informed consent was waived owing to the use of anonymized clinical data and the observational, retrospective design of the study.

Footnotes

Author Contributions

Concept - M.O., E.Ç.; Design - M.O., E.Ç.; Data Collection or Processing - E.Ş., E.C.; Analysis or Interpretation - M.O., T.A., S.G.T.; Literature Search - M.O., E.Ş., E.C., E.Ç.; Writing - M.O., T.A., S.G.T., E.Ç.

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REFERENCES

1. *Rahnemai-Azar AA, Rahnemaiazar AA, Naghshizadian R, Kurtz A, Farkas DT. Percutaneous endoscopic gastrostomy: indications, technique, complications and management. World J Gastroenterol. 2014;20:7739-7751.*
2. *Wei M, Ho E, Hegde P. An overview of percutaneous endoscopic gastrostomy tube placement in the intensive care unit. J Thorac Dis. 2021;13:5277-5296.*
3. *Arora G, Rockey D, Gupta S. High In-hospital mortality after percutaneous endoscopic gastrostomy: results of a nationwide population-based study. Clin Gastroenterol Hepatol. 2013;11:1437-1444.e3.*
4. *Johnston SD, Tham TC, Mason M. Death after PEG: results of the national confidential enquiry into patient outcome and death. Gastrointest Endosc. 2008;68:223-227.*
5. *Lima DL, Miranda LEC, da Penha MRC, Lima RNCL, Dos Santos DC, Eufrânio MS, et al. Factors associated with 30-day mortality in patients after percutaneous endoscopic gastrostomy. JSLS. 2021;25:e2021.00040.*
6. *Holt DQ, McDonald JF, Murray ML, Hair C, Devonshire DA, Strauss BJ, et al. Clinical selection criteria can predict futile intervention in patients referred for percutaneous endoscopic gastrostomy insertion. Intern Med J. 2015;45:648-652.*
7. *Pih GY, Na HK, Hong SK, Ahn JY, Lee JH, Jung KW, et al. Clinical outcomes of percutaneous endoscopic gastrostomy in the surgical intensive care unit. Clin Endosc. 2020;53:705-716.*
8. *Seyhan S, Tosun Taşar P, Karaşahin Ö, Albayrak B, Sevinç C, Şahin S. Complications and factors associated with mortality in patients undergoing percutaneous endoscopic gastrostomy. Clin Sci Nutr. 2024;6:97-106.*
9. *Karasahin O, Tosun Tasar P, Timur O, Binici DN, Kiper Yilmaz T, Aslan A, et al. High C-reactive protein and low albumin levels predict high 30-day mortality in patients undergoing percutaneous endoscopic gastrotomy. Gastroenterol Res. 2017;10:172-176.*
10. *Pih GY, Na HK, Ahn JY, Jung KW, Kim DH, Lee JH, et al. Risk factors for complications and mortality of percutaneous endoscopic gastrostomy insertion. BMC Gastroenterol. 2018;18:101.*
11. *Duzenli T, Ketenci M, Akyol T, Koseoglu H, Tanoglu A, Kaplan M, et al. Predictive factors of complications and 30-day mortality in patients undergoing percutaneous endoscopic gastrostomy: the*

utility of C-reactive protein to albumin ratio. Acta Gastroenterol Belg. 2021;84:283-288.

12. *Barbosa M, Magalhaes J, Marinho C, Cotter J. Predictive factors of early mortality after percutaneous endoscopic gastrostomy placement: the importance of C-reactive protein. Clin Nutr ESPEN. 2016;14:19-23.*
13. *Feinfeld DA, Bargouthi H, Niaz Q, Carvounis CP. Massive and disproportionate elevation of blood urea nitrogen in acute azotemia. Int Urol Nephrol. 2002;34:143-145.*
14. *Keskinkılıç Yağız B, Yalaza M. Evaluating the factors affecting mortality and survival of the patients who underwent percutaneous endoscopic gastrostomy; the short-term and long-term results. J Cukurova Anesth Surg. 2024;7:153-157.*
15. *Welbank T, Kurien M. To PEG or not to PEG that is the question. Proc Nutr Soc. 2021;80:1-8.*
16. *Kamran U, Lee PC, Coupland B, Abbasi A, Steed H, Ispoglou S, et al. Improving 30-day mortality after PEG tube placement in England from 2007 to 2019: a retrospective national cohort analysis of 87,862 patients. Gastrointest Endosc. 2022;96:943-953.e11.*

ORIGINAL ARTICLE
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Current status and barriers of ultrasonography utilization among general surgeons in Türkiye: Results of a nationwide survey

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ABSTRACT

Objective: Point-of-care ultrasonography is rapidly becoming a key tool in many medical fields. Although its value in surgical practice is well established, adoption among general surgeons in Türkiye still seems quite limited.

Material and Methods: We conducted a nationwide cross-sectional survey of practicing general surgeons and surgery residents in Türkiye. The questionnaire covered participants' background, ultrasound training history, current usage patterns, and views on future training.

Results: A total of 147 surgeons responded (44 residents, 77 specialists, and 26 academic faculty). Only 10.2% had received structured ultrasound training during residency, whereas 21.8% had attended a postgraduate course. More than three-quarters (75.5%) described their competence in ultrasound-guided procedures as low or non-existent. Self-reported competency was significantly higher among specialists and faculty than residents ($p<0.001$). Multivariable analysis showed that attending a postgraduate ultrasound course [adjusted odds ratio (aOR) 12.92, 95% confidence interval (CI) 4.66-35.83] and having access to a dedicated ultrasound device (aOR 4.39, 95% CI 1.36-14.16) were the strongest predictors of greater competency. Notably, more than 93% of participants reported a willingness to pay for ultrasound training courses. Our results highlight a significant gap between available training opportunities and what surgeons need. Although competency improves somewhat with experience and formal training, it remains low across all career stages.

Conclusion: There is an urgent need to integrate structured, hands-on ultrasonography training into general surgery residency programs in Türkiye and to expand accessible postgraduate options.

Keywords: Cancer, minimal invasive surgery, thyroid surgery

INTRODUCTION

Point-of-care ultrasonography (POCUS) has become an essential part of daily practice in many specialties. It helps clinicians make faster decisions, reduces reliance on radiology departments, and improves patient safety (1-3). Bedside ultrasound has become an important skill in surgical practice. It is especially valuable in trauma, emergency cases, and minimally invasive procedures, where rapid decision-making can directly affect patient care (4,5).

Globally, many countries have already incorporated USG training into surgical curricula (6-8). However, the situation in Türkiye is different. Despite growing interest in procedures such as thyroid and breast biopsies, radiofrequency ablation, and perioperative guidance, most general surgeons still have very limited access to proper training and equipment (4,5,9). This study aimed to understand the current level of ultrasonography use, training backgrounds, and attitudes among general surgeons throughout the country.

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MATERIAL and METHODS

This was a nationwide cross-sectional survey targeting general surgeons and surgery residents in Türkiye. The study received ethical approval from the Institutional Review Board University of Health Sciences Türkiye, Sancaktepe Şehit Prof. Dr. İlhan Varank Training and Research Hospital (approval no: 2025/331, date: 24.09.2025). Written informed consent was not obtained, as the study was conducted as a survey-based research. We developed the questionnaire using Google forms and distributed it electronically via surgical mailing lists and professional networks, employing snowball sampling. Participants had one week to respond, followed by a reminder and three extra days.

The survey included 30 questions covering demographics, professional experience, USG training, device access, self-reported competency, and opinions about future education. Self-reported competency was measured on a five-point scale and subsequently grouped into low and moderate-to-high for analysis. The primary outcome was self-reported USG competency, assessed using a five-point ordinal scale: No experience, insufficient, moderate, sufficient, and very sufficient. For logistic regression analyses, this was dichotomized as low (no experience or insufficient) versus moderate-to-high (moderate, sufficient, or very sufficient). Secondary outcomes included frequency of ultrasonography use, access to USG devices, prior training or certification, and perceived barriers to adoption.

Statistical Analysis

Data were exported from Google forms into Microsoft Excel and analyzed using IBM SPSS v21.0. We used the chi-square, Fisher's exact, Kruskal-Wallis, and Mann-Whitney U tests where appropriate. Multivariable logistic regression was performed to identify independent predictors of higher competency. A p-value <0.05 was considered statistically significant.

RESULTS

Participant Characteristics

A total of 496 invitations were sent, and 147 participants (29.6%) completed the questionnaire. Baseline demographic and professional characteristics are summarized in Table 1. The sample was predominantly male (n=101, 68.7%). The most represented age group was 31-35 years (31.3%), and the majority of participants were in the early career stage. Residents constituted 29.9% (n=44), specialists 52.4% (n=77), and academic faculty 17.7% (n=26) of the sample. Most respondents had fewer than five years of post-graduation practice (59.2%), while 26.5% had ten or more years of experience. The largest institutional group consisted of training and research hospitals (43.5%), followed by university hospitals (21.8%), resulting in a combined academic affiliation of 65.3%. Participants represented 39 provinces, with the highest representation from İstanbul (25.2%), Ankara (11.6%), and İzmir (10.2%). A small number of respondents (n=4, 2.7%) practiced in Azerbaijan and were included as affiliates of relevant surgical associations.

USG Training, Certification, and Institutional Resources

Table 2 presents the survey findings on training, institutional resources, and attitudes. Only 15 respondents (10.2%) reported receiving structured USG training during residency, and 32

Table 1. Baseline demographic and professional characteristics of survey respondents (n=147)

Characteristic	n	%
Sex		
Male	101	68.7
Female	46	31.3
Age group (years)		
24-30	33	22.4
31-35	46	31.3
36-40	26	17.7
41-45	17	11.6
46-50	11	7.5
51-55	9	6.1
≥56	5	3.4
Professional level		
Resident	44	29.9
Specialist	77	52.4
Asst. Prof.	11	7.5
Assoc. Prof.	9	6.1
Professor	6	4.1
Years in practice		
0-5 years	87	59.2
5-10 years	21	14.3
≥10 years	39	26.5
Institution type		
University hospital	32	21.8
Training and research hospital	64	43.5
Secondary state hospital	26	17.7
Tertiary state hospital	12	8.2
Private hospital	10	6.8
Outpatient clinic	3	2.0
Geographic distribution (top 5 cities)		
İstanbul	37	25.2
Ankara	17	11.6
İzmir	15	10.2
Trabzon	10	6.8
Diyarbakır	5	3.4
Other provinces	63	42.9

Table 2. USG training, certification, institutional resources, and attitudes among respondents (n=147)			
Variable	**n (yes)**	**% (yes)**	**p***
Training & certification			
Structured residency USG training	15	10.2	<0.001
Postgraduate USG course attendance	32	21.8	<0.001
Simulation-based USG training	38	25.9	<0.001
Formal USG certification	26	17.7	<0.001
Institutional resources			
Dedicated USG device for general surgery	24	16.3	<0.001
Endocrinologist present at institution	118	80.3	<0.001
Radiologist present at institution	143	97.3	<0.001
Interventional radiologist present	113	76.9	<0.001
Ablation performed at institution	76	51.7	0.897
Attitudes & opinions			
USG training should be in surgery curriculum (ÇEP)	139	94.6	<0.001
Interventional USG should be in core program	140	95.2	<0.001
Biopsy & ablation within general surgery scope	136	92.5	<0.001
Surgeon input needed in ablation decisions	138	93.9	<0.001
Interventional procedures will replace surgery	96	65.3	<0.001
Field of general surgery will narrow	96	65.3	<0.001
Would still refer patients if capable (would NOT self-perform)	12	8.2	<0.001
Willing to attend paid USG training courses	137	93.2	<0.001

USG: Ultrasound, ÇEP: *Çekirdek eğitim programı*, *: A p-value of <0.05 was considered statistically significant.

(21.8%) had attended at least one postgraduate USG course. Simulation-based training was reported by 38 participants (25.9%), and formal USG certification was held by 26 participants (17.7%). Only 24 respondents (16.3%) reported access to a dedicated USG device for general surgical use. All binary training proportions were significantly below the neutral 50% threshold (all p<0.001, one-sample binomial test), confirming widespread underexposure.

Regarding institutional infrastructure, radiologists were present in 143 institutions (97.3%), interventional radiologists in 113 (76.9%), and endocrinologists in 118 (80.3%). Ablation was performed at 76 institutions (51.7%). Where performed, ablation was conducted primarily by radiologists (n=73, representing 96% of performing institutions). Thyroid biopsies were performed by radiologists in 92 cases (62.6%), by endocrinologists in 23 cases (15.6%), and by general surgeons in 7 cases (4.8%); they were not performed at 23 institutions (15.6%). Breast biopsies were most commonly performed by radiologists (76.2%), whereas general surgeons performed them in 14 institutions (9.5%).

Self-reported Competency

Self-reported competency in ultrasonography was generally low across the entire cohort (Figure 1). The majority of respondents indicated either no experience (n=76, 51.7%) or insufficient competency (n=35, 23.8%), resulting in a combined low competency rate of 75.5%. Only 26 participants (17.7%) reported moderate competency, 8 (5.4%) reported sufficient competency, and 2 (1.4%) reported very sufficient competency.

Competency by Professional Level

When data were stratified by professional level, self-reported competency showed a clear increasing trend with career seniority (Kruskal-Wallis H =26.36, p<0.001; Mann-Whitney U

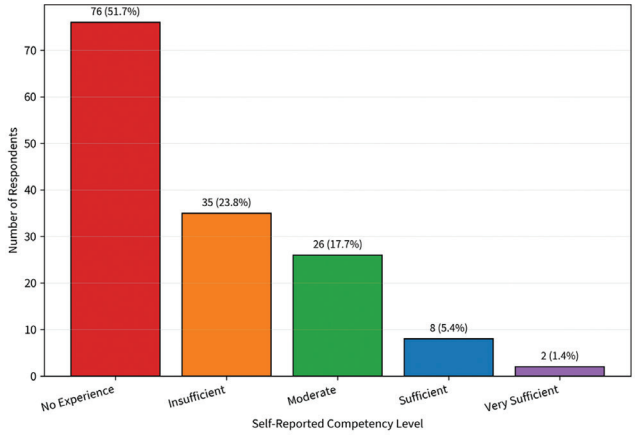

Figure 1. Distribution of self-reported USG competency among 147 general surgeons in Türkiye.

USG: Ultrasound.

test for residents versus specialists/faculty: p<0.001). Among residents, only one out of 44 (2.3%) reported moderate or higher competency. In comparison, 21 of 77 specialists (27.3%) and 14 of 26 academic faculty members (53.8%) reported moderate-to-high competency (Table 3 and Figure 2). Importantly, the problem was not limited to trainees. Even among specialists, 72.7% still described their competency as low or non-existent. This indicates that the deficiency persists across all stages of a surgical career and cannot be attributed solely to the inclusion of residents in the sample.

Multivariable Logistic Regression

In the multivariable logistic regression model, moderate-to-high self-reported USG competency (score ≥2) was used as the outcome variable. The model included the following predictors: structured residency training, attendance at postgraduate USG courses, access to a dedicated USG device, years in practice (categorized), and institution type (academic versus non-academic). For binary variables, the reference categories were the unexposed groups.

Postgraduate USG course attendance emerged as the strongest independent predictor of higher competency [an adjusted odds ratio (aOR) of 12.92, 95% confidence interval (CI) 4.66-35.83; p<0.001]. Access to a dedicated USG device was also significantly associated with better competency (aOR 4.39, 95% CI 1.36-14.16; p=0.013). Structured residency training showed a relatively large effect size (aOR 4.34, 95% CI 0.95-19.81), but it did not reach statistical significance (p=0.058). This is most likely due to the very small number of participants who received such training during residency (n=15). Neither years in practice nor institution type (academic vs. non-academic) was independently associated with self-reported competency (both p>0.05) (Table 4 and Figure 3).

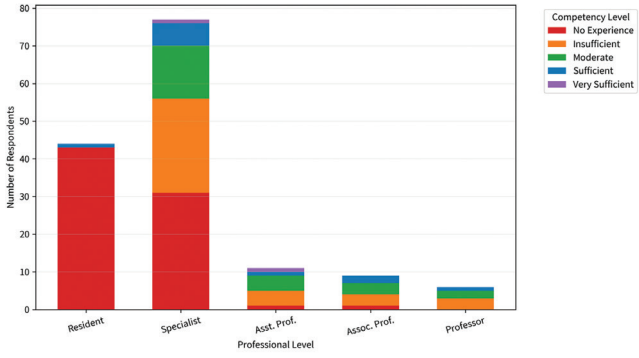

Figure 2. Self-reported USG competency by professional level. Low competency was present across all career stages, though significantly higher rates of moderate-to-high competency were observed among academic faculty (Kruskal-Wallis p<0.001).

USG: Ultrasound.

Attitudes and Willingness

Despite the low levels of training and competency observed in the study, participants demonstrated markedly positive attitudes toward integrating ultrasonography into surgical practice. An overwhelming majority supported the inclusion of USG training in the general surgery core curriculum (94.6%) and agreed that interventional USG procedures should be part of the standard training program (95.2%). Similarly, 92.5% believed that performing biopsies and ablation procedures should fall within the scope of general surgical practice. Nearly all respondents (93.9%) emphasized the importance of surgeon involvement in decision-making for ablation therapies. Importantly, 93.2% of participants stated that they would be willing to attend paid USG training courses. This high level of motivation highlights a strong professional demand that is not met by current educational opportunities (Figure 4). When asked about the future of the specialty, 65.3% of surgeons believed that interventional procedures would eventually replace some traditional surgical treatments, and a similar proportion anticipated a gradual narrowing of the scope of general surgery. The current referral burden was also evident: when ablation or biopsy services were not available at their institutions, only 8.2% reported they would prefer to refer patients even if they themselves were technically capable of performing the procedures (Table 4).

DISCUSSION

The findings of this nationwide survey indicate that ultrasonography remains significantly underutilized in general

Table 3. Self-reported USG competency distribution by professional level

Professional level	No Exp. n (%)	Insuff. n (%)	Moderate n (%)	Sufficient n (%)	V.Suff. n (%)	p†
Resident (n=44)	43 (97.7)	0 (0)	0 (0)	1 (2.3)	0 (0)	
Specialist (n=77)	31 (40.3)	25 (32.5)	14 (18.2)	6 (7.8)	1 (1.3)	
Asst. Prof. (n=11)	1 (9.1)	4 (36.4)	4 (36.4)	1 (9.1)	1 (9.1)	**<0.001**
Assoc. Prof. (n=9)	1 (11.1)	3 (33.3)	3 (33.3)	2 (22.2)	0 (0)	
Professor (n=6)	0 (0)	3 (50.0)	2 (33.3)	1 (16.7)	0 (0)	
Total (n=147)	**76 (51.7)**	**35 (23.8)**	**26 (17.7)**	**8 (5.4)**	**2 (1.4)**	

†: A p-value of <0.05 was considered statistically significant, USG: Ultrasound.

surgical practice in Türkiye (6,7,10). This appears to stem primarily from inadequate training opportunities during residency and limited institutional support. Notably, the deficiency is not confined to early-career surgeons; rather, it represents a widespread structural issue that affects surgeons at all stages of their professional lives.

Three main findings stand out from our data. First, formal ultrasonography training is rarely incorporated into general surgery residency programs or continuing medical education programs. Second, self-reported competency remains low overall, although it improves modestly with greater experience and exposure to training. Third, there is a strong and consistent interest among surgeons in acquiring these skills, underscoring that current educational resources fail to meet surgeons' professional needs and expectations.

Internationally, structured USG training has become well established in many surgical programs (6,11). In Germany, certified USG modules are mandatory for board certification. In the United Kingdom, the Royal College of Surgeons actively supports structured POCUS training for both trainees and consultants. In North America, the American College of Surgeons offers dedicated "USG for surgeons" courses that combine simulation, supervised practice, and competency-based evaluation (2,3,9).

In contrast, our study shows that fewer than one in ten general surgeons in Türkiye received formal USG training during residency, a proportion that remains considerably below international standards (12-14).

A particularly important finding of this study is that low ultrasonography competency was not confined to residents. Even among specialists with more than ten years of experience, the majority reported limited or no proficiency in USG. This indicates that the problem goes well beyond the early stages of training and instead points to a systemic lack of structured training opportunities at all levels of surgical practice (15).

We observed a clear gradient in competency according to academic rank: approximately 50% of academic faculty reported moderate-to-high competency, compared with 27% of specialists and only 2% of residents. This difference most likely reflects self-selection; surgeons who pursue academic careers may have had greater exposure to ultrasonography through research projects or institutional protocols.

Our multivariable regression analysis showed that attendance at postgraduate USG courses was the strongest independent predictor of higher levels of self-reported competency (aOR 12.92, 95% CI 4.66-35.83). Access to a dedicated USG device was also independently associated with greater competency (aOR

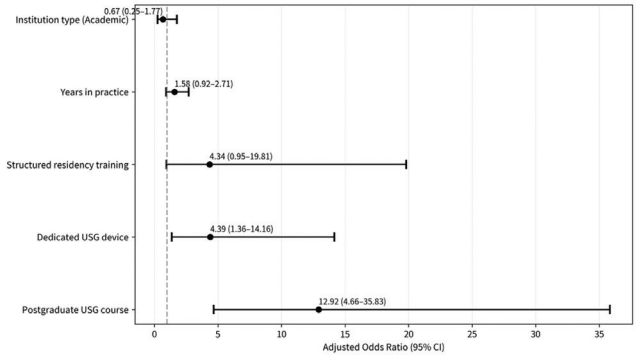

Figure 3. Forest plot of adjusted odds ratios from multivariable logistic regression. Postgraduate USG course attendance and dedicated device access were independently associated with higher self-reported competency.

USG: Ultrasound, CI: Confidence interval.

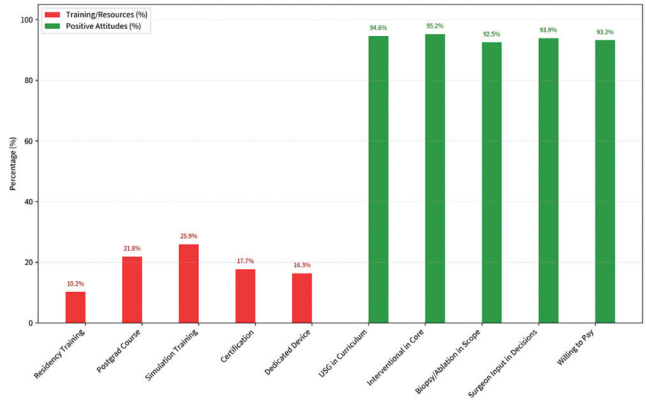

Figure 4. Training gaps versus attitudes toward USG education among general surgeons in Türkiye (n=147).

USG: Ultrasound.

Table 4. Independent predictors of moderate-to-high self-reported USG competency—multivariable logistic regression (n=147)

Predictor variable	aOR	95% CI	p
Postgraduate USG course attendance (Ref: No postgraduate training)	**12.92**	4.66-35.83	**<0.001**
Dedicated USG device access (Ref: No dedicated device)	**4.39**	1.36-14.16	**0.013**
Structured residency USG training (Ref: No residency training)	4.34	0.95-19.81	0.058
Years in practice (grouped: 0-5/5-10/≥10)	1.58	0.92-2.71	0.101
Institution type (academic vs. non-academic)	0.67	0.25-1.77	0.419

USG: Ultrasound, CI: Confidence interval, aOR: Adjusted odds ratio.

4.39, 95% CI 1.36-14.16). Notably, access to equipment alone was insufficient. Many surgeons who had a dedicated device still reported low confidence.

In contrast, structured residency training showed a large effect estimate (aOR 4.34, 95% CI 0.95-19.81) but did not reach statistical significance (p=0.058); this is most likely because very few participants (n=15) had received such training. Taken together, these results highlight that formal educational exposure, rather than the mere availability of equipment, is the key factor in developing and maintaining competency.

The procedural landscape revealed by this survey also deserves attention. Thyroid and breast biopsies, as well as ablation procedures, are currently performed almost exclusively by radiologists and endocrinologists, with general surgeons playing a very limited role. In 15.6% of institutions, thyroid biopsy is not performed at all, meaning patients must be referred elsewhere. This creates a significant logistical and clinical burden. Importantly, most respondents indicated that they would prefer to perform these procedures themselves if they had the necessary skills. This strong referral dependency, together with the surgeons' clear willingness to acquire USG skills, supports the need for targeted training programs.

Ultrasonography training is especially relevant for minimally invasive management of thyroid and breast pathology, ablative therapies (such as radiofrequency and microwave ablation), intraoperative tumor margin assessment, and emergency bedside evaluation (e.g., FAST protocol). As surgical care continues to shift toward image-guided and organ-preserving approaches, general surgeons who lack proficiency in ultrasonography may gradually be excluded from important aspects of patient care. Notably, 65.3% of participants anticipated a narrowing of the scope of general surgery due to these developments, although only a minority expressed concern about this trend.

Study Limitations

Several limitations of this study should be acknowledged. Selection bias may have occurred because the survey was distributed electronically and participation was voluntary. Surgeons who were already interested in ultrasonography were probably more likely to respond, which may have influenced our findings.

Second, competency was measured by self-report rather than objective assessment. Self-reported skill levels are subject to bias and may not accurately reflect true proficiency. This is particularly relevant for residents, who reported the lowest competency levels and likely had the lowest actual skills. Third, the questionnaire was not based on a previously validated tool for assessing USG competency.

Fourth, although the survey reached surgeons across the country, the non-probability sampling method limits the generalizability of the results. Finally, some subgroups were small (for example, only six professors), which reduced the precision of the findings in those categories.

CONCLUSION

This nationwide survey shows that self-reported competency in ultrasonography among general surgeons in Türkiye is low, and that formal training opportunities remain limited. The fact that this gap exists across all career stages—from residents to experienced specialists and academic faculty—suggests that the problem is systemic rather than individual.

Given the strong interest expressed by surgeons in acquiring these skills and the growing importance of image-guided procedures in modern surgical practice, there is a clear need to integrate structured ultrasonography training into general surgery residency programs. In addition, expanding accessible, practical, hands-on postgraduate courses would be an important step toward closing the current competency gap among practicing surgeons.

Ethics

Ethics Committee Approval: The study received ethical approval from the Institutional Review Board University of Health Sciences Türkiye, Sancaktepe Şehit Prof. Dr. İlhan Varank Training and Research Hospital (approval no: 2025/331, date: 24.09.2025).

Informed Consent: Written informed consent was not obtained, as the study was conducted as a survey-based research.

Footnotes

Author Contributions

Concept - U.U.Ş.; Design - U.U.Ş.; Data Collection or Processing - U.U.Ş., M.Ç.C., M.T., B.G., O.A., K.C.; Analysis or Interpretation - U.U.Ş., S.A., K.C.; Literature Search - U.U.Ş., M.T., B.G., A.G., O.A.; Writing - U.U.Ş., K.C.

Conflict of Interest: One of the authors of this article (A.G.) is a member of the Editorial Board of this journal. He was completely blinded to the peer review process of the article. No conflict of interest was declared by the authors.

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REFERENCES

1. *Ramsingh D, Bronshteyn YS, Haskins S, Zimmerman J. Perioperative point-of-care ultrasound: from concept to application. Anesthesiology. 2020;132:908-916.*
2. *Haskins SC, Bronshteyn Y, Perlas A, El-Boghdadly K, Zimmerman J, Silva M, et al. American Society of Regional Anesthesia and Pain Medicine expert panel recommendations on point-of-care ultrasound education and training for regional anesthesiologists and pain physicians-part I: clinical indications. Reg Anesth Pain Med. 2021;46:1031-1047.*
3. *Meineri M, Bryson GL, Arellano R, Skubas N. Core point-of-care ultrasound curriculum: what does every anesthesiologist need to know? Can J Anaesth. 2018;65:417-426. English.*
4. *Dumbrava BD. Point of care ultrasound by surgeons: a multicentric trial (POCUSS Trial) [thesis]. Dublin: Royal College of Surgeons in Ireland; 2022.*

5. *Pezzotta G, Masiero G, Malagnino A, Bozzo S, Brescacin A, Carrara G, et al. Cost and benefit analysis of surgeon-performed point-of-care ultrasound (SP-POCUS) supporting decision making in a general surgery department. Mecosan. 2024;129:25-40.*
6. *Bronshteyn YS, Blitz J, Hashmi N, Krishnan S. Logistics of perioperative diagnostic point-of-care ultrasound: nomenclature, scope of practice, training, credentialing/privileging, and billing. Int Anesthesiol Clin. 2022;60:1-7.*
7. *Andersen CA, Hedegård HS, Løkkegaard T, Frølund J, Jensen MB. Education of general practitioners in the use of point-of-care ultrasonography: a systematic review. Fam Pract. 2021;38:484-494.*
8. *Mollenkopf M, Tait N. Is it time to include point-of-care ultrasound in general surgery training? A review to stimulate discussion. ANZ J Surg. 2013;83:908-911.*
9. *Gray RB. Formal training predicts point-of-care ultrasound innovation adoption and competency [dissertation]. Phoenix: Grand Canyon University; 2024.*
10. *Park Y, Han J, Leikin S, Díaz-Gómez JL. Essential point-of-care ultrasound insights for 2024. Semin Ultrasound CT MR. 2024;45:22-28.*
11. *Novitch M, Prabhakar A, Siddaiah H, Sudbury AJ, Kaye RJ, Wilson KE, et al. Point of care ultrasound for the clinical anesthesiologist. Best Pract Res Clin Anaesthesiol. 2019;33:433-446.*
12. *Panebianco N, Baston C. Training, Competency, and interdisciplinary collaboration in point-of-care ultrasound. Semin Ultrasound CT MR. 2024;45:91-97.*
13. *Mongodi S, Bonomi F, Vaschetto R, Robba C, Salve G, Volta CA, et al. Point-of-care ultrasound training for residents in anaesthesia and critical care: results of a national survey comparing residents and training program directors' perspectives. BMC Med Educ. 2022;22:647.*
14. *Hsieh A, Baker MB, Phalen JM, Mejias-Garcia J, Hsieh A, Hsieh A, et al. Handheld point-of-care ultrasound: safety considerations for creating guidelines. J Intensive Care Med. 2022;37:1146-1151.*
15. *Deshpande R, Montealegre-Gallegos M, Matyal R, Belani K, Chawla N. Training the anesthesiologist in point-of-care ultrasound. Int Anesthesiol Clin. 2016;54:71-93.*

ORIGINAL ARTICLE
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General surgery residency training: Learning and teaching processes from the perspective of an educator?

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ABSTRACT

Objective: Educator perspectives on general surgery residency training have been insufficiently investigated in Türkiye. Understanding educational processes and institutional challenges may contribute to the development of standardized competency-based surgical training models. This study aimed to evaluate educators' perspectives on general surgery residency training in Türkiye, identify learning and teaching processes, and evaluate current educational practices that may inform future standardization efforts.

Material and Methods: A nationwide cross-sectional survey study was conducted among general surgery educators between August and December 2019. The questionnaire included 21 closed-ended and 3 open-ended questions evaluating educational structure, faculty involvement, and perceived adequacy of residency training programs. Survey questions were prepared following a literature review and expert evaluation. A pilot study involving 10 educators was conducted prior to national distribution.

Results: A total of 156 educators completed the survey. Although 97% of educators supported structured residency programs, only 44% considered the current curriculum content sufficient and fewer than one-fifth reported full curriculum implementation. Faculty members working simultaneously at private institutions reported lower institutional presence, despite perceiving their educational contribution as adequate. Participants also identified inconsistencies in curriculum implementation and faculty participation.

Conclusion: Educators perceive significant limitations in the standardization and implementation of general surgery residency training programs in Türkiye. Strengthening competency-based curricula, improving faculty engagement, and developing validated educational assessment tools may improve the quality of residency training.

Keywords: General surgery residency training, Türkiye, educator perspective, competency-based education, residents, standardized curricula

INTRODUCTION

The increasing complexity of healthcare systems, rapid advances in medical knowledge and variability in institutional resources have highlighted the need for standardization in medical education. This need extends beyond undergraduate education and includes residency training, where the development of competent specialists depends on structured educational programs, effective supervision, and clearly defined learning outcomes (1-5).

Residency training is commonly described through three interconnected domains: Structure, process, and outcomes. Structure refers to the institutions, regulations, and resources that support training. The process includes educational activities, clinical exposure, supervision and assessment methods. Outcomes represent the competencies expected from residents upon completion of training (5). In surgical specialties, residency programs are expected to develop cognitive knowledge, technical skills, clinical judgment, professionalism, communication skills, and lifelong learning habits (6).

Over the past two decades, competency-based medical education has become the dominant framework for postgraduate training worldwide. International educational models such as CanMEDS, the Accreditation Council for Graduate Medical Education (ACGME) competencies, and the Royal Australasian College of Surgeons framework have emphasized measurable competencies and educational outcomes rather than time-based training alone (7-12).

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In Türkiye, efforts to standardize postgraduate medical education have been supported by professional organizations and national regulatory bodies. The Board of Specialization in Medicine Curriculum Creation and Standard Determination System (TUKMOS) has developed specialty-specific curricula, including the General Surgery Core Curriculum, which was most recently updated in 2022 (12,13). The curriculum defines multiple competency domains and provides a framework for residency training. However, variability in curriculum implementation, educational content, faculty participation, and institutional resources continues to be reported across training centers (14-19).

While several studies have investigated residents' satisfaction, educational experiences, and perceived deficiencies in training programs, relatively few studies have examined residency education from the perspective of educators. Educators play a central role in the implementation of the curriculum, supervision, assessment, and professional development of residents. Understanding their perceptions may help identify barriers to effective training and contribute to future standardization efforts.

Therefore, this study aimed to evaluate educators' perspectives on general surgery residency training in Türkiye, to identify key learning and teaching processes, and to explore challenges affecting the implementation of residency education.

MATERIAL and METHODS

Study Design and Participants

This nationwide, cross-sectional survey was conducted between August and December 2019 to explore educators' perspectives on general surgery residency training in Türkiye. The study was based on the premise that limited information is available regarding educational standardization, faculty involvement, and curriculum implementation in general surgery residency programs.

The study sought to address two primary questions:

1. What are the key learning and teaching processes in general surgery residency training?

2. What challenges do educators encounter during the training process?

Survey Development

A structured electronic questionnaire consisting of 21 closed-ended and 3 open-ended questions was developed by the investigators following a review of the literature on competency-based medical education, surgical residency training, and curriculum standardization. International educational frameworks, including CanMEDS competencies, ACGME core competencies, and TUKMOS recommendations, were considered during questionnaire development.

The survey was designed to evaluate:

- Faculty involvement in residency training,

- Educational structure and curriculum implementation,

- Learning environments and teaching methods,

- Time allocated to educational activities,

- Perceived adequacy of training programs.

To improve content validity and clarity, the draft questionnaire was reviewed by experienced general surgery educators and subsequently pilot-tested with 10 educators from different institutions. Minor modifications were made based on participant feedback before nationwide distribution.

Data Collection

The survey was distributed electronically to general surgery educators working in university hospitals, private university hospitals, and training and research hospitals throughout Türkiye.

The survey link was initially shared through the Turkish Surgical Association, the largest professional organization representing general surgery educators and specialists in the country. To increase participation, reminder invitations were sent to general surgery specialists for whom contact information was available, followed by direct e-mail invitations to known educators involved in residency training.

Although the exact number of eligible educators was unavailable, the target population was estimated at approximately 400 educators actively involved in residency training. A total of 291 individuals responded to the survey. After excluding participants who were not actively involved in resident education or who did not complete the questionnaire, 156 completed responses were included in the final analysis, corresponding to an estimated response rate of 39%.

Qualitative Analysis

Responses to open-ended questions were independently reviewed by two investigators and grouped into recurring themes related to educational adequacy, faculty involvement, and institutional challenges. Qualitative findings were analyzed descriptively and used to complement the quantitative results. Because the survey was not designed as a formal qualitative study, no validated qualitative coding framework or thematic saturation analysis were performed.

Statistical Analysis

Survey responses were entered into an SPSS database for analysis. Descriptive statistics were used to summarize participant characteristics and survey responses. Associations between categorical variables were evaluated using chi-square tests. Continuous variables were analyzed using Student's t-test

or One-Way Analysis of Variance, as appropriate. Statistical significance was defined as a two-sided p-value <0.05.

Because of the relatively limited sample size and unequal subgroup distributions, advanced multivariable analyses were not considered statistically reliable, and therefore were not performed. Consequently, the identified associations should be interpreted as exploratory rather than causal.

Ethical Considerations

Ethical approval was obtained from the İstanbul University Ethics Committee (approval no: 2015/504, date: 27.02.2015). Participation was voluntary, and all respondents provided informed consent before completing the survey.

RESULTS

A total of 156 educators completed the survey and were included in the analysis. The median age of participants was 48 years (range: 34-70 years). Most respondents were male (n=139, 89.1%); 17 (10.9%) were female. Professors constituted the largest academic group (n=81, 51.9%), followed by associate professors (n=50, 32.1%) and assistant professors (n=15, 9.6%). Most participants were employed at university hospitals (n=104, 66.7%) and more than half worked as faculty members for over 10 years (n=83, 53.2%) (Table 1).

Among respondents, 33 educators (21.2%) reported simultaneous employment in private institutions. The majority spent more than 75% of their professional time at their primary institution (n=114, 73.1%) and 131 (84.0%) considered this time allocation sufficient for educational activities (Table 2).

Table 1. Characteristics of the educators participating in the study

	Number	%
Age [median (min-max)]	48 (34-70)	
Sex		
Female	17	10.9
Male	139	89.1
Academic title		
Assistant Professor	15	9.6
Associate Professor	50	32.1
Professor	81	51.9
Institution		
University hospital	104	66.7
Private university hospital	8	5.1
Education and research hospital	44	28.2
Total working time in the institution		
<5 years	22	14.1
5-10 years	31	19.9
>10 years	102	65.4
Duration of work as a faculty member		
<5 years	29	18.6
5-10 years	43	27.6
>10 years	83	53.2

There was broad agreement regarding the importance of structured residency education. Nearly all participants (n=152, 97.4%) stated that general surgery residency training should be conducted within a formal educational program. Furthermore, 114 educators (73.1%) reported implementing the national curriculum framework at their institutions. However, only 68 participants (43.6%) considered the current curriculum content sufficient, whereas 40 (25.6%) regarded it as insufficient (Table 2).

When asked about curriculum implementation, only 27 educators (17.3%) reported full implementation, whereas 73 educators (46.8%) indicated partial implementation, and 17 educators (10.9%) reported that the curriculum was not adequately implemented (Table 2). Although 134 respondents (85.9%) considered the duration of residency training adequate, perceptions of educational quality were less favorable. Only 35 educators (22.4%) considered the quality of the educational program sufficient, while 57 (36.5%) described it as partially sufficient, and 46 (29.5%) believed that improvements were needed (Table 3).

Table 2. Educators' views on education-1

	Number	%
Simultaneous working in a private institution		
Yes	33	21.2
No	122	78.2
Proportion of time spent in the main institution (%)		
<25	13	8.3
25-50	10	6.4
50-75	17	10.9
>75	114	73.1
Time allocation sufficient for educational activities		
Yes	131	84.0
No	23	14.7
Need for a structured residency program		
Yes	152	97.4
No	1	0.6
Program currently implemented		
No	25	16.0
National Curriculum Framework	114	73.1
Their own programs	6	3.8
Foreign program	11	7.1
Curriculum content adequacy		
Sufficient	68	43.6
Insufficient	40	25.6
Undecided	7	4.5
Implementation of educational content		
Yes	27	17.3
No	17	10.9
Partially	73	46.8
Is the duration of the specialized training sufficient?		
Sufficient	134	85.9
Should be shorter	4	2.6
Should be longer	18	11.5

Faculty involvement in educational activities was generally perceived as moderate. Eighty educators (51.3%) rated faculty support as moderate, whereas only 37 (23.7%) considered it sufficient. Active participation in educational activities was reported by 72 educators (46.2%), while 40 (25.6%) reported only partial participation and 28 (17.9%) reported that participation was adequate, but could be improved (Table 3).

Regarding educational methods, respondents strongly supported clinical and practice-based learning environments. Operating room training was endorsed by 153 educators (98.1%), while clinic-based patient care and on-call training were each supported by 151 participants (96.8%). Seminars (93.6%), ward rounds (92.3%), outpatient clinic activities (92.3%), and minor surgical procedures (91.7%) were also frequently identified as essential components of residency education. Rotations received comparatively less support (78.8%) (Table 4).

Similarly, educators emphasized the importance of faculty participation across multiple educational settings. One hundred and forty-seven respondents (94.2%) supported participation in all surgical procedures and educational meetings, while 143 (91.7%) considered faculty involvement in case discussions essential. Participation in inpatient care activities was endorsed by 137 educators (87.8%), and involvement in outpatient care was endorsed by 127 educators (81.4%) (Table 5).

Several statistically significant associations were identified. Male educators were more likely than female educators to report simultaneous employment in private institutions (p=0.022). Female educators more frequently reported allocating sufficient time to educational activities (p=0.039). Compared with other academic ranks, professors were more commonly employed at university hospitals and reported greater participation in educational activities (p=0.014). Faculty members with more than 10 years of academic experience reported greater satisfaction with educational time allocation (p=0.025), curriculum implementation (p=0.017), and curriculum content adequacy (p=0.029) as satisfactory.

Educators working simultaneously in private institutions reported lower institutional presence despite perceiving their educational contribution as adequate. Although statistically significant associations were identified, these findings should be interpreted as exploratory because multivariable analyses were not performed.

Qualitative analysis yielded insights from three trainers who contended that faculty members need not actively engage in training. Detailed evaluation of their survey responses revealed that all three were male and employed at state universities for over 10 years. One trainer did not hold an adjunct position at a private institution, while the other two did. Their time commitments varied: two dedicated 50-75% of their schedules

Table 3. Responses of educators to questions related to training-2

	Number	%
Faculty support for educational activities		
Very little	20	12.8
Moderate	80	51.3
Sufficient	37	23.7
Sufficient but could be better	19	12.2
Active participation in educational activities		
Yes	72	46.2
No	16	10.3
Partially	40	25.6
Sufficient but could be better	28	17.9
Time allocated to educational activities		
Yes	92	59.0
No	63	40.4
Perceived quality of educational program		
Insufficient	17	10.9
Partially sufficient	57	36.5
Sufficient	35	22.4
Could be better	46	29.5

Table 4. Responses of educators to the question "What training methods should be used?"

What educational methods should be used?	Number	%
Clinic patient care	151	96.8
Polyclinic practices	144	92.3
Minor procedures	143	91.7
Operating room	153	98.1
Shifts	151	96.8
Ward rounds	144	92.3
Seminars	146	93.6
Case discussions	130	83.3
Rotations	123	78.8
Congress-symposium	133	85.3
Research-thesis	0	0
Other:		
External center rotation	3	
Endoscopy	6	
Simulation-skills training	3	
Council-patient presentation	4	
Writing articles	5	
Courses	3	

Table 5. What educational activities should the faculty member participate in?

Training activities that the faculty member is required to participate in	Number	%
Outpatient patient care	127	81.4
Inpatient patient care	137	87.8
All surgical procedures	147	94.2
All training meetings, seminars	147	94.2
All case meetings	143	91.7
Other		
- Thesis-publication studies	6	
- Advanced surgical procedures	3	
- Bedside visits	2	
- Socio-cultural activities	1	
- There is no need to participate in any of them.	**1**	

to their institutions, while one dedicated less than 25%; nevertheless, all three considered their commitments adequate. None of these trainers implemented a training program at their institutions.

DISCUSSION

This study provides a national overview of educators' perceptions regarding general surgery residency training in Türkiye. The findings suggest strong support for structured residency education among educators, while also highlighting concerns related to curriculum implementation, educational content, faculty participation, and standardization across institutions.

One of the most notable findings was the discrepancy between the widespread implementation of residency training programs and educators' perceptions of their adequacy. Although most participants reported the existence of a formal training program at their institution, fewer than half considered the curriculum content sufficient. This finding suggests that the presence of a structured program alone may not ensure effective implementation or educational quality. Similar concerns have been reported in previous studies evaluating postgraduate medical education in Türkiye, where trainees frequently described inconsistencies in curriculum delivery and educational opportunities (15-19).

The findings also emphasize the importance of faculty engagement in residency education. Participants generally viewed faculty involvement as essential for clinical teaching, surgical training, case discussions, and educational meetings. However, many educators reported only moderate levels of participation and indicated that faculty involvement could be improved. Because surgical training relies heavily on supervised clinical experience and mentorship, variability in educator participation may contribute to differences in educational experiences between institutions.

Another important observation was the relationship between faculty members' partly institutional presence and their perceived educational contribution. Educators simultaneously employed at private institutions tended to spend less time in their primary training centers, yet still perceived their educational contribution as adequate. Although this finding may reflect differences between perceived and actual educational involvement, the current study was not designed to objectively evaluate educational performance. Therefore, no conclusions can be drawn regarding the impact of this observation on resident outcomes or training quality.

The study further demonstrated that educators with greater academic experience were more likely to perceive educational time allocation, curriculum implementation, and program content as adequate. This finding may reflect increased familiarity with institutional educational processes or differing expectations regarding residency training. However, additional research is needed to better understand the factors influencing these perceptions.

The qualitative findings complemented the quantitative results by identifying concerns regarding variability in curriculum implementation and faculty engagement. Several respondents emphasized that educational quality often depended on individual faculty commitment rather than consistently applied institutional standards. These observations support ongoing efforts to strengthen educational standardization within residency programs (12,19).

The findings of this study should also be interpreted within the broader context of competency-based medical education. International frameworks such as CanMEDS and ACGME competencies emphasize measurable educational outcomes, structured assessment, and continuous program evaluation. These principles form the foundation of competency-based medical education and have increasingly shaped postgraduate surgical training worldwide (7-11,20). While the TUKMOS General Surgery Core Curriculum provides an important framework for residency education in Türkiye, variability in implementation remains a challenge. Continued efforts toward curriculum standardization, faculty development, and educational quality assurance may help reduce these differences between institutions.

Study Limitations

Several limitations should be considered when interpreting the results. The response rate was relatively low, which may have introduced non-response bias. Data were collected in 2019, before the publication of the updated 2022 TUKMOS General Surgery Core Curriculum. In addition, the survey instrument underwent expert review and pilot testing, but was not formally psychometrically validated. Qualitative responses were analyzed descriptively and should, therefore, be interpreted cautiously. Because this was a cross-sectional perception-based study, the findings reflect educators' opinions rather than objective measures of educational quality and do not permit causal inferences.

Despite these limitations, this study contributes valuable national-level data regarding educators' perspectives on general surgery residency training. Given the limited number of studies focusing on educators rather than residents, these findings may help inform future curriculum development, faculty development initiatives, and efforts aimed at improving the consistency and quality of surgical residency education in Türkiye.

CONCLUSION

This national survey of general surgery educators identified important challenges related to curriculum implementation, educational content, faculty engagement, and standardization of residency training in Türkiye. Although there was strong support for structured and competency-based residency programs, educators reported substantial variability in program delivery and in perceived educational quality.

The findings suggest that strengthening curriculum implementation, promoting faculty participation, and establishing more consistent educational standards may contribute to improving residency training. Given that these results reflect educators' perceptions, future studies incorporating validated assessment tools and objective educational outcome measures are needed to better evaluate the effectiveness of residency education and guide ongoing curriculum development efforts.

Ethics

Ethics Committee Approval: Ethical approval was obtained from the İstanbul University Ethics Committee (approval no: 2015/504, date: 27.02.2015).

Informed Consent: Participation was voluntary, and all respondents provided informed consent before completing the survey.

Footnotes

Author Contributions

Concept - B.Ö., E.V., A.H.B.; Design - B.Ö., E.V., A.H.B.; Data Collection or Processing - B.Ö., E.V., A.H.B.; Analysis or Interpretation - B.Ö., E.V., A.H.B.; Literature Search - B.Ö., E.V., A.H.B.; Writing - B.Ö., E.V., A.H.B.

Conflict of Interest: No conflict of interest was declared by the authors.

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REFERENCES

1. *Yükseköğretim Kurulu. Ulusal çekirdek eğitim programı. Erişim adresi: https://egitim.yok.gov.tr/tr/page/499 Erişim tarihi: Aralık 29, 2024.*
2. *American Medical Association. About the AMA. Available from: https://www.ama-assn.org. Accessed: December 29, 2024.*
3. *Flexner A. Medical education in the United States and Canada. New York: Carnegie foundation for the advancement of teaching; 1910.*
4. *Terzi C. Tıp eğitimi: toplum sağlığına bir köprü. İstanbul: İletişim Yayınları; 2001.*
5. *Türk Tabipleri Birliği Ulusal Yeterlik Kurulu. Tıpta uzmanlık eğitiminde rehber el kitabı. Ankara: Türk Tabipleri Birliği Yayınları; 2006.*
6. *Aggarwal R, Hance J, Darzi A. Surgical education and training in the new millennium. Surg Endosc. 2004;18:1409-1410.*
7. *Royal College of Physicians and Surgeons of Canada. CanMEDS Framework. Available from: https://www.royalcollege.ca. Accessed: December 29, 2024.*
8. *Royal Australasian College of Surgeons. RACS Competencies. Available from: https://www.surgeons.org/Trainees/the-set-program/racs-competencies Accessed: December 29, 2024.*
9. *Stanford Medicine Graduate Medical Education. ACGME Core Competencies. Available from: https://med.stanford.edu/gme/housestaff/current/core_competencies.html. Accessed: December 29, 2024.*
10. *Eberlein TJ. A new paradigm in surgical training. J Am Coll Surg. 2014;218:511-518.*
11. *Camison L, Brooker JE, Naran S, Potts JR III, Losee JE. The history of surgical education in the United States: past, present, and future. Ann Surg Open. 2022;3:e148.*
12. *Sayek İ, Aktan AÖ, Demir T, Özyurt A. Tıpta uzmanlık eğitimi raporu. Ankara: Türk Tabipleri Birliği Yayınları; 2015.*
13. *T.C. Sağlık Bakanlığı Tıpta Uzmanlık Kurulu. Genel cerrahi uzmanlık eğitimi çekirdek müfredatı 2022. Erişim adresi: https://tuk.saglik.gov.tr/TR-87040/v-25-dokumanlari.html. Erişim tarihi: Aralık 29, 2024.*
14. *Türk Cerrahi Derneği. Genel cerrahi uzmanlık eğitimi raporu 2003-2004. Erişim adresi: https://www.turkcer.org.tr/files/publications/7/4c7fc2f9dbbebe721e5a5f6d5fff570c.pdf. Erişim tarihi: Aralık 29, 2024.*
15. *Yılmaz Y, Uçar E, Ertin H. Tıpta uzmanlık eğitimi ve asistan hekimlerin sorunlarının irdelenmesi: bir anket çalışması [Postgraduate medical education and screening the problems of resident physicians: a survey study]. Tıp Eğitimi Dünyası. 2019;18:21-29. Turkish.*
16. *Çiçek C, Terzi C. Tıpta uzmanlık eğitimi: İzmir ölçekli iki araştırma ve karşılaştırmalı sonuçları. Ankara: Türk Tabipleri Birliği Yayınları; 2006.*
17. *Ekmekci P, Kurtoğlu B, Güner MD. Change in choices regarding the residency of Turkish medical students during the course of medical education. Tip Egitimi Dunyası. 2021;20:35-48.*
18. *Çapa Kaya G, Koluaçık Ş, Aktaş N, Musal B. Dokuz Eylül üniversitesi tıp fakültesi tıpta uzmanlık eğitimi programlarına ilişkin eğitici ve öğrenci geribildirimleri [Trainers and trainee feedback on residency training programs in Dokuz Eylül University medical faculty]. Tıp Eğitimi Dünyası. 2018;17:5-13. Turkish.*
19. *Vatansever E. Needs assessment study of the basic surgical skills of general surgery residents: a national survey. Doctoral Thesis. İzmir: Dokuz Eylül University; 2021.*
20. *Frank JR, Snell LS, Cate OT, Holmboe ES, Carraccio C, Swing SR, et al. Competency-based medical education: theory to practice. Med Teach. 2010;32:638-645.*

ORIGINAL ARTICLE
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Diagnostic value of preoperative hemogram parameters in patients with papillary thyroid cancer: An age- and sex-matched retrospective study

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ABSTRACT

Objective: The aim of this study was to evaluate the diagnostic value of preoperative hemogram parameters —platelet count (PLT), plateletcrit (PCT), platelet distribution width (PDW), mean platelet volume (MPV), and red cell distribution width (RDW)— in differentiating papillary thyroid carcinoma (PTC) from benign thyroid pathology in an age- and sex-matched patient series.

Material and Methods: A total of 2.080 patients who underwent total thyroidectomy at the Gazi University Faculty of Medicine, Department of General Surgery between January 2015 and January 2023 were retrospectively reviewed. After applying exclusion criteria and removing outliers, 1.955 patients were identified. Cases with a histopathological diagnosis of PTC were matched 1:1 with patients with benign thyroid pathology based on sex and 10-year age groups. The final analysis included 348 PTC patients and 348 benign patients (n=696). Preoperative hemogram parameters were compared between the groups using the Mann-Whitney U test, and the diagnostic value was assessed using receiver operating characteristic (ROC) curve analysis.

Results: After matching, no significant difference was found between groups in terms of age (48.0±12.7 vs. 48.3±12.9 years; p=0.754) or sex distribution (p=0.930). None of the parameters —PLT (277.0±70.4 vs. 275.7±69.1 $\times 10^9$/L; p=0.723), PCT (0.270±0.072 vs. 0.270±0.075; p=0.680), PDW (14.1±2.9 vs. 13.8±2.8; p=0.300), MPV (9.54±1.33 vs. 9.42±1.14 fL; p=0.591), or RDW (13.8±1.4 vs. 14.1±1.5; p=0.053)— showed a statistically significant difference between groups. ROC analysis confirmed that none of the parameters demonstrated meaningful diagnostic value (AUC: PLT 0.508, PCT 0.510, PDW 0.473, MPV 0.488, RDW 0.543).

Conclusion: When age- and sex-matching are applied, preoperative PLT, PCT, PDW, MPV, and RDW values do not provide meaningful discrimination between PTC and benign thyroid pathology. Positive findings reported in the literature may be partly attributable to demographic confounding. The potential diagnostic value of combined indices or integration with other complete blood count parameters warrants investigation in prospective studies.

Keywords: Papillary thyroid carcinoma, mean platelet volume, platelet distribution width, plateletcrit, red cell distribution width, hemogram parameters

INTRODUCTION

Thyroid cancer is the most common malignancy of the endocrine system, and its incidence has markedly increased worldwide in recent years. This rise is largely attributed to papillary thyroid carcinoma (PTC), which is both the most common and the least aggressive subtype among all thyroid cancers (1-3). Although fine-needle aspiration biopsy (FNAB) remains the gold standard for preoperative diagnosis of PTC, this method has notable limitations, including inadequate sampling and operator dependency (4). These shortcomings have driven interest in inexpensive and readily accessible complete blood count (CBC) parameters obtainable from routine preoperative blood tests.

The role of chronic inflammation in cancer development, progression, and metastasis is increasingly well understood. Platelets play a pivotal role in this process, actively contributing to tumor angiogenesis, formation of the metastatic niche, and immune evasion (5). The morphological changes induced by platelet activation are reflected in hemogram parameters such as platelet distribution width (PDW), mean platelet volüme (MPV), platelet count (PLT), plateletcrit (PCT) and red cell distribution width (RDW). Among these, MPV and PDW have attracted particular attention; the fact that PDW increases only during pseudopod formation rather than simple platelet swelling makes it a more specific marker of activation compared to MPV (6).

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The results of studies examining these parameters specifically in PTC are conflicting. While some studies have reported significantly elevated MPV in PTC compared to benign nodules and attributed diagnostic value to it (7,8), others have failed to detect any significant intergroup difference (9,10). Studies reporting lower PDW in PTC coexist alongside those reporting higher values (10,11). These contradictory findings point to two main methodological issues: Small sample sizes and lack of age and sex matching. Since PTC is considerably more prevalent in women and middle-aged individuals, unmatched comparisons may mask or exaggerate the true diagnostic value of these parameters due to demographic confounding.

The aim of this study was to evaluate the discriminatory ability of preoperative values of PLT, PCT, PDW, MPV, and RDW to distinguish PTC from benign thyroid disease in a large, age- and sex-matched (1:1) series of patients operated on at Gazi University Faculty of Medicine, Department of General Surgery between January 2015 and January 2023.

MATERIAL and METHODS

Study Design and Patient Selection

This study retrospectively reviewed data from patients who underwent total thyroidectomy at Gazi University Faculty of Medicine, Department of General Surgery, between January 2015 and January 2023. The study protocol was approved by the Gazi University Faculty of Medicine Non-Interventional Clinical Research Ethics Committee (decision number: 598, date: 17.07.2023) and carried out in accordance with the principles of the Declaration of Helsinki. The university hospital obtains general consent from all patients upon admission for the use of anonymized clinical data in scientific research. Informed consent was obtained from all individual participants included in the study.

Inclusion criteria were as follows: (1) Age ≥18 years, (2) total thyroidectomy performed, (3) availability of postoperative histopathological diagnosis, and (4) availability of preoperative complete blood count data. Patients meeting any of the following criteria were excluded: (1) Thyroid dysfunction (TSH <0.27 or >4.2 mIU/L), as both hypothyroidism and hyperthyroidism are known to independently affect platelet indices; (2) history of chronic inflammatory or autoimmune disease such as type 2 diabetes mellitus, rheumatoid arthritis, systemic lupus erythematosus, or inflammatory bowel disease; (3) history of hematological disorders such as thrombocytopenia, thrombocytosis, or myeloproliferative disease; (4) active infection or suspicion of infection within two weeks of admission; (5) use of anticoagulant, antiplatelet, or steroid medications; (6) history of concurrent or prior malignancy; and (7) pregnancy.

Patient selection was carried out in three stages. In the first stage, 2.080 patients who underwent total thyroidectomy within the specified period were screened. In the second stage, the inclusion and exclusion criteria were applied; patients with extreme hemogram values that were deemed clinically implausible were also excluded for data quality reasons. This resulted in the exclusion of 125 patients (6.0%), leaving 1.955 patients (784 PTC, 1.171 benign) eligible for analysis. In the third stage, 1:1 matching based on age and sex was applied to minimize the effect of potential confounders. Matching was performed based on the same sex and 10-year age group (20-29, 30-39, 40-49, 50-59, 60-69, ≥70 years), with one benign patient assigned to each PTC patient. The sample size was determined based on similar studies in the literature. A total of 350 patients were randomly selected from the 784 PTC cases, and matching was applied. As suitable benign matches could not be found for 2 patients, they were excluded. This process yielded two groups of 348 patients each, totaling 696 patients included in the final analysis. The patient selection process is illustrated by a flow diagram in Figure 1.

Hemogram Parameters and Laboratory Method

Preoperative venous blood samples were collected from the antecubital vein the morning before surgery, after at least 8 hours of fasting, and transferred into K_2EDTA tubes (1.8 mg/mL). All hemogram measurements were performed within 2 hours of sample collection using an automated hematology analyzer (Sysmex XN-1000, Sysmex Corporation, Kobe, Japan). To standardize measurements, all samples were analyzed in the same laboratory using the same device.

The parameters included in the study were (PLT, $\times 10^9$/L), (PCT, %), (PDW, %), mean platelet volume (MPV, fL), and red cell distribution width (RDW, %). PLT, MPV, and PCT were measured directly by the analyzer; PDW reflects the breadth of platelet volume distribution and indicates platelet size heterogeneity. RDW is an indicator of anisocytosis, calculated by dividing the standard deviation (SD) of erythrocyte volume by the mean corpuscular volume.

Extreme values considered clinically implausible or attributable to data entry errors were excluded from analysis. For this purpose, measurements falling outside the following reference ranges were excluded: PLT 50-800 $\times 10^9$/L, MPV 5-15 fL, PDW 8-25%, PCT 0.01-1.0%, RDW 10-20%.

Statistical Analysis

Statistical analyses were performed using SPSS 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± SD and median (minimum-maximum). Normality of distribution was assessed using the Shapiro-Wilk test; the Mann-Whitney U test was used for intergroup comparisons. Categorical variables were compared using the chi-square test. The diagnostic value of the parameters was evaluated by receiver operating characteristic (ROC) curve analysis; the area under the curve (AUC), cut-off value, sensitivity, and specificity were calculated. A p-value <0.05 was considered statistically significant.

RESULTS

Patient Characteristics

A total of 2,080 patients were initially included. After excluding 125 patients who did not meet the inclusion criteria and removing outliers, 1.955 patients remained. Of the 784 patients with a histopathological diagnosis of PTC, 350 were randomly selected; 2 patients could not be matched by age and sex. The final analysis included 348 PTC patients and 348 benign thyroid pathology patients, for a total of 696 patients.

Matching was successful; no statistically significant difference was found between the groups regarding age (benign: 48.0±12.7 years, PTC: 48.3±12.9 years, p=0.754) or sex distribution (p=0.930). Patient demographic characteristics and preoperative hemogram parameters are summarized in Table 1.

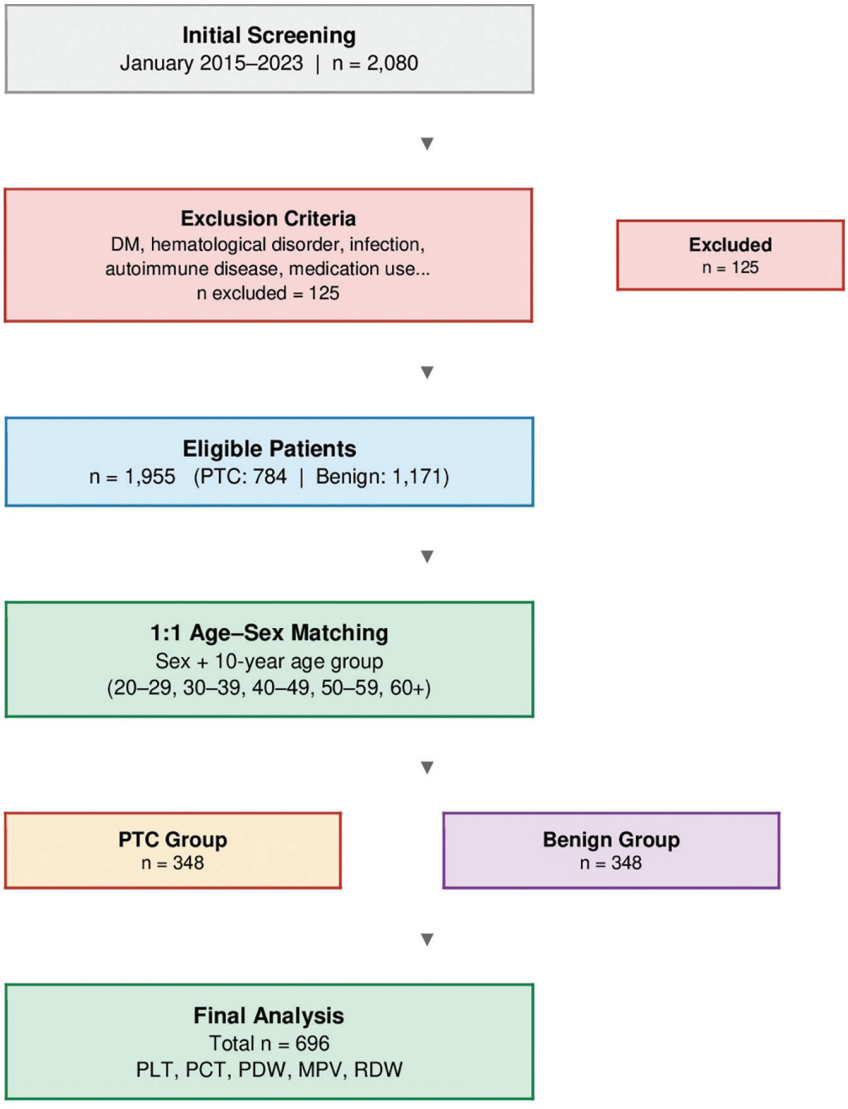

Figure 1. Patient selection flow diagram.

DM: Diabetes mellitus, PTC: Papillary thyroid carcinoma, PLT: Platelet count, PCT: Plateletcrit, PDW: Platelet distribution width, MPV: Mean platelet volume, RDW: Red cell distribution width

Intergroup Comparison of Hemogram Parameters

PLT, PCT, PDW, MPV, and RDW values did not differ significantly between the PTC and benign groups (p>0.05 for all parameters).

PLT values were 277.0±70.4 $\times 10^9$/L in the benign group and 275.7±69.1 $\times 10^9$/L in the PTC group (p=0.723). PCT values were 0.270 in both groups (benign: 0.270±0.072; PTC: 0.270±0.075; p=0.680). PDW was 14.1±2.9 in the benign group and 13.8±2.8 in the PTC group (p=0.300). MPV was 9.54±1.33 fL in the benign group and 9.42±1.14 fL in the PTC group (p=0.591). RDW was 13.8±1.4 in the benign group and 14.1±1.5 in the PTC group; this difference approached but did not reach statistical significance (p=0.053).

ROC Curve Analysis

None of the parameters demonstrated statistically significant diagnostic value in differentiating PTC from benign thyroid pathology. AUC values were 0.508 [95% confidence interval (CI): 0.466-0.550] for PLT, 0.510 (95% CI: 0.468-0.552) for PCT, 0.473 (95% CI: 0.430-0.516) for PDW, 0.488 (95% CI: 0.446-0.530) for MPV, and 0.543 (95% CI: 0.501-0.585) for RDW. All values were close to the reference line (AUC=0.500), indicating no meaningful discriminatory power (Table 2).

DISCUSSION

In a large series comprising 696 age- and sex-matched patients, preoperative PLT, PCT, PDW, MPV, and RDW values did not differ significantly between patients with PTC and those with benign thyroid pathology. ROC curve analysis further confirmed that none of the parameters carried clinically acceptable diagnostic value. This negative result conflicts with the positive findings of previous studies that had methodological limitations such as small sample sizes and lack of matching, and suggests that the true contribution of these parameters to PTC diagnosis warrants reassessment.

Platelets function not as passive bystanders but as active participants in tumor biology. Gkolfinopoulos et al. (5) comprehensively demonstrated that platelets play a critical role in tumor metastasis through three main mechanisms: Preparation of the metastatic niche via extracellular matrix formation and granulocyte recruitment, support of neoangiogenesis through vascular endothelial growth factor and platelet-derived growth factor secretion, and facilitation of immune evasion by suppressing natural killer cells. These biological functions lead to activation of platelets, which interact with tumor cells and in turn cause morphological changes reflected in parameters such as MPV and PDW (6). Vagdatli et al. (6) demonstrated that PDW increases only during pseudopod formation and not with simple platelet swelling, highlighting its greater specificity as an activation marker compared to MPV. Detopoulou et al. (12) reported that hemogram indices are associated with inflammation and tumor progression in many cancer types, but also noted that these associations vary considerably by cancer type and methodology used. This biological basis has accelerated interest in the potential diagnostic value of hemogram parameters in cancer, yet results from PTC-specific studies remain controversial.

Table 1. Comparison of demographic characteristics and hemogram parameters between groups

Parameter	Benign (n=348)	PTC (n=348)	Reference range	p-value
Age (years), mean ± SD	48.0±12.7	48.3±12.9	-	0.754
Sex (F/M), n	264/84	262/86	-	0.930
PLT ($\times 10^9$/L), mean ± SD	277.0±70.4	275.7±69.1	**150-400**	0.723
PCT (%), mean ± SD	0.270±0.072	0.270±0.075	**0.190-0.390**	0.680
PDW (%), mean ± SD	14.1±2.9	13.8±2.8	**9.0-17.0**	0.300
MPV (fL), mean ± SD	9.54±1.33	9.42±1.14	**7.5-12.5**	0.591
RDW (%), mean ± SD	13.8±1.4	14.1±1.5	**11.5-14.5**	0.053

PTC: Papillary thyroid carcinoma, PLT: Platelet count, PCT: Plateletcrit, PDW: Platelet distribution width, MPV: Mean platelet volume, RDW: Red cell distribution width, F: Female, M: Male, SD: Standard deviation. Reference ranges are based on Sysmex XN-1000 analyzer specifications.

Table 2. ROC curve analysis results

Parameter	AUC (95% CI)	Cut-off	Sensitivity (%)	Specificity (%)
PLT	0.508 (0.466-0.550)	275.4	48.6	56.3
PCT	0.510 (0.468-0.552)	0.222	69.8	32.9
PDW	0.473 (0.430-0.516)	12.1	73.3	33.0
MPV	0.488 (0.446-0.530)	8.1	85.3	16.2
RDW	0.543 (0.501-0.585)	13.8	50.1	56.5

AUC: Area under the curve, CI: Confidence interval, PLT: Platelet count, PCT: Plateletcrit, PDW: Platelet distribution width, MPV: Mean platelet volume, RDW: Red cell distribution width, ROC: Receiver operating characteristic.

The direction of findings in the literature on MPV in PTC is inconsistent. Baldane et al. (7) found preoperative MPV values to be significantly elevated in PTC patients compared to benign goiter and healthy controls (8.05, 7.57, and 7.36 fL respectively; p=0.001) in a study of 126 patients, and also observed a significant postoperative decrease. These findings suggest that MPV may be a dynamic marker related to tumor burden. Sit et al. (8) reported significantly higher MPV in malignant compared to benign nodules (9.1±1 vs. 7.8±0.8 fL; p<0.001) in a larger series of 199 patients, with an AUC of 0.84 at a cut-off of 8.25 fL.

In contrast, other studies have not supported these findings. Yaylaci et al. (10) found no significant difference in MPV between PTC and benign goiter groups (9.1±1.3 vs. 9.0±1.1 fL; p=0.697) in a series of 79 patients. Similarly, Machairas et al. (9) demonstrated that MPV did not carry discriminatory value between PTC and multinodular hyperplasia (p=0.283) in 228 patients, although MPV was found to be lower in the presence of multifocality. Yildiz et al. (13) showed significantly elevated MPV in PTC cases with tumor diameter greater than 1 cm in a series of 90 patients and interpreted this as a prognostic marker. Yu et al. (14) unexpectedly reported significantly lower MPV in thyroid cancer patients compared to controls (9.1±1.3 vs. 10.0±1.2 fL; p<0.001); this contradictory result may stem from the inclusion of different thyroid cancer histotypes (papillary, follicular, medullary) within the same group. In our study, after age and sex matching, MPV was 9.54±1.33 fL in the benign group and 9.42±1.14 fL in the PTC group, with no significant difference (p=0.591). Given that the majority of studies that reported high AUC values did not perform matching and used healthy control groups, demographic differences may have played a determining role in the reported positive outcomes.

The direction of PDW findings is also inconsistent across studies. Dincel and Bayraktar (11) reported significantly lower PDW in PTC patients compared to benign goiter and healthy controls (18.24±2.34 vs. 19.34±2.24 and 19.33±1.24; p<0.01). Yaylaci et al. (10) similarly found significantly lower PDW in the PTC group compared to the benign group (15.4±1.7 vs. 16.3±1.2; p=0.013). In contrast, Jin et al. (15) demonstrated significantly higher PDW in the PTC group compared to benign nodules and healthy controls in a large series of 1.001 patients, and showed that the combination of PDW/PLT ratio (PPR) with serum thyroglobulin (AUC=0.738) substantially increased the diagnostic value over PDW alone (AUC=0.610). Yu et al. (14) also reported higher PDW in thyroid cancer patients compared to controls (16.5±1.4 vs. 15.1±2.1; p<0.001). Deniz (16) proposed a novel index in a study comparing PTC with benign thyroid nodules and showed that the PLR/PDW ratio (AUC=0.827) had superior diagnostic value compared to PLR (AUC=0.786) or PDW alone. Machairas et al. (9) found lower PDW in T3 tumors but could not detect a significant difference between PTC and benign pathology. Li et al. (17) reported that PDW predicted lateral lymph node metastasis in medullary thyroid carcinoma (AUC=0.645), drawing attention to the prognostic potential of PDW. In our study, PDW was 14.1±2.9 in the benign group and 13.8±2.8 in the PTC group, with no significant difference (p=0.300; AUC=0.473). The contradictory directional findings in the literature indicate that the role of PDW in thyroid cancer has yet to be established, raising the question of whether PDW reflects a genuine biological signal or merely reflects methodological differences.

PCT, calculated from PLT and MPV, is an indicator of platelet mass. Dincel and Bayraktar (11) reported significantly elevated PCT in PTC patients (0.24±0.05 vs. 0.19±0.04; p<0.01). Yaylaci et al. (10) did not find a significant difference in PCT between groups. Machairas et al. (9) found no difference in PCT between PTC and benign groups but demonstrated significantly elevated PCT in tumors with extrathyroidal extension (p=0.012). Yilmaz et al. (18) reported that PCT was associated with clinicopathological features in PTC patients. In our study, PCT was 0.270 in both groups, with no significant difference (p=0.680). This finding supports the hypothesis that PCT may be related not to intergroup differences but to intraoperative tumor characteristics.

RDW is an indicator of heterogeneity in erythrocyte size and is used as a marker of inflammation and malnutrition. Han et al. (19) found significantly higher RDW in the PTC group compared to 400 healthy controls (13.13±0.85 vs. 12.40±0.58; p<0.001) in a study of 780 PTC patients, with an AUC of 0.808. However, the control group in that study consisted of healthy individuals rather than patients with benign thyroid nodules. In our study, RDW was 13.8±1.4 in the benign group and 14.1±1.5 in the PTC group; this difference approached but did not reach statistical significance (p=0.053; AUC=0.543). This borderline result warrants re-examination, particularly with larger sample sizes.

The majority of studies investigating the relationship between PLT and PTC have found no significant difference. Yildiz et al. (13) found no significant difference in PLT between PTC and nodular hyperplasia (265,981±57,340 vs. 241,783±63,289; p=0.062). Dincel and Bayraktar (11) also reported similar PLT values between groups. Machairas et al. (9) showed that PLT was unrelated to tumor size and lymphovascular invasion but was significantly elevated in T3 tumors with extrathyroidal extension. In contrast, Jin et al. (15) found significantly lower PLT in the PTC group compared to the benign group. In our study, PLT was 277.0±70.4 $\times 10^9$/L in the benign group and 275.7±69.1 $\times 10^9$/L in the PTC group, with no significant difference (p=0.723), consistent with the prevailing trend in the literature.

The contradictory findings in the literature are thought to stem largely from methodological differences. Since PTC is considerably more prevalent in women and middle-aged

individuals, demographic factors can introduce significant confounding in unmatched studies. Additionally, the following factors complicate the interpretation of the results: Whether the control group consists of patients with benign thyroid nodules or healthy individuals; the potential effect of analyzer type on MPV and PDW measurements; whether the interval between blood collection and measurement was standardized; and the adequacy of sample size. Vagdatli et al. (6) demonstrated that MPV increases with storage time while PDW decreases, clearly illustrating the extent to which non-standardized preanalytical conditions can affect measurements.

The most fundamental strength of the present study is the application of 1:1 age-sex matching, which minimizes demographic confounding that was overlooked in the majority of previous studies and provides a stronger basis for the validity of our negative finding. Given that FNAB may be inadequate in certain cases, particularly in nodules ≥3 cm (4), routine hemogram parameters appear insufficient to fill this diagnostic gap.

The clinical implications of these findings are noteworthy. The absence of discriminatory power in these widely available and inexpensive parameters suggests that clinicians should not rely on routine hemogram indices as standalone preoperative tools for differentiating PTC from benign thyroid pathology. In clinical practice, normal or elevated MPV, PDW, or RDW values should neither reassure nor alarm the clinician regarding malignancy risk. The diagnostic workup should continue to rely on ultrasonographic evaluation and FNAB as the primary modalities. Nevertheless, these parameters may still be valuable when integrated into multiparametric models or combined with established markers (e.g., thyroglobulin) or with ultrasonographic risk stratification systems. Future research should focus on developing and validating such composite scoring systems in prospective multicenter settings.

As PTC incidence continues to rise (1,3), the need for inexpensive and readily accessible CBC parameters to strengthen preoperative diagnosis persists. However, the present findings indicate that hemogram parameters used individually are insufficient to meet this need. As demonstrated by Deniz (16) with the PLR/PDW combination and by Jin et al. (15) with the PPR plus thyroglobulin combination, indices combining multiple parameters may offer more promising diagnostic performance than single parameters alone. This suggests that future studies should focus on combined indices rather than individual parameters.

Study Limitations

This study has several important limitations. First, its retrospective design carries the risk of selection bias. Second, PCT is not directly measured by some automated analyzers; instead, it is calculated from PLT and MPV, which may limit the reliability of PCT data. Third, although TSH values were used as an exclusion criterion, potential confounders such as thyroid autoantibodies, Hashimoto's thyroiditis, and nodule size were not separately controlled for in the analysis. Fourth, although the study was conducted at a single center, the large sample size partially offsets this limitation. Fifth, neutrophil counts and red blood cell indices were not recorded in this study, precluding the evaluation of combined inflammatory parameters, such as the neutrophil-to-lymphocyte ratio and red blood cell indices. Prospective studies incorporating these parameters alongside platelet indices may provide a more comprehensive assessment of hemogram-based diagnostic tools in PTC.

The study also has important strengths. Unlike most similar studies, 1:1 age-sex matching was applied, thereby systematically controlling for demographic confounding inherent to the epidemiological characteristics of PTC. Furthermore, the sample size of 696 patients substantially exceeds that of most studies in this field. Performing all hemogram measurements on the same analyzer in the same laboratory under standardized conditions minimizes preanalytical variability. Finally, the eight-year study period enables the sample to capture seasonal and annual biological fluctuations.

CONCLUSION

In this study, preoperative PLT, PCT, PDW, MPV, and RDW did not differ significantly between papillary thyroid carcinoma and benign thyroid pathology in a large age- and sex-matched patient series, and none showed clinically acceptable diagnostic value.

Given that a substantial proportion of the positive findings in the literature derive from studies that lack demographic matching, have small sample sizes, and include heterogeneous control groups, the methodological strengths of the present study suggest that this negative result reflects a genuine biological signal. The disappearance of statistically significant differences after matching implies that previously reported positive findings may have been at least partly due to demographic confounding.

These findings indicate that the parameters examined do not provide a meaningful contribution to the preoperative diagnosis of PTC when used individually. Nevertheless, the possibility that novel indices combining multiple parameters or approaches integrating these parameters with other established markers, such as thyroglobulin, may enhance diagnostic value appears to be worth investigating. Future prospective, multicenter studies conducted under standardized preanalytical conditions will more reliably establish the true role of hemogram parameters in thyroid cancer diagnosis.

Ethics

Ethics Committee Approval: The study protocol was approved by the Gazi University Faculty of Medicine Non-Interventional Clinical Research Ethics Committee (decision number: 598, date: 17.07.2023) and carried out in accordance with the principles of the Declaration of Helsinki.

Informed Consent: Informed consent was obtained from all individual participants included in the study.

Footnotes

Author Contributions

Concept - E.G., Y.F.A., Ç.B., M.A.; Design - E.G., Y.F.A., Ç.B., M.A.; Data Collection or Processing - E.G., E.A., Ç.B., M.A.; Analysis or Interpretation - E.G., Y.F.A.; Literature Search - E.G., Y.F.A., E.A.; Writing - E.G.

Conflict of Interest: No conflict of interest was declared by the authors.

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REFERENCES

1. *Siegel RL, Miller KD, Jemal A. Cancer statistics, 2020. CA Cancer J Clin. 2020;70:7-30.*
2. *Lim H, Devesa SS, Sosa JA, Check D, Kitahara CM. Trends in thyroid cancer incidence and mortality in the United States, 1974-2013. JAMA. 2017;317:1338-1348.*
3. *Nguyen QT, Lee EJ, Huang MG, Park YI, Khullar A, Plodkowski RA. Diagnosis and treatment of patients with thyroid cancer. Am Health Drug Benefits. 2015;8:30-40.*
4. *Zargham R, Johnson H, Anderson S, Ciolino A. Conditions associated with the need for additional needle passes in ultrasound-guided thyroid fine-needle aspiration with rapid on-site pathology evaluation. Diagn Cytopathol. 2021;49:105-108.*
5. *Gkolfinopoulos S, Jones RL, Constantinidou A. The emerging role of platelets in the formation of the micrometastatic niche: current evidence and future perspectives. Front Oncol. 2020;10:374.*
6. *Vagdatli E, Gounari E, Lazaridou E, Katsibourlia E, Tsikopoulou F, Labrianou I. Platelet distribution width: a simple, practical and specific marker of activation of coagulation. Hippokratia. 2010;14:28-32.*
7. *Baldane S, Ipekci SH, Sozen M, Kebapcilar L. Mean platelet volume could be a possible biomarker for papillary thyroid carcinomas. Asian Pac J Cancer Prev. 2015;16:2671-2674.*
8. *Sit M, Aktas G, Ozer B, Kocak MZ, Erkus E, Erkol H, et al. Mean platelet volume: an overlooked herald of malignant thyroid nodules. Acta Clin Croat. 2019;58:417-420.*
9. *Machairas N, Kostakis ID, Prodromidou A, Stamopoulos P, Feretis T, Garoufalia Z, et al. Trends in white blood cell and platelet indices in a comparison of patients with papillary thyroid carcinoma and multinodular goiter do not permit differentiation between the conditions. Endocr Res. 2017;42:311-317.*
10. *Yaylaci S, Tosun O, Sahin O, Genc AB, Aydin E, Demiral G, et al. Lack of variation in inflammatory hematological parameters between benign nodular goiter and papillary thyroid cancer. Asian Pac J Cancer Prev. 2016;17:2321-2323.*
11. *Dincel O, Bayraktar C. Evaluation of platelet indices as a useful marker in papillary thyroid carcinoma. Bratisl Lek Listy. 2017;118:153-155.*
12. *Detopoulou P, Panoutsopoulos GI, Mantoglou M, Michailidis P, Pantazi I, Papadopoulos S, et al. Relation of mean platelet volume (MPV) with cancer: a systematic review with a focus on disease outcome on twelve types of cancer. Curr Oncol. 2023;30:3391-3420.*
13. *Yildiz S, Eker E, Ozturk M, Alay M. A comparison of haemogram parameters of patients with thyroid papillary cancer and nodular goiter in Van, Turkey. J Pak Med Assoc. 2019;69:1642-1646.*
14. *Yu YJ, Li N, Yun ZY, Niu Y, Xu JJ, Liu ZP, et al. Preoperative mean platelet volume and platelet distribution associated with thyroid cancer. Neoplasma. 2017;64:594-598.*
15. *Jin J, Wu G, Ruan C, Ling H, Zheng X, Ying C, et al. Preoperative platelet distribution width-to-platelet ratio combined with serum thyroglobulin may be objective and popularizable indicators in predicting papillary thyroid carcinoma. J Clin Lab Anal. 2022;36:e24443.*
16. *Deniz MS. A novel proportional index to differentiate between demographically and clinically matched cases with papillary thyroid carcinoma or non-cancerous nodule: PLR-to-PDW ratio. Am J Transl Res. 2023;15:2820-2827.*
17. *Li C, Zhang H, Li S, Zhang D, Li J, Dionigi G, et al. Prognostic impact of inflammatory markers PLR, LMR, PDW, MPV in medullary thyroid carcinoma. Front Endocrinol (Lausanne). 2022;13:861869.*
18. *Yilmaz S, Bolukbasi H, Ocakoglu A, Yildirim EO, Bozkurt MA. Role of platelets and indices in the clinicopathological features of papillary thyroid carcinoma. IKSSTD. 2022;14:97-103.*
19. *Han J, Wang J, Wang Q, Li Y, Li T, Zhang J, et al. Clinical values of preoperative red blood cell distribution width and platelet parameters in patients with papillary thyroid carcinoma. Oncol Lett. 2024;28:460.*

ORIGINAL ARTICLE
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Use of oral iohexol in patients with adhesive small intestinal obstruction

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ABSTRACT

Objective: To evaluate the clinical impact of orally administered iohexol on the restoration of bowel passage and surgical outcomes in patients with adhesive small bowel obstruction.

Material and Methods: This retrospective study included 120 adult patients diagnosed with adhesive small bowel obstruction between August 2021 and January 2024. Patients were categorized according to the treatment strategy used in routine clinical practice: Conservative management with oral iohexol or standard conservative management alone. Demographic data, laboratory parameters, time to restoration of bowel passage, length of hospital stay, need for surgery, readmission, recurrence, morbidity, and mortality were analyzed and compared between groups. Restoration of bowel passage was defined by both radiological and clinical criteria and was assessed using abdominal radiographs obtained at 24-hour intervals and clinical improvement.

Results: Bowel passage was successfully restored with conservative treatment in 109 patients (90.8%), while 11 patients (9.2%) required surgical intervention. No statistically significant difference was observed between the groups regarding surgical requirement (p=0.755). However, patients who received oral iohexol achieved bowel passage significantly earlier than those managed without contrast [median 1 day [interquartile range (IQR) 1-2] vs. 4 days (IQR 3-5); p<0.001]. The corresponding mean times to bowel passage were 1.35 and 4.10 days, respectively. Mortality occurred only in surgically treated patients.

Conclusion: Oral iohexol appears to be a safe adjunct to conservative management in patients with adhesive small bowel obstruction and is associated with earlier restoration of bowel passage. Failure of bowel passage to resolve in the early period remains an important indicator for operative management. Although no statistically significant difference in surgical requirement was observed in this cohort, larger prospective randomized controlled studies are needed to further clarify the impact of oral iohexol on clinical outcomes in adhesive small bowel obstruction.

Keywords: Intestinal obstruction, iohexol, conservative treatment

INTRODUCTION

Adhesive small bowel obstruction (ABSO) is a common surgical emergency associated with substantial morbidity and significant mortality, particularly when surgical intervention is delayed (1). The adhesions causing such bowel obstructions are typically the footprints of previous abdominal surgical procedures (2,3). After surgery, the balance between fibrin formation and disintegration in the peritoneal cavity is effective in adhesion formation (4). ASBO is a condition in which mechanical intestinal obstruction occurs due to adhesions following abdominal surgery. Treatment is surgical or conservative (5). However, water-soluble contrast media has become a popular non-surgical approach to treatment.

The Bologna guidelines revised in 2018 recommend that conservative management of ASBO be proposed first in the absence of bowel pain or hemodynamic intolerance. It is stated that in cases of obstruction without signs of strangulation and persistent vomiting or combined computed tomography findings (free fluid, mesenteric oedema, small bowel faecal sign, de-vascularized bowel), patients can be safely treated with conservative treatment and NG tube decompression. It has been suggested that conservative treatment can be continued for up to 72 hours if there are no signs of strangulation or peritonitis. Still, if no improvement is observed, surgical treatment should be applied (3).

Iohexol, a water-soluble non-ionic radiopaque contrast agent, is widely used for diagnostic purposes and can be administered orally. In this study, we retrospectively

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evaluated outcomes of patients with ASBO who received oral iohexol compared with those who underwent standard conservative management.

MATERIAL and METHODS

Between August 2021 and January 2024, a total of 120 patients admitted with ASBO were retrospectively evaluated. Ethical permission was obtained from the Mersin University Medical Faculty Clinical Research Ethics Committee for this study with date 03/04/2024 and number 2024/349. Informed consent was waived due to the retrospective nature of the study and the use of anonymized data, as described in the appropriate section of the manuscript. The study was conducted in accordance with the Declaration of Helsinki.

Inclusion and Exclusion Criteria

Patients were included if they were over 18 years of age, had a history of previous abdominal surgery, and had a radiologically confirmed diagnosis of ASBO. Exclusion criteria comprised patients with clinical peritonitis, bowel ischemia, closed-loop obstruction on computed tomography, hemodynamic instability, or other obstructive pathologies requiring urgent surgery. Patients who did not attend follow-up or had incomplete data were also excluded.

Data Collection

Patient data were obtained from hospital records and telephone follow-up. The collected variables included age, sex, number of previous operations, indication (benign vs. malignant), and baseline leukocyte and C-reactive protein (CRP) values, treatment modality, treatment outcomes, recurrence, length of hospital stay (days), time to first oral intake, 30-day readmission, morbidity, and mortality were recorded.

Treatment Allocation and Intervention

Patients were divided into two groups according to whether oral iohexol was used in the management of ASBO. Given the retrospective design of the study, patients were not prospectively assigned to treatment groups for research purposes. During the study period, there was no institutional protocol regarding the routine use of oral iohexol in ASBO. The decision to administer oral iohexol was made by the treating surgeon according to clinical assessment and established practice patterns. Accordingly, treatment allocation was not based on predefined patient characteristics, disease severity, or other systematic clinical criteria. Rather, some surgeons routinely incorporated oral iohexol into conservative management based on their clinical experience, whereas others routinely preferred standard conservative treatment alone. Consequently, the study groups were defined retrospectively according to existing variations in clinical practice rather than being created specifically for the study.

In the iohexol group, 200 mL of water mixed with 100 mL of iohexol (300 mg/mL) was administered orally over 2-3 hours. Patients with gastric distension underwent nasogastric (NG) decompression prior to iohexol administration, and the NG tube was clamped. Bowel transit was evaluated using a plain abdominal radiograph obtained approximately 24 hours after oral contrast administration (Figure 1). Restoration of bowel passage was defined by both radiological and clinical criteria. Radiological improvement was defined as the presence of contrast material in the colon and regression of air-fluid levels (Figure 2). Clinical improvement was defined as the passage of flatus and stool, absence of vomiting and abdominal distension, and tolerance of oral intake without the need for NG decompression. Oral feeding was initiated only after both radiological and clinical criteria had been met, and NG tubes were subsequently removed. In patients without evidence of restored bowel passage at the initial assessment, follow-up was continued with plain abdominal radiographs obtained at 24-hour intervals.

Patients in the non-contrast group were also followed with plain abdominal radiographs obtained at 24-hour intervals. In this group, restoration of bowel passage was considered when regression of air-fluid levels was accompanied by the passage of flatus and stool, absence of vomiting and abdominal distension, and tolerance of oral intake. Patients who failed to tolerate oral intake or showed no evidence of clinical and radiological improvement were considered to have persistent obstruction.

Surgical intervention was performed in patients who developed acute abdominal symptoms, persistent vomiting, or in whom intestinal passage could not be established during follow-up (Figure 3).

Figure 1. Abdominal X-ray.

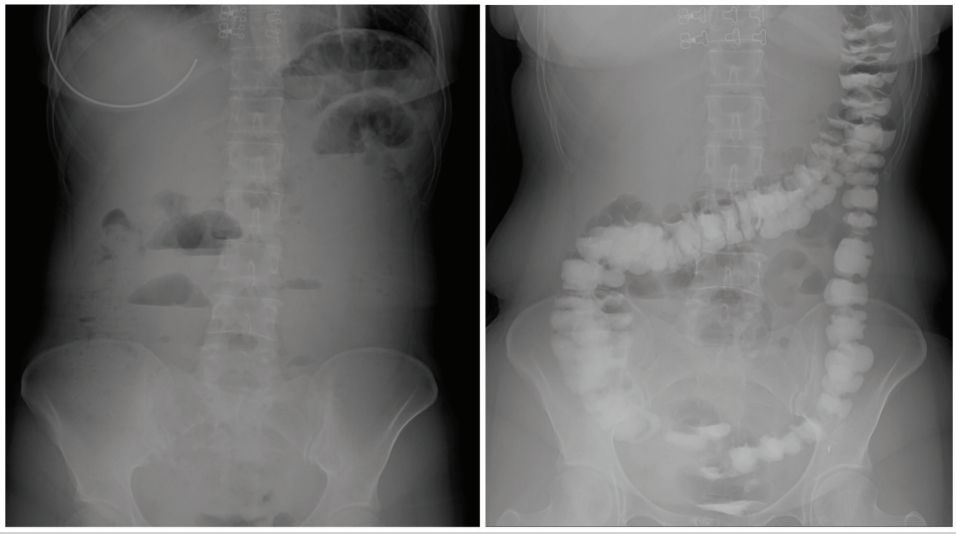

Figure 2. Abdominal X-ray before and after oral contrast, showing initial ileus and restoration of bowel passage following administration of oral contrast.

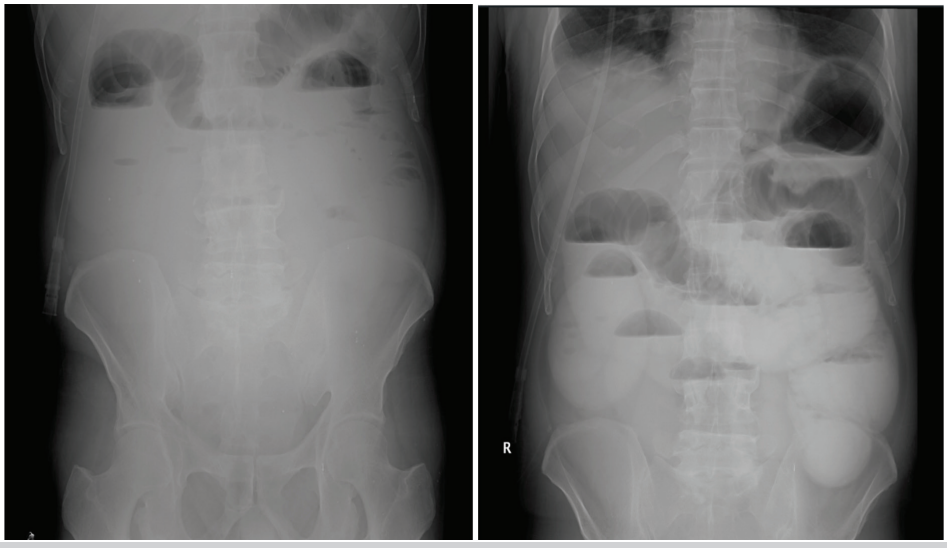

Figure 3. Oral contrast was administered, but bowel passage did not progress.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics for Windows, version 21.0. Continuous variables with a normal distribution were expressed as mean ± standard deviation, whereas non-normally distributed variables were presented as median and interquartile range (IQR). The Independent Samples t-test was used for normally distributed continuous variables, while the Mann-Whitney U test was used for non-normally distributed data. Categorical variables were compared using the chi-square test or Fisher's exact test when expected counts were low. A p-value less than 0.05 is considered statistically significant.

RESULTS

A total of 120 patients were included in this retrospective analysis. Among them, 57 patients received oral iohexol, while 63 did not. Bowel passage was restored with conservative management in 109 patients (90.8%), whereas 11 patients (9.2%) required surgical intervention due to failure of non-operative treatment. No mortality occurred among patients managed conservatively.

Baseline characteristics, including age, sex, indication for previous surgery (benign vs. malignant), number of prior laparotomies, and admission laboratory values (white blood cell and CRP), were compared between groups (Tables 1, 2).

Table 1. Baseline characteristics of patients with ASBO (iohexol vs. control)			
Variable	**Iohexol (+) (n=57)**	**Iohexol (-) (n=63)**	**p-value**
Age (years, mean ± SD)	63.26±16.21	59.97±17.07	0.282
Sex (male/female)	39/18	43/20	0.984
Number of prior laparotomies (IQR)	1 (1-3)	1 (1-4)	0.075
Malignancy/benign indication	15/42	23/40	0.231
Baseline WBC ($\times 10^3/\mu L$, mean ± SD)	10.63±2.93	11.24±3.35	0.291
Baseline CRP (mg/dL, mean ± SD)	3.73±4.65	4.29±6.93	0.925
Surgical requirement, n (%)	6 (10.5%)	5 (7.9%)	0.755
WBC: White blood cell, CRP: C-reactive protein, SD: Standard deviation, ABSO: Adhesive small bowel obstruction, IQR: Interquartile range.			

Table 2. Logistic regression analysis for surgical requirement			
Variable	**OR [exp(B)]**	**95% CI**	**p-value**
Age	1.014	0.973-1.057	0.532
WBC	0.869	0.7-1.079	0.203
CRP	1.048	0.964-1.140	0.272
Number of prior laparotomies	0.448	0.069-2.901	0.4
Oral contrast (yes/no)	1.172	0.314-4.374	0.814
OR: Odds ratio, CI: Confidence interval, WBC: White blood cell, CRP: C-reactive protein.			

Among the 11 patients who underwent surgery, 6 were in the iohexol group and 5 were in the control group. There was no statistically significant difference in the need for surgery between patients who received oral contrast and those who did not (p=0.755).

Postoperative mortality occurred in three patients (2.5% of the total cohort and 27.3% of surgically treated patients). One patient in the iohexol group died due to intestinal ischemia and subsequent sepsis with multiorgan failure. The remaining two deaths occurred in the control group and were associated with advanced age and severe postoperative complications, including cardiopulmonary failure and septic shock secondary to delayed strangulation and bowel perforation.

In the subgroup of 109 patients successfully managed conservatively, 51 had received iohexol and 58 had not. Among the 109 patients successfully managed conservatively, the median time to restoration of bowel passage was significantly shorter in the iohexol group than in the control group [1 day (IQR, 1-2) vs. 4 days (IQR, 3-5), p<0.001]. The corresponding mean times to restoration of bowel passage were 1.35±0.48 days and 4.10±1.30 days, respectively.

Post-discharge outcomes were further analyzed among patients who did not undergo surgery. Early readmission within 30 days, recurrence, and follow-up duration were evaluated and are summarized in Table 3.

DISCUSSION

Adhesions that develop after surgery are the most common cause of mechanical intestinal obstruction (6,7). ASBO is a common cause of hospital admission, and although both conservative and surgical treatment options are available, conservative management has become increasingly common (8).

Water-soluble contrast agents are used in both diagnosis and conservative treatment. Gastrografin (meglumine and sodium diatrizoate) is the water-soluble contrast agent most frequently used in ASBO according to the literature (9,10).

Water-soluble contrast agents are believed to facilitate the resolution of ABSO through several mechanisms, including the creation of an osmotic gradient that promotes intraluminal fluid influx, reduction of bowel wall edema, and stimulation of intestinal motility (8,11). Although iohexol is hyperosmolar relative to plasma (approximately 670 mOsm/kg versus 290

Table 3. Comparative post-discharge outcomes in patients with adhesive small bowel obstruction managed non-operatively			
	Iohexol (+) (n=51)	**Iohexol (-) (n=58)**	**p-value**
Early readmission (<30 days), n (%)	10 (19.6%)	8 (13.8%)	0.415
Recurrence, n (%)	4 (7.8%)	10 (17.2%)	0.112
Follow-up duration, months (mean ± SD)	14.04±7.73	10.53±8.70	0.002
SD: Standard deviation.			

mOsm/kg), it is considered a low-osmolar contrast agent and is substantially less hyperosmolar than gastrografin (approximately 1900 mOsm/kg) (12,13). Despite this lower osmotic activity, patients receiving oral iohexol in our study experienced significantly earlier restoration of bowel passage. This finding suggests that mechanisms other than osmotic fluid shifts alone may contribute to its clinical efficacy (8,14).

Previous studies evaluating water-soluble contrast agents in ASBO have demonstrated earlier restoration of bowel passage after contrast administration (9,15). Similarly, in our study, oral iohexol was associated with significantly earlier restoration of bowel passage. A total of 300 mL of fluid, consisting of 200 mL water mixed with 100 mL iohexol, was administered orally. Most patients who were successfully managed without surgery achieved bowel passage within the first two days after contrast administration.

Several studies have reported that oral contrast administration not only accelerates bowel passage but may also reduce the need for surgery (16,17). In our study, the time to restoration of bowel passage was significantly shorter in patients receiving oral iohexol; however, no reduction in surgical requirement was observed. Although previous meta-analyses, including that of Koh et al. (8), have suggested that water-soluble contrast agents may reduce the need for surgery in ASBO, we did not observe such an effect (18). Several factors may explain this discrepancy. First, our study evaluated iohexol rather than gastrografin, and differences in osmolarity may influence therapeutic efficacy. Second, the number of surgical events was small, limiting statistical power. Third, treatment allocation was not randomized and local surgical decision thresholds may have influenced operative management. Finally, differences in patient selection across studies may also contribute to the observed variation.

Most studies evaluating water-soluble contrast agents in ASBO have focused on gastrografin, a highly hyperosmolar ionic contrast medium (9,10). In contrast, the present study evaluated iohexol, a non-ionic low-osmolar contrast agent. Despite its substantially lower osmolality compared with gastrografin, iohexol was associated with a significantly shorter time to restoration of bowel passage. This finding suggests that the beneficial effects of oral contrast agents in ASBO may not be solely dependent on osmotic properties and supports further investigation of non-ionic contrast agents as potential alternatives to gastrografin.

Although the difference did not reach statistical significance, the recurrence rate was numerically lower in the iohexol group than in the control group (7.8% vs. 17.2%). This finding may suggest a potential effect of iohexol on bowel wall edema and subsequent bowel function. However, it should be interpreted cautiously given the limited sample size. Further prospective studies with larger cohorts are needed to determine whether oral iohexol has a role in reducing recurrence following conservative management of ABSO.

Studies have shown that failure of contrast to reach the colon within 24 hours and failure of conservative treatment within 72 hours are associated with an increased need for operative intervention (19). In our study, bowel passage was restored within the first two days in nearly all patients who received oral contrast and did not require surgery. Early restoration of bowel passage may facilitate earlier recovery and return to normal activities. Moreover, persistence of obstruction beyond three days despite oral contrast administration may indicate the need for surgical intervention, allowing earlier operative management and potentially preventing complications related to delayed treatment. Delayed intervention has been associated with increased mortality (3,20).

Different methods have been used to predict which patients may benefit most from nonsurgical treatment. Computed tomography and ultrasonography have been reported to be useful in detecting intestinal strangulation and monitoring conservative treatment (21,22). With oral iohexol, the need for surgery can be monitored in the early period using only abdominal radiographs. This approach is simple, inexpensive, and widely available, potentially reducing the need for additional radiological examinations.

Although the overall number of patients requiring surgery was limited, postoperative mortality in this subgroup was notable and highlights the clinical severity of complicated ABSO. The three deaths occurred exclusively in elderly male patients (78-84 years), all of whom had severe complications such as bowel ischemia, perforation, or major postoperative cardiopulmonary events. These findings emphasize that delayed identification of patients who fail conservative management may lead to progression toward irreversible ischemia and systemic complications. Therefore, earlier recognition of non-responders to conservative treatment, particularly within the first 72 hours, may be critical in reducing morbidity and improving survival outcomes.

Study Limitations

This study has several limitations. First, its retrospective and non-randomized design introduces the possibility of selection bias, as treatment allocation reflected individual surgeon practice patterns rather than a standardized protocol. Second, restoration of bowel passage was defined using both radiological and clinical criteria. Although predefined assessment criteria were applied in both groups, the retrospective and non-blinded nature of the study may have introduced some degree of assessment bias, particularly regarding the timing of oral intake initiation. In addition, differences in follow-up duration between groups may

have influenced the evaluation of long-term outcomes such as recurrence. Finally, the relatively small number of surgical events limited the statistical power to detect differences in operative outcomes. Larger prospective randomized controlled studies are needed to confirm these findings.

CONCLUSION

In addition to its diagnostic utility, water-soluble iohexol can be safely administered orally in the conservative management of ASBO. Oral iohexol facilitates earlier restoration of bowel passage and shortens the time to return to normal daily activities. Furthermore, failure of bowel passage to resolve in the early period remains an important indicator for operative management. Although no statistically significant difference in surgical requirement was observed between the study groups, this finding should be interpreted in the context of the limited number of surgical events. Larger prospective randomized controlled studies are needed to provide more robust evidence and to further clarify the impact of oral iohexol on clinical outcomes in patients with ASBO.

Ethics

Ethics Committee Approval: Ethical permission was obtained from the Mersin University Medical Faculty Clinical Research Ethics Committee for this study with date 03/04/2024 and number 2024/349.

Informed Consent: Informed consent was waived due to the retrospective nature of the study and the use of anonymized data, as described in the appropriate section of the manuscript.

Footnotes

Author Contributions

Surgical and Medical Practices - G.E., G.D., S.S.; Concept - G.E., G.D., F.Y.; Design - G.E., G.D., S.S.; Data Collection or Processing - G.E., S.S., F.Y.; Analysis or Interpretation - G.E., G.D., S.S., F.Y.; Literature Search - F.E., S.S., F.Y.; Writing - F.E., S.S., F.Y.

Conflict of Interest: No conflict of interest was declared by the authors.

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REFERENCES

1. *Podda M, Khan M, Di Saverio S. Adhesive small bowel obstruction and the six w's: who, how, why, when, what, and where to diagnose and operate? Scand J Surg. 2021;110:159-169.*
2. *Long S, Emigh B, Wolf JS Jr, Byrne C, Coopwood TB, Aydelotte J. This too shall pass: standardized gastrografin protocol for partial small bowel obstruction. Am J Surg. 2019;217:1016-1018.*
3. *Ten Broek RPG, Krielen P, Di Saverio S, Coccolini F, Biffl WL, Ansaloni L, et al. Bologna guidelines for diagnosis and management of adhesive small bowel obstruction (ASBO): 2017 update of the evidence-based guidelines from the world society of emergency surgery ASBO working group. World J Emerg Surg. 2018;13:24.*
4. *Shen CJ, Wang JJ. Advancements in the clinical management of adhesive small bowel obstruction: a perspective. Medicine (Baltimore). 2025;104:e43246.*
5. *Ghimire P, Maharjan S. Adhesive small bowel obstruction: a review. JNMA J Nepal Med Assoc. 2023;61:390-396.*
6. *Figueroa-Giralt M, Torrealba A, Gonzalez T, Almeida P, Braghetto I, Csendes A. Risk factors for reoperation, morbidity, and mortality in patients with small bowel obstruction submitted to surgical treatment. Arq Bras Cir Dig. 2022;35:e1654.*
7. *Green L, Stienstra R, Brown LR, McLean RC, Wilson MSJ, Crumley ABC, et al. Evaluating temporal trends and the impact of surgical subspecialisation on patient outcomes following adhesional small bowel obstruction: a multicentre cohort study. Eur J Trauma Emerg Surg. 2023;49:1343-1353.*
8. *Koh A, Adiamah A, Chowdhury A, Mohiuddin MK, Bharathan B. Therapeutic role of water-soluble contrast media in adhesive small bowel obstruction: a systematic review and meta-analysis. J Gastrointest Surg. 2020;24:473-483. Erratum in: J Gastrointest Surg. 2020;24:497.*
9. *Almeghthawi AH, Alrawithi MS, Alshehri ZA, Alrwaita NF, Alharbi MM, Albarakati RA, et al. Evaluating hyperosmolar water-soluble contrast media for diagnosing adhesive small bowel obstruction: a systematic review and meta-analysis of randomized controlled trials. Cureus. 2025;17:e95937.*
10. *Alnachoukati O, Ray-Zack M, Godin S, Apodaca T, Zielinski M, Dunn J. Optimal timing of first abdominal radiography after gastrografin administration for small bowel obstruction. J Surg Res. 2020;256:193-197.*
11. *Abbas S, Bissett IP, Parry BR. Oral water soluble contrast for the management of adhesive small bowel obstruction. Cochrane Database Syst Rev. 2007;2007:CD004651.*
12. *Andreucci M, Solomon R, Tasanarong A. Side effects of radiographic contrast media: pathogenesis, risk factors, and prevention. Biomed Res Int. 2014;2014:741018.*
13. *Klingbeil KD, Wu JX, Osuna-Garcia A, Livingston EH. Management of small bowel obstruction and systematic review of treatment without nasogastric tube decompression. Surg Open Sci. 2022;12:62-67.*
14. *Ceresoli M, Coccolini F, Catena F, Montori G, Di Saverio S, Sartelli M, et al. Water-soluble contrast agent in adhesive small bowel obstruction: a systematic review and meta-analysis of diagnostic and therapeutic value. Am J Surg. 2016;211:1114-1125.*
15. *VON-Diemen V, Volkweis BS, Martins EF, Silva LLM, Cavazzola LT. The water-soluble contrast for adhesive small bowel obstruction: are there advantages? Arq Bras Cir Dig. 2023;36:e1777.*
16. *Cohen RB, Olafson SN, Krupp J, Parsikia A, Kaplan MJ, Moran B, et al. Timing of gastrografin administration in the management of adhesive small bowel obstruction (ASBO): does it matter? Surgery. 2021;170:596-602.*
17. *Paily A, Kotecha J, Sreedharan L, Kumar B. Resolution of adhesive small bowel obstruction with a protocol based on gastrografin administration. J Med Life. 2019;12:10-14.*
18. *Branco BC, Barmparas G, Schnüriger B, Inaba K, Chan LS, Demetriades D. Systematic review and meta-analysis of the diagnostic and therapeutic role of water-soluble contrast agent in adhesive small bowel obstruction. Br J Surg. 2010;97:470-478.*
19. *Eze VN, Parry T, Boone D, Mallett S, Halligan S. Prognostic factors to identify resolution of small bowel obstruction without need for operative management: systematic review. Eur Radiol. 2024;34:3861-3871.*
20. *Teixeira PG, Karamanos E, Talving P, Inaba K, Lam L, Demetriades D. Early operation is associated with a survival benefit for patients with adhesive bowel obstruction. Ann Surg. 2013;258:459-465.*
21. *Nelms DW, Kann BR. Imaging modalities for evaluation of intestinal obstruction. Clin Colon Rectal Surg. 2021;34:205-218.*
22. *Paisant A, Burgmaier J, Calame P, Loison M, Molière S, Brigand C, et al. The angers CT score is a risk factor for the failure of the conservative management of adhesive small bowel obstruction: a prospective observational multicentric study. World J Surg. 2023;47:975-984.*

ORIGINAL ARTICLE
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Association between preoperative HALP score and anastomotic leakage following colorectal cancer resection: A retrospective cohort study

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ABSTRACT

Objective: Anastomotic leakage remains a major complication following colorectal surgery. This study aimed to evaluate the association between the preoperative hemoglobin, albumin, lymphocyte, and platelet (HALP) score and postoperative anastomotic leakage in patients undergoing colorectal cancer resection.

Material and Methods: This single-center retrospective cohort study included 505 patients who underwent colorectal resection with primary anastomosis for stage II-III colorectal cancer. The association between preoperative HALP score and anastomotic leakage was evaluated using univariable analyses and receiver operating characteristic (ROC) analysis. A multivariable logistic regression model adjusted for age and tumor location was fitted, and Firth's penalized likelihood estimation was used for the adjusted analysis because of the limited number of events. The study is reported in accordance with the strengthening the reporting of observational studies in epidemiology statement.

Results: Anastomotic leakage occurred in 18 patients (3.6%). Patients who developed leakage had significantly lower preoperative HALP scores than those without leakage [median 18.0 (10.8-33.3) vs. 34.5 (16.6-90.4); p<0.001]. ROC analysis demonstrated good discriminative ability (area under the curve =0.877; 95% confidence interval, 0.802-0.951; p<0.001). The Youden-derived cut-off value of 22.1 yielded a sensitivity of 72.2% and a specificity of 85.0%. In the Firth penalized multivariable logistic regression model, a higher HALP score remained independently associated with lower odds of anastomotic leakage after adjustment for age and tumor location (adjusted odds ratio, 0.83 per 1-unit increase; 95% confidence interval, 0.76-0.91; p<0.001). Given the limited number of leakage events, these findings should be interpreted as exploratory.

Conclusion: Lower preoperative HALP scores were associated with postoperative anastomotic leakage. Because of the retrospective study design, these findings should be interpreted as exploratory and require confirmation in larger prospective multicenter studies.

Keywords: Anastomotic leakage, HALP score, colorectal surgery, immunonutritional status, risk assessment

INTRODUCTION

Colorectal cancer continues to impose a substantial global disease burden and remains one of the leading causes of cancer-related mortality worldwide (1). Curative treatment primarily relies on oncological surgical resection with restoration of intestinal continuity whenever feasible (2). Despite continuous advances in surgical techniques and perioperative management, anastomotic leakage remains one of the most serious postoperative complications. It is associated with increased postoperative morbidity and mortality, prolonged hospital stay, higher reoperation rates, increased healthcare costs, and impaired oncological outcomes (3,4). Reported incidence rates vary between approximately 3% and 19% across different studies (5). Therefore, identifying patients at increased risk for anastomotic leakage remains an important objective in colorectal surgery.

Growing attention has recently been directed toward biomarkers reflecting patients' inflammatory and nutritional status because of their potential association with postoperative outcomes. Systemic inflammation adversely affects tissue healing, while adequate nutritional status is essential for wound repair and immune competence (6,7). Consequently, several composite inflammatory and nutritional indices have been proposed as prognostic biomarkers in surgical oncology.

The hemoglobin, albumin, lymphocyte, and platelet (HALP) score is a composite immunonutritional index first introduced by Chen et al. (8) in 2015 as a prognostic marker in gastric cancer. It integrates four routinely available laboratory parameters

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reflecting oxygen-carrying capacity, nutritional status, immune function, and systemic inflammatory activity (9). Since its introduction, reduced HALP scores have been associated with poor survival and adverse postoperative outcomes in several malignancies, including gastric, prostate, bladder, and colorectal cancers (9,10).

In the surgical setting, HALP has also been associated with postoperative complications. Tarle et al. (11) demonstrated that the HALP score was associated with postoperative complications following head and neck microvascular free-flap reconstruction.

In colorectal cancer, Yalav et al. (12) identified HALP as an independent prognostic factor for overall survival in patients undergoing curative surgery. Likewise, Dagmura et al. (13) demonstrated that lower HALP scores were associated with poorer survival outcomes in colorectal cancer patients. However, evidence regarding the association between preoperative HALP score and anastomotic leakage remains limited.

Therefore, the present retrospective single-center cohort study aimed to evaluate the association between the preoperative HALP score and postoperative anastomotic leakage following colorectal cancer resection. We hypothesized that patients with lower preoperative HALP scores would have a higher likelihood of developing anastomotic leakage. If confirmed, the HALP score may represent a simple, inexpensive, and readily available adjunctive biomarker for preoperative risk assessment in colorectal surgery.

MATERIAL and METHODS

Study Design and Setting

This retrospective single-center cohort study is reported in accordance with the strengthening the reporting of observational studies in epidemiology statement for observational research (14). It was conducted in accordance with the Declaration of Helsinki and approved by the Local Ethics Committee of Zonguldak Bülent Ecevit University (approval no: 2025/16; date: 17 September 2025). Because of the retrospective study design, the requirement for informed consent was waived.

Participants

Medical records of 505 consecutive adult patients who underwent curative colorectal resection with primary anastomosis for histologically confirmed colorectal cancer at a tertiary referral center between January 2016 and December 2024 were retrospectively reviewed. Patients who did not undergo surgical treatment, had no histopathological confirmation of malignancy, had metachronous malignancies, had incomplete clinical records, had stage I disease treated by local excision, or had stage IV disease undergoing palliative surgery without curative intent were excluded. As a consequence of these predefined criteria, the final analytical cohort comprised exclusively patients with pathological stage II or III disease; no stage I or stage IV patients remained after exclusion. This restriction was applied a priori to obtain a clinically homogeneous population undergoing resection with curative intent, in which restoration of intestinal continuity is the standard approach and anastomotic integrity is the relevant outcome. The potential impact of this restriction on generalizability is addressed in the limitations section. A patient selection flow diagram is presented in Figure 1.

Outcome Definition

Patients were classified into two groups according to the occurrence of postoperative anastomotic leakage. Anastomotic leakage was defined according to the criteria of the International Study Group of Rectal Cancer (ISREC) and diagnosed based on clinical findings, radiological evidence, or intraoperative confirmation. Leakage severity was graded according to the ISREC classification (Grades A-C). All leakage events were identified within the first 30 postoperative days or during the initial hospitalization. Although the ISREC definition was originally developed for rectal anastomoses, its constituent criteria—a defect of the intestinal wall at the anastomotic site resulting in communication between the intra- and extraluminal compartments, graded by the intensity of the required intervention—are anatomically generic and are not specific to the rectum. In the absence of a universally accepted colonic counterpart, the ISREC framework has been widely adopted for colonic anastomoses in both cohort studies and systematic reviews (5), and applying a single definition across both sites avoids differential outcome misclassification between the colonic and rectal subgroups. We therefore applied identical criteria to colonic and rectal anastomoses.

Mortality was defined as all-cause death occurring within 30 days of surgery or during the index hospitalization, whichever

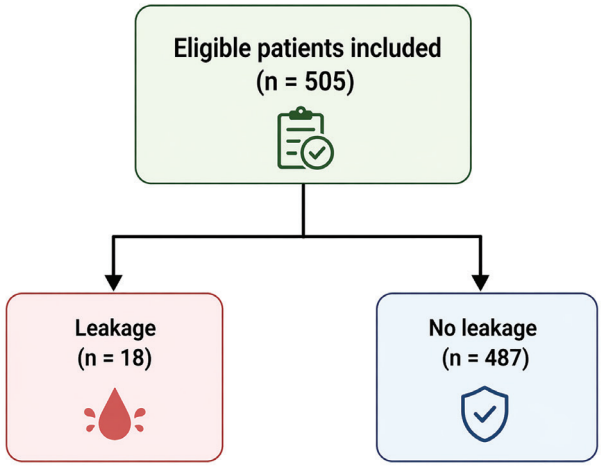

Figure 1. Flow diagram of patient selection according to predefined inclusion and exclusion criteria.

was longer. Because the present analysis was restricted to this fixed perioperative window, no longer-term or cause-specific (leakage-attributable) mortality was assessed, and survival beyond discharge was not analyzed.

Variables

Collected variables included age, sex, family history of malignancy, tumor location, pathological TNM stage, preoperative HALP score, and mortality. Tumor staging was performed according to the 2016 TNM classification system. The HALP score was calculated from the most recent preoperative laboratory values as:

HALP = Hemoglobin (g/L)×albumin (g/L)×lymphocyte count (/L)/platelet count (/L)

Because of the retrospective nature of the study, several important perioperative and comorbidity-related variables—including American Society of Anesthesiologists (ASA) score, body mass index, diabetes mellitus, smoking status, steroid use, neoadjuvant therapy, diverting ileostomy, type of resection, anastomotic level, operative approach, surgeon experience, and transfusion data—were not consistently recorded in the institutional database and therefore could not be included in the analyses. The consequences of this omission for causal interpretation are discussed in the limitations section.

Pre-specified and Post-hoc Analyses

The primary exposure variable was the preoperative HALP score and the primary outcome was postoperative anastomotic leakage. Age and tumor location (colon vs. rectum) were pre-specified as clinically relevant covariates for the adjusted model. One subgroup analysis—stratification by tumor location (colon vs. rectum)—was pre-specified. All other subgroup analyses, including the comparison of HALP scores between patients aged ≥80 years and younger patients, were performed post-hoc and are explicitly labeled as such in the results. No adjustment for multiple comparisons was applied; given the number of subgroup and outcome comparisons performed, nominal p-values from these analyses should be regarded as descriptive rather than inferential.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA); Firth's penalized likelihood logistic regression was performed in R version 4.3.1 using the logistf package, because this estimator is not implemented in SPSS. Two-sided p-values <0.05 were considered statistically significant.

Continuous variables were summarized as mean ± standard deviation or median (minimum-maximum), depending on data distribution, whereas categorical variables were presented as frequencies and percentages. Normality was assessed using the Shapiro-Wilk test. Comparisons between groups were performed using the independent-samples t-test for normally distributed variables and the Mann-Whitney U test for non-normally distributed variables. Categorical variables were compared using the chi-square test or Fisher's exact test, as appropriate.

Receiver operating characteristic (ROC) analysis was performed to assess the ability of the preoperative HALP score to discriminate between patients with and without anastomotic leakage. The area under the curve (AUC) was reported with a 95% confidence interval derived from the nonparametric (DeLong) method. The optimal cut-off was determined by maximizing the Youden index (sensitivity + specificity -1), and the corresponding sensitivity, specificity, positive and negative predictive values, and likelihood ratios were calculated with 95% Wilson confidence intervals. Because the cut-off was derived and evaluated in the same dataset, internal validation was performed using 1000 bootstrap resamples to estimate optimism in the AUC.

A multivariable binary logistic regression model was specified with anastomotic leakage as the dependent variable and HALP score, age, and tumor location as covariates. The conventional maximum likelihood model demonstrated complete separation and failed to produce finite, reliable coefficient estimates. Therefore, Firth's penalized likelihood logistic regression was used as the primary adjusted analysis. This bias-reduction method provides finite estimates in the presence of sparse data and separation. Adjusted odds ratios with 95% confidence intervals and two-sided p-values are reported. Because only 18 leakage events occurred, the adjusted results should be considered exploratory.

Because of the limited number of events, the multivariable and ROC analyses are considered exploratory and hypothesis-generating rather than confirmatory; no clinical decision threshold is proposed on the basis of these data. This caveat is not repeated elsewhere in the manuscript and applies to all model-based results reported below.

Cases with missing key variables were excluded from the relevant analyses; no imputation was performed. Since this was a retrospective cohort study, no a priori sample size calculation was performed, and the study population consisted of all eligible patients treated during the study period.

RESULTS

The analysis included 505 patients, of whom 18 (3.6%) developed anastomotic leakage and 487 (96.4%) did not. All included patients had pathological stage II (n=262, 51.9%) or stage III (n=243, 48.1%) disease; no patients with stage I or stage IV disease remained in the cohort after application of the exclusion criteria. Table 1 summarizes the demographic and

clinical characteristics of the study population according to the occurrence of anastomotic leakage. The median age of the entire cohort was 59 years (range, 32-86 years).

Patients who developed anastomotic leakage were significantly older than those without leakage [median 70.5 (52-85) vs. 58 (32-86) years; p=0.001]. Sex distribution was comparable between the two groups (p=0.13).

Tumor location differed significantly between groups. Rectal tumors were more frequent among patients with leakage than among those without leakage (66.7% vs. 30.0%; p=0.003); the leakage rate was 7.6% (12/158) after rectal resection compared with 1.7% (6/347) after colonic resection. Pathological stage III disease was also more frequent in the leakage group (77.8% vs. 47.0%; p=0.014).

Patients who developed anastomotic leakage had significantly lower preoperative HALP scores than those without leakage [median 18.0 (10.8-33.3) vs. 34.5 (16.6-90.4); p<0.001]. Perioperative mortality occurred in 14 patients (2.8%) overall. Mortality was numerically higher among patients who developed anastomotic leakage than among those who did not (11.1% vs. 2.5%), but this difference did not reach statistical significance (p=0.08, Fisher's exact test). No other demographic or clinical variables differed significantly between the groups.

ROC analysis demonstrated good discriminatory performance of the preoperative HALP score for anastomotic leakage [AUC =0.877; 95% confidence interval (CI), 0.802-0.951; p<0.001] (Figure 2). The optimal cut-off identified by the Youden index was a HALP score of 22.1, corresponding to a sensitivity of 72.2% (95% CI, 49.1-87.5), a specificity of 85.0% (95% CI, 81.6-87.9), a positive predictive value of 15.1%, a negative predictive value of 98.8%, and positive and negative likelihood ratios of 4.82 and 0.33, respectively. Anastomotic leakage occurred in 13 of 86 patients (15.1%) with a HALP score ≤22.1 compared with 5 of 419 patients (1.2%) above this threshold (p<0.001). Internal validation using 1000 bootstrap resamples yielded a negligible optimism estimate for the AUC (<0.005), which is expected for a single continuous predictor evaluated without model fitting; the bootstrap percentile confidence interval (0.800-0.945) was closely concordant with the DeLong interval.

In univariable logistic regression, each one-unit increase in the preoperative HALP score was associated with lower odds of anastomotic leakage [odds ratio (OR) 0.79; 95% CI, 0.71-0.89; p<0.001], corresponding to an approximately threefold increase in odds for every 5-unit decrease in HALP score (OR 3.18; 95% CI, 1.81-5.57).

Because complete separation was detected and the conventional maximum likelihood logistic regression model failed to converge, Firth's penalized likelihood logistic regression was used for the adjusted analysis. After adjustment for age and tumor location, each 1-unit increase in the preoperative HALP score was independently associated with a 16.8% reduction in the odds of anastomotic leakage (adjusted OR 0.83; 95% CI, 0.76-0.91; p<0.001). Expressed on a more clinically interpretable scale,

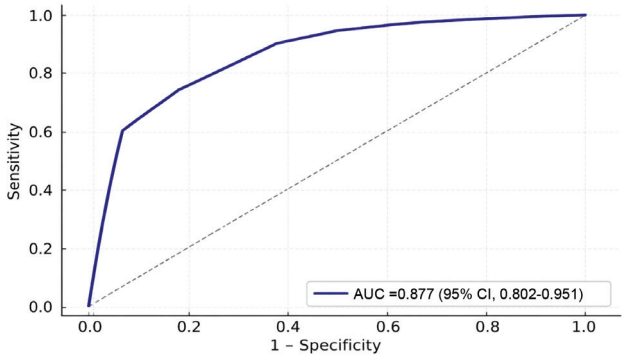

Figure 2. Receiver operating characteristic curve of the preoperative HALP score for postoperative anastomotic leakage (AUC = 0.877; 95% CI, 0.802-0.951). The marked point corresponds to the Youden-derived cut-off of 22.1 (sensitivity 72.2%, specificity 85.0%).

HALP: Hemoglobin, albumin, lymphocyte, and platelet, AUC: Area under the curve, CI: Confidence interval.

Table 1. Baseline demographic and clinical characteristics of patients with and without anastomotic leakage

Variable	Anastomotic leakage (n=18)	No leakage (n=487)	Test	p
Age, years, median (min-max)	70.5 (52-85)	58 (32-86)	Mann-Whitney U	0.001
Sex, female/male, n (%)	9 (50.0)/9 (50.0)	155 (31.8)/332 (68.2)	Fisher's exact	0.13
First-degree family history of cancer, yes/no, n (%)	4 (22.2)/14 (77.8)	85 (17.4)/402 (82.6)	Fisher's exact	0.54
Tumor location, rectum/colon, n (%)	12 (66.7)/6 (33.3)	146 (30.0)/341 (70.0)	Fisher's exact	0.003
Pathological TNM stage, II/III, n (%)	4 (22.2)/14 (77.8)	258 (53.0)/229 (47.0)	Fisher's exact	0.014
Preoperative HALP score, median (min-max)	18.0 (10.8-33.3)	34.5 (16.6-90.4)	Mann-Whitney U	<0.001
Perioperative mortality, yes/no, n (%)	2 (11.1)/16 (88.9)	12 (2.5)/475 (97.5)	Fisher's exact	0.08

HALP: Hemoglobin, albumin, lymphocyte, and platelet. Data are presented as median (minimum-maximum) or number (percentage). Continuous variables were compared using the Mann-Whitney U test and categorical variables using Fisher's exact test; two-sided p<0.05 was considered statistically significant. Perioperative and comorbidity-related variables (American Society of Anesthesiologists score, body mass index, diabetes mellitus, smoking status, neoadjuvant therapy, diverting stoma, anastomotic level, operative approach, transfusion, surgeon experience) were not consistently available because of the retrospective design and are therefore not shown.

each 5-unit decrease in the HALP score was associated with approximately 2.5-fold higher odds of leakage (adjusted OR 2.51; 95% CI, 1.62-3.89; p<0.001).

Each 10-year increase in age was independently associated with higher odds of anastomotic leakage (adjusted OR 1.49; 95% CI, 1.22-1.81; p<0.001). Rectal tumor location showed a positive but highly imprecise association with leakage (adjusted OR 160.75; 95% CI, 0.64-40,499.54; p=0.072). The extreme effect estimate and wide confidence interval for tumor location likely reflect sparse outcome data and residual separation despite penalization and therefore should not be interpreted as a reliable estimate of the true effect size.

In the pre-specified subgroup analysis by tumor location, the association between a lower HALP score and anastomotic leakage was more evident among patients with rectal cancer, whereas a similar direction of effect was observed in patients with colon cancer without reaching statistical significance. In a post-hoc analysis, patients aged ≥80 years had lower HALP scores than younger patients, consistent with an age-related decline in immunonutritional status. Because this analysis was not pre-specified and no correction for multiplicity was applied, it should be regarded as descriptive.

DISCUSSION

In this retrospective single-center cohort study, lower preoperative HALP scores were associated with the occurrence of postoperative anastomotic leakage following colorectal cancer resection. Patients who developed leakage had significantly lower HALP values than those without leakage, the HALP score discriminated between the two groups with an AUC of 0.877, and the association persisted after adjustment for age and tumor location. Consistent estimates obtained with Firth's penalized likelihood method suggest that these findings are not an artifact of the limited number of events.

Nevertheless, several established risk factors for anastomotic leakage were unavailable for adjustment. Therefore, the observed association may partly reflect residual confounding rather than an independent biological effect of the HALP score itself. Furthermore, the identified HALP threshold requires external validation before clinical implementation.

Subgroup analyses suggested that the association between lower HALP score and anastomotic leakage was more evident among patients with rectal cancer than among those with colon cancer. This observation is biologically plausible because rectal surgery is technically more demanding, the anastomosis is typically lower and less well vascularized, and rectal resection is generally associated with a higher baseline risk of anastomotic leakage—a pattern also reflected in the present cohort, in which the leakage rate after rectal resection was more than four times that after colonic resection.

Our findings are consistent with previous reports evaluating the clinical relevance of HALP in surgical oncology. Tarle et al. (11) reported similar associations with postoperative complications following head and neck microvascular reconstruction. Likewise, studies in colorectal cancer have primarily focused on the prognostic value of HALP for long-term survival rather than postoperative morbidity (12,13). Our findings extend these observations by suggesting that lower preoperative HALP scores may also be associated with an increased likelihood of anastomotic leakage.

The HALP score is increasingly recognized as a composite biomarker reflecting both nutritional and immunological status in patients with solid malignancies. Hemoglobin and albumin reflect oxygen-carrying capacity and nutritional reserve, whereas lymphocyte and platelet counts represent immune competence and systemic inflammatory activity. Consequently, a reduced HALP score may indicate impaired wound healing potential and diminished physiological reserve. Previous studies have consistently demonstrated that hypoalbuminemia, anemia, and lymphopenia are individually associated with increased postoperative complications, whereas the HALP score combines these parameters into a single immunonutritional index that may better reflect overall patient vulnerability (15-20).

Preoperative nutritional optimization may represent one potential strategy for reducing postoperative complications in patients with poor immunonutritional status. Jie et al. (21) demonstrated that perioperative nutritional support shortened postoperative hospital stay in patients undergoing abdominal surgery. Although our study was not designed to evaluate nutritional interventions, these findings support the concept that optimization of preoperative nutritional status may contribute to improved postoperative recovery. Whether preoperative correction of a low HALP score translates into a lower leakage rate remains an untested hypothesis that would require a prospective interventional design.

Study Limitations

Several limitations should be acknowledged. First, the retrospective single-center design may have introduced selection bias and limits generalizability; because stage I and stage IV patients were excluded by design, the findings apply only to patients undergoing resection with curative intent for stage II-III disease.

Second, only 18 leakage events occurred, yielding an events-per-variable ratio of 6 in the multivariable model. Although Firth's penalized estimation and bootstrap internal validation

were used to mitigate small-sample bias and optimism, the confidence intervals remain wide, external validation was not possible, and the model should not be used for individual risk prediction. Multiple subgroup and outcome comparisons were performed without correction for multiplicity, which further increases the probability of chance findings.

Third, several clinically relevant perioperative and comorbidity-related variables—ASA score, body mass index, diabetes mellitus, smoking status, steroid use, neoadjuvant therapy, diverting stoma, anastomotic level, operative approach, transfusion data, and surgeon experience—were not available. Because these are among the strongest recognized determinants of anastomotic leakage, residual confounding cannot be excluded and the observed association must not be interpreted as causal.

Fourth, HALP was measured at a single preoperative time point, so longitudinal changes in immunonutritional status could not be evaluated. Fifth, mortality was assessed only within a fixed perioperative window and was all-cause; leakage-attributable deaths could not be distinguished. With only 14 deaths, the study was underpowered to detect a difference in perioperative mortality between the groups, and the numerically higher mortality observed after anastomotic leakage should not be interpreted as evidence of absence of an effect. Finally, detailed information regarding leakage severity grade, management strategy, and time to diagnosis was not consistently recorded.

CONCLUSION

In conclusion, lower preoperative HALP scores were associated with postoperative anastomotic leakage in patients undergoing resection for stage II-III colorectal cancer. Given its low cost and routine availability, the HALP score may serve as a simple adjunctive marker of preoperative physiological vulnerability. Further prospective multicenter studies with comprehensive perioperative data are warranted to validate these findings before clinical implementation.

Ethics

Ethics Committee Approval: It was conducted in accordance with the Declaration of Helsinki and approved by the Local Ethics Committee of Zonguldak Bülent Ecevit University (approval no: 2025/16; date: 17 September 2025).

Informed Consent: Because of the retrospective study design, the requirement for informed consent was waived.

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For transparency, the authors note that an artificial intelligence-assisted language model (ChatGPT, OpenAI) was utilized for language assistance and linguistic refinement. This assistance was limited to linguistic refinement; all scientific content, critical analysis, and final editorial decisions were made exclusively by the authors.

Footnotes

Author Contributions

Surgical and Medical Practices - U.T.; Concept - U.T.; Design - U.T.; Data Collection or Processing - U.T.; Analysis or Interpretation - U.T., A.İ.B., B.S.; Literature Search - U.T.; Writing - U.T.

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REFERENCES

1. *Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. Global Cancer Statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin. 2021;71:209-249.*
2. *Benson AB, Venook AP, Adam M, Chang G, Chen YJ, Ciombor KK, et al. Colon cancer, version 3.2024, NCCN clinical practice guidelines in oncology. J Natl Compr Canc Netw. 2024;22:e240029.*
3. *Litchinko A, Buchs N, Balaphas A, Toso C, Liot E, Meurette G, et al. Score prediction of anastomotic leak in colorectal surgery: a systematic review. Surg Endosc. 2024;38:1723-1730.*
4. *Rodriguez SLR, Montoro DFS, De la Cruz Ku G, Del Rocio Luna Munoz C, Bustamante CRR. Risk factors of anastomotic leak in colorectal cancer: a multicentric study in a Latin American country. Ecancermedicalscience. 2024;18:1696.*
5. *Rennie O, Sharma M, Helwa N. Colorectal anastomotic leakage: a narrative review of definitions, grading systems, and consequences of leaks. Front Surg. 2024;11:1371567.*
6. *Kim M, Son IT, Oh BY. Inflammatory response markers as predictors of colorectal cancer prognosis. Ewha Med J. 2023;46(Suppl 1):e24.*
7. *Arends J, Baracos V, Bertz H, Bozzetti F, Calder PC, Deutz NEP, et al. ESPEN expert group recommendations for action against cancer-related malnutrition. Clin Nutr. 2017;36:1187-1196.*
8. *Chen XL, Xue L, Wang W, Chen HN, Zhang WH, Liu K, et al. Prognostic significance of the combination of preoperative hemoglobin, albumin, lymphocyte and platelet in patients with gastric carcinoma: a retrospective cohort study. Oncotarget. 2015;6:41370-41382.*
9. *Xu H, Zheng X, Ai J, Yang L. Hemoglobin, albumin, lymphocyte, and platelet (HALP) score and cancer prognosis: a systematic review and meta-analysis of 13,110 patients. Int Immunopharmacol. 2023;114:109496.*
10. *Matsui Y, Matsuda A, Maejima A, Shinoda Y, Nakamura E, Komiyama M, et al. The clinical significance of perioperative inflammatory index as a prognostic factor for patients with retroperitoneal soft tissue sarcoma. Int J Clin Oncol. 2022;27:1093-1100.*
11. *Tarle M, Čvrljević I, Raguž M, Lukšić I. Hemoglobin-albumin-lymphocyte-platelet (HALP) score as a predictive model for the success of reconstruction of head and neck defects with free microvascular Flaps. J Clin Med. 2023;12:5314.*
12. *Yalav O, Topal U, Unal AG, Eray IC. Prognostic significance of preoperative hemoglobin and albumin levels and lymphocyte and platelet counts (HALP) in patients undergoing curative resection for colorectal cancer. Ann Ital Chir. 2021;92:283-292.*
13. *Dagmura H, Daldal E, Okan I. The efficacy of hemoglobin, albumin, lymphocytes, and platelets as a prognostic marker for survival in octogenarians and nonagenarians undergoing colorectal cancer surgery. Cancer Biother Radiopharm. 2022;37:955-962.*

14. *von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP; STROBE Initiative. The strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. Lancet. 2007;370:1453-1457.*
15. *Shevchenko I, Grigorescu CC, Serban D, Cristea BM, Simion L, Gherghiceanu F, et al. The value of systemic inflammatory indices for predicting early postoperative complications in colorectal cancer. Medicina (Kaunas). 2024;60:1481.*
16. *Zhao H, Wu L, Yan G, Chen Y, Zhou M, Wu Y, et al. Inflammation and tumor progression: signaling pathways and targeted intervention. Signal Transduct Target Ther. 2021;6:263.*
17. *Rock CL, Thomson CA, Sullivan KR, Howe CL, Kushi LH, Caan BJ, et al. American Cancer Society nutrition and physical activity guideline for cancer survivors. CA Cancer J Clin. 2022;72:230-262.*
18. *Deng Y, Weng M, Zhang J. Preoperative anemia and long-term survival in patients undergoing colorectal cancer surgery: a retrospective cohort study. World J Surg Oncol. 2023;21:122.*
19. *Xia Z, Fu X, Li J, Wu J, Niu C, Xu Y, et al. Prognostic value of pretreatment serum albumin-globulin ratio in urothelial carcinoma: a systematic review and meta-analysis. Front Oncol. 2022;12:992118.*
20. *Pagès F, Mlecnik B, Marliot F, Bindea G, Ou FS, Bifulco C, et al. International validation of the consensus Immunoscore for the classification of colon cancer: a prognostic and accuracy study. Lancet. 2018;391:2128-2139.*
21. *Jie B, Jiang ZM, Nolan MT, Zhu SN, Yu K, Kondrup J. Impact of preoperative nutritional support on clinical outcome in abdominal surgical patients at nutritional risk. Nutrition. 2012;28:1022-1027.*

ORIGINAL ARTICLE
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Clinical characteristics, treatment strategies, and amputation outcomes in electrical burn patients: A single-center experience

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ABSTRACT

Objective: Electrical burns are associated with deep tissue damage and a high risk of limb loss. Early identification of patients at risk for amputation remains challenging, as traditional predictors such as voltage level and total body surface area (TBSA) may not adequately reflect tissue injury. This study aimed to evaluate clinical, laboratory, and treatment-related factors associated with amputation in adult patients with electrical burns, with a focus on biomarker-based risk prediction.

Material and Methods: This single-center retrospective cohort study included adult patients hospitalized for electrical burns between February 2019 and October 2025. Patients with incomplete records or hospital stays <7 days were excluded. Demographic data, burn characteristics, electrocardiographic findings, surgical interventions, and laboratory parameters at admission and day 7 were recorded. Univariate and multivariate logistic regression analyses were performed to identify factors associated with amputation. Discriminative ability was assessed using receiver operating characteristic (ROC) curve analysis.

Results: A total of 83 patients were included (91.6% male; median age 32 years), with 75.9% exposed to high voltage. Amputation was required in 22.9%, and mortality was 2.4%. Compared with patients who did not undergo amputation, those requiring amputation had significantly higher admission levels of creatine kinase (CK), CK-MB, aspartate aminotransferase, alanine aminotransferase (ALT), lactate dehydrogenase (LDH), C-reactive protein, neutrophils, and neutrophil/lymphocyte ratio, whereas albumin, lymphocyte count, and HALP score were significantly lower. No significant differences were observed between the amputation and non-amputation groups with respect to voltage level or TBSA. In multivariable analysis, none of the evaluated variables remained independently associated with amputation; however, LDH (odds ratio=1.001, p=0.074) and HALP score (odds ratio=0.683, p=0.056) showed borderline associations. ROC analysis showed good performance for HALP, ALT, and LDH (area under the curve: 0.76-0.77).

Conclusion: Amputation risk in electrical burns is more closely related to biomarkers of muscle injury and inflammation than to voltage or TBSA. Although no independent predictors were identified in multivariable analysis, admission LDH and HALP score showed borderline associations with amputation risk, and several laboratory biomarkers demonstrated meaningful discriminatory performance. Early laboratory assessment may therefore contribute to risk stratification and support limb-preserving strategies. Prospective multicenter studies are needed for validation.

Keywords: Electrical burn, amputation, HALP score

INTRODUCTION

Electrical burns account for a significant proportion of burn injuries worldwide. While electrical burns constitute approximately 4-5% of all burn cases in the general population, this rate can reach as high as 27% in developing countries (1-3). A notable demographic feature of electrical injuries is that the majority of cases involve young and middle-aged male patients (particularly those injured in occupational accidents) (4). The damage caused by electric current in the body can be more complex and deeper than ordinary thermal burns; extensive areas of necrosis may be found even under injuries that appear limited on the skin surface (5). Therefore, it can be difficult to determine the true extent of the damage in electrical injuries during the initial assessment, and these patients may initially develop a multiple organ failure syndrome with an intense inflammatory response (6).

Electrical burns can lead to high morbidity and mortality rates, as well as serious long-term sequelae. Complications such as cardiac arrhythmia, acute renal failure, and neurological deficits are common in the acute phase; compartment syndrome developing in the limbs and subsequent amputation are considered one of the

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most severe consequences of electrical burns (7). Amputation is also not uncommon in adult patients exposed to electrical injury: For example, a large-scale database analysis showed that approximately 30% of patients hospitalized for electrical burns required at least one amputation (8). In contrast, the amputation rate is significantly lower (~6-7%) in non-electrical burn etiologies (8). Patients with electrical burns who experience limb loss suffer from serious psychosocial problems in addition to permanent loss of working capacity and physical disadvantages. In these individuals, the lifelong limitations brought about by amputation, social stigmatization, difficulties returning to work, and psychological problems such as depression and post-traumatic stress disorder are markedly increased (8). Consequently, amputation is the complication of electrical burns with the most devastating effects on both the patient and society; therefore, its prevention, risk reduction, and accurate prediction should be among the most critical goals.

Identifying risk factors leading to amputation after an electrical burn is critical for recognizing high-risk patients early and enabling appropriate interventions. The literature reports that factors such as high voltage exposure, direct passage of electrical current through the body (contact burn), and the presence of deep tissue damage increase the risk of amputation (1,9). However, comprehensive studies on this subject, particularly those based on single-center experience, are limited. To fill this gap, we retrospectively examined the clinical determinants affecting the development of amputation in adult patients treated for electrical burns at our center using a cohort design. The findings of our study were interpreted in light of the existing literature and our center's experience.

MATERIAL and METHODS

Ethical Statement

The study was conducted with the approval of the Local Ethics Committee of University of Health Sciences Türkiye, Ankara Bilkent City Hospital (approval no: TABED 2-25-1618, date: 12.11.2025) and was carried out in accordance with the principles of the Declaration of Helsinki. Due to the retrospective design of the study and the use of anonymized patient data, the requirement for informed consent was waived by the local ethics committee.

Study Design

This study is a single-center, retrospective observational cohort study analyzing the medical records of patients hospitalized and treated for electrical burns at a tertiary burn center between February 2019 and October 2025. The study was designed and reported in accordance with the STROBE Statement guidelines.

Since our burn unit serves adult patients, pediatric cases were excluded. Initially, 99 patients were evaluated; 10 patients were excluded because of incomplete clinical data and 6 patients were excluded because they were discharged within the first 7 days. None of the patients excluded due to early discharge died or underwent major amputation within the first 6 days. Patients with a hospital stay shorter than 7 days were excluded because adequate follow-up assessment of temporal laboratory changes could not be performed. A total of 83 patients with complete clinical records were included in the final analysis. Patients with thermal, chemical, or radiation burns other than electrical burns were also excluded.

Data Collection

Demographic characteristics, burn etiology, electrical voltage (high/low), burn depth and total body surface area, affected anatomical regions, length of hospital stay, and surgical interventions (escharotomy, fasciotomy, grafting, amputation, etc.) were recorded.

Laboratory parameters at admission and on the 7th day of treatment were collected, including creatinine, blood urea nitrogen (BUN), aspartate aminotransferase (AST), alanine aminotransferase (ALT), lactate dehydrogenase (LDH), white blood cell (WBC), neutrophil/lymphocyte ratio (NLR), hemoglobin (Hb), platelet (PLT), C-reactive protein (CRP), creatine kinase (CK), CK-MB, myoglobin, and HALP score.

All data were obtained retrospectively from the hospital electronic archive system. The HALP score was calculated using the standard formula reported in the literature (Hb × albumin × lymphocyte / PLT) and used as an indicator of systemic inflammatory status.

Statistical Analysis

All statistical analyses were performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). The distribution of continuous variables was assessed using the Kolmogorov-Smirnov test. Since most variables were not normally distributed, data are presented as median (minimum-maximum).

Comparisons between admission and day 7 laboratory values were performed using the Wilcoxon signed-rank test. Differences between patients with and without amputation were evaluated using the Mann-Whitney U test for continuous variables and the chi-square test for categorical variables.

Univariate logistic regression analysis was performed to identify factors associated with amputation, and odds ratios (ORs) with 95% confidence intervals (CIs) were reported. Given the limited number of amputation events, a parsimonious multivariable logistic regression model was established using three clinically meaningful variables selected according to univariate analysis results and clinical relevance.

Receiver operating characteristic (ROC) curve analysis was used to evaluate the predictive performance of clinical and laboratory

markers. The area under the curve (AUC), optimal cut-off values, sensitivity, and specificity were calculated. A p-value <0.05 was considered statistically significant.

Due to the retrospective design, potential limitations such as measurement bias, variability in laboratory timing, and incomplete documentation may exist. Efforts were made to minimize bias by excluding incomplete or inconsistent data. No a priori sample size calculation was performed.

RESULTS

A total of 83 patients hospitalized due to electrical burns were included in the study. The median age was 32 years (18-66), and the majority were male (91.6%, n=76). Most injuries resulted from occupational accidents (80.7%), and high-voltage contact was reported in 75.9% of cases. Comorbidities were uncommon: Diabetes mellitus was present in 3.6% of patients, coronary artery disease in 2.4%, and no patient had chronic kidney disease. The overall mortality rate was 2.4% (n=2). Multitrauma associated with electrical injury was identified in 19.3% of patients.

Regarding burn distribution, the most frequently affected region was the upper extremity (94%), followed by the lower extremity (68.7%) and the trunk (37.3%). Joint involvement was observed in 78.3% of the cohort. The median total body surface area (TBSA) burned was 8% (1-47), with second- and third-degree burns predominating. The median length of hospital stay was 25 days (7-98), and the median number of surgical procedures was 4 (0-29). Cardiac involvement during hospitalization was assessed: 84.3% had a normal electrocardiography (ECG), while arrhythmias were detected in 13.3%, atrioventricular block in 1.2%, and repolarization abnormalities in 1.2%.

Laboratory parameters demonstrated marked elevations in muscle injury markers, including CK [700 (31-148.906) U/L], myoglobin [472 (13-1000) µg/L], and CK-MB [9.62 (0.23-300) µg/L]. The median troponin level, indicative of potential cardiac involvement, was 9 ng/L (1-12.087) (Table 1).

The majority of patients required surgical debridement, with escharectomy performed in 96.4%, grafting in 63.9%, fasciotomy in 28.9%, and escharotomy in 25.3%. As regenerative treatment, scaffold application was performed in 26.5% of cases, and stem cell therapy in 7.2%. Amputation was performed in a total of 19 patients (22.9%) (Table 1).

The average time to amputation in patients who underwent amputation was 15.58±7.56 days after the burn, and the most common sites of amputation were below the knee (n=5) and the toes. The revision amputation rate was 36.8%, indicating continued advanced tissue necrosis (Table 1).

When laboratory parameters at admission and on day 7 were compared, significant changes were observed in several biochemical, inflammatory, and hematological markers. Among

Table 1. Clinical, demographic, laboratory, treatment, and amputation-related characteristics of patients

Age (years)	32 (18-66)
Gender	
Male	76 (91.6%)
Female	7 (8.4%)
DM status	
Present	3 (3.6%)
Absent	80 (96.4%)
CAD status	
Present	2 (2.4%)
Absent	81 (97.6%)
CKD status	
Absent	83 (100%)
Mortality	
Survived	81 (97.6%)
Died	2 (2.4%)
Length of stay (days)	25 (7-98)
Upper extremity burn	
Present	78 (94%)
Absent	5 (6%)
Lower extremity burn	
Present	57 (68.7%)
Absent	26 (31.3%)
Head, neck burn	
Present	11 (13.3%)
Absent	72 (86.7)
Facial burn	
Present	15 (18.1%)
Absent	68 (81.9%)
Body burn	
Present	31 (37.3%)
Absent	52 (62.7%)
Perineal burn	
Present	8 (9.6%)
Absent	75 (90.4%)
Burns in the joint areas	
Present	65 (78.3%)
Absent	18 (21.7%)
Electrical voltage	
High voltage	63 (75.9%)
Low voltage	20 (24.1%)
Work accident situation	
Work accident	67 (80.7%)
Not a work accident	16 (19.3%)

Table 1. Continued	
1st-degree burn (%)	0 (0-15)
2nd-degree burn (%)	5 (0-45)
3rd-degree burn (%)	1 (0-20)
4th-degree burn (%)	0 (0-7)
Total burn surface area (%)	8 (1-47)
Total number of operations	4 (0-29)
Presence of multiple trauma	
Present	16 (19.3%)
Absent	67 (80.7)
ECG change	
Absent	70 (84.3%)
Rhythm disorder	11 (13.3%)
AV block	1 (1.2%)
Repolarization problem	1 (1.2%)
Admission CK (U/L)	700 (31-148906)
Admission CK-MB (µg/L)	9.62 (0.23-300)
Admission myoglobin (µg/L)	472 (13-1000)
Admission troponin (ng/L)	9 (1-12087)
Stem cell therapy	
Present	6 (7.2%)
Absent	77 (92.8%)
Scaffold treatment	
Present	22 (26.5%)
Absent	61 (73.5%)
Escarectomy	
Present	80 (96.4%)
Absent	3 (3.6%)
Graft application	
Present	53 (63.9)
Absent	30 (36.1)
Escharotomy	
Present	21 (25.3%)
Absent	62 (74.7%)
Fasciotomy	
Present	24 (28.9%)
Absent	59 (71.1%)
Amputation	
Present	19 (22.9%)
Absent	64 (77.1%)
Days after burn to amputation (days)	15.58±7.56
Amputation sites (n=19)	
Right below-knee	3 (15.8%)
Right foot first toe	3 (15.8%)
Left below-knee	2 (10.5%)
Right foot	2 (10.5%)
Right fifth toe	2 (10.5%)
Right forearm	2 (10.5%)
Left foot	1 (5.3%)
Left foot toes	1 (5.3%)
Right foot toes	1 (5.3%)
Left forearm	1 (5.3%)
Left hand	1 (5.3%)
Revision amputation required	
Present	7 (36.8%)
Absent	12 (63.2%)

DM: Diabetes mellitus, CAD: Coronary artery disease, CKD: Chronic kidney disease, ECG: Electrocardiography, AV: Atrioventricular, CK: Creatine kinase.

renal function parameters, median creatinine levels decreased from 0.80 mg/dL at admission to 0.67 mg/dL on day 7, and this reduction was statistically significant (p=0.001). Similarly, median albumin levels decreased from 41 g/L to 37 g/L (p=0.001), while median BUN levels decreased from 14.93 mg/dL to 12.13 mg/dL during follow-up (p=0.007).

Markers of tissue injury demonstrated significant improvement over time. Median AST levels decreased from 90 U/L at admission to 43 U/L on day 7, median ALT levels decreased from 64 U/L to 53 U/L, and median LDH levels decreased from 432 U/L to 247 U/L (all p=0.001).

Inflammatory markers also showed significant changes during hospitalization. Median WBC count decreased from 14.06×10^9/L to 9.06×10^9/L, median neutrophil count decreased from 11.81×10^9/L to 5.60×10^9/L, and median NLR decreased from 6.95 to 3.95 (all p=0.001). In contrast, median lymphocyte count remained relatively stable (1.59×10^9/L vs. 1.63×10^9/L, p=0.906). Among hematological parameters, median Hb levels decreased from 15.0 g/dL at admission to 12.3 g/dL on day 7 (p=0.001), whereas median PLT count increased from 272×10^9/L to 300×10^9/L (p=0.008). Median CRP levels increased from 25 mg/L to 50 mg/L; however, this difference did not reach statistical significance (p=0.149). Finally, median HALP score significantly decreased from 3.10 at admission to 1.88 on day 7 (p=0.001) (Table 2).

Significant elevation in muscle and cardiac injury markers was observed in patients with ECG changes. CK (p=0.022), CK-MB (p=0.042), and troponin (p=0.017) levels were markedly elevated in the group with ECG changes, indicating the effect of electrical current on the cardiac conduction system. No significant relationship was observed between electrical voltage and ECG changes (p=0.725) (Table 3).

Table 2. Patients' admission and day 7 laboratory values						
Variables	**Mean**	**Standard deviation**	**Median**	**Minimum**	**Maximum**	***p-value**
Admission creatinine (mg/dL)	0.79	0.15	0.8	0.5	1.15	**0.001**
7th-day creatinine (mg/dL)	0.71	0.38	0.67	0.35	3.81	
Admission albumin (g/L)	39.96	6.12	41	26	51	**0.001**
7th-day albumin (g/L)	36.55	7.84	37	19	50	
Admission BUN (mg/dL)	15.31	5.11	14.93	7	34.07	**0.007**
7th-day BUN (mg/dL)	13.9	8.25	12.13	6.07	79.80	
Admission AST (U/L)	324.28	630.638	90	10	4877	**0.001**
7th-day AST (U/L)	64.17	67.99	43	10	404	
Admission ALT (U/L)	125.46	153.15	64	11	818	**0.001**
7th-day ALT (U/L)	76.42	67.31	53	8	381	
Admission LDH (U/L)	723.70	961.41	432	144	7784	**0.001**
7th-day LDH (U/L)	278.81	103.84	247	129	576	
Admission WBC ($x10^9$/L)	15.24	6.26	14.06	4.57	35.24	**0.001**
7th-day WBC ($x10^9$/L)	10.14	4.33	9.06	3.23	23.9	
Admission neutrophil ($x10^9$/L)	12.38	6.4	11.81	2.87	32.42	**0.001**
7th-day neutrophil ($x10^9$/L)	7.47	4.43	5.6	1.76	21.66	
Admission lymphocyte ($x10^9$/L)	1.79	1.06	1.59	0.16	6.02	0.906
7th-day lymphocyte ($x10^9$/L)	1.64	0.76	1.63	0.29	3.8	
Admission NLR	12.15	15.54	6.95	0.94	97.81	**0.001**
7th-day NLR	6.39	6.26	3.95	1.25	31.05	
Admission Hb (g/dL)	14.66	2.18	15	7.9	19.6	**0.001**
7th-day Hb (g/dL)	12.23	2.41	12.3	7.7	16.9	
Admission PLT ($x10^9$/L)	281.34	107.54	272	101	905	**0.008**
7th-day PLT ($x10^9$/L)	317.39	110.74	300	87	585	
Admission CRP (mg/L)	59.55	71.77	25	1	296	0.149
7th-day CRP (mg/L)	87.84	91.65	50	1	350	
Admission HALP	4.35	3.6	3.1	0.45	22.29	**0.001**
7th-day HALP	2.85	2.26	1.88	0.37	9.01	

*: Wilcoxon signed-rank test, BUN: Blood urea nitrogen, AST: Aspartate aminotransferase, ALT: Alanine aminotransferase, LDH: Lactate dehydrogenase, WBC: White blood cell, NLR: Neutrophil-to-lymphocyte ratio, Hb: Hemoglobin, PLT: Platelet, CRP: C-reactive protein, HALP score: Hemoglobin (g/dL) × albumin (g/L) × lymphocyte count ($\times10^9$/L)/platelet count ($\times10^9$/L).

Table 3. Effect of laboratory and stress on predicting ECG changes				
Variables		**ECG change detected (n=13, 15.7%)**	**No ECG changes (n=70, 84.3%)**	**p-value**
Admission CK (U/L)		1512 (330-148906)	588.5 (31-82900)	***0.022**
Admission CK-MB (µg/L)		20.2 (1.37-300)	8.55 (0.23-300)	***0.042**
Admission myoglobin (µg/L)		800 (30-1000)	401 (13-1000)	*0.166
Admission troponin (ng/L)		30 (2-12087)	7.5 (1-2145)	***0.017**
Electrical voltage	**High voltage**	11 (17.5%)	52 (82.5%)	**0.725
	Low voltage	2 (10%)	18 (90%)	

*: Mann-Whitney U test, **: Chi-square test, CK: Creatine kinase, ECG: Electrocardiography.

Among patients who underwent amputation (n=19), the median length of hospital stay was 50 days (15-98), which was significantly longer than in the non-amputation group [15.5 days (7-77); p=0.001]. The total number of surgical interventions was also substantially higher in the amputation cohort [11 procedures (3-29)] compared with patients who did not require amputation [3 procedures (0-20); p=0.001]. The TBSA burned was 12% (2-47) in the amputation group and 7% (1-45) in the non-amputation group; however, this difference did not reach statistical significance (p=0.114).

Admission laboratory parameters demonstrated notable differences between groups. Median albumin levels were significantly lower in the amputation group (35 g/L) compared with the non-amputation group (42 g/L; p=0.001). Likewise, the admission HALP score was significantly reduced in patients requiring amputation (2.18 vs. 3.81; p=0.001).

Markers of muscle injury were markedly elevated among amputated patients. CK levels were significantly higher in the amputation group (11.720 U/L) than in the non-amputation group (480.5 U/L; p=0.007). Similarly, CK-MB levels (30.2 vs. 5.57 μg/L; p=0.005), AST (442 vs. 75.5 U/L; p=0.002), ALT (173 vs. 50.5 U/L; p=0.001), and LDH (819 vs. 365 U/L; p=0.001) were all significantly increased in the amputation cohort.

Inflammatory markers also differed significantly between groups. WBC counts were higher in the amputation group (17.95×10^9/L vs. 13.16×10^9/L; p=0.023), as were neutrophil counts (15.15×10^9/L vs. 10.5×10^9/L; p=0.013). Conversely, lymphocyte levels were lower among amputated patients (1.2×10^9/L vs. 1.7×10^9/L; p=0.004). The NLR demonstrated a significant disparity, with values of 10 in the amputation group and 5.7 in the non-amputation group (p=0.003).

CRP levels were substantially higher in patients who underwent amputation (90 mg/L) compared with those who did not (21 mg/L; p=0.015). Myoglobin levels were also elevated (1000 vs. 376 μg/L; p=0.047), and troponin concentrations were significantly increased in the amputation cohort (21 vs. 7.5 ng/L; p=0.008).

Regarding clinical variables, amputation was significantly more frequent in patients with lower-extremity burns (31.6%) than in those without lower-extremity burns (3.8%; p=0.012). Fasciotomy was significantly associated with amputation, with an amputation rate of 54.2% among patients who underwent the procedure compared with 10.2% in those without fasciotomy (p=0.001). No significant associations were observed between amputation and sex, electrical voltage exposure, upper-extremity burns, or joint involvement (all p>0.05) (Table 4).

In the univariate logistic regression analysis performed to identify parameters associated with the development of amputation, length of hospital stay, total number of operations, albumin, CK, AST, ALT, LDH, WBC count, neutrophil count, lymphocyte count, NLR, Hb, PLT count, CRP, and the HALP score were found to be significantly associated with amputation. In addition, lower extremity burn and fasciotomy status were significantly associated with amputation in the univariate analysis (Table 5).

When variables that were significant in the univariate analysis together with clinically relevant parameters were included in the multivariable logistic regression model, none of the variables remained independently associated with amputation risk. However, admission LDH levels [odds ratio (OR) =1.001, p=0.074] and admission HALP score (OR =0.683, p=0.056) demonstrated borderline associations with amputation in the adjusted analysis. Similarly, fasciotomy status showed a trend toward significance but did not remain an independent predictor after adjustment (OR =0.319, p=0.118) (Table 5).

According to ROC analysis, the parameter with the highest AUC value for predicting amputation was the HALP score, with an AUC value of 0.772 (p=0.001) and a cut-off point of 2.67; at this threshold, sensitivity was determined to be 68.4% and specificity 68.8%. For ALT levels, the AUC was 0.766 (p=0.001), with a cut-off value of 96 U/L; sensitivity was determined to be 68.4% and specificity 67.2%.

The AUC value for predicting amputation based on LDH level was 0.761 (p=0.001), with a cut-off value of 570.5 U/L, sensitivity of 73.7%, and specificity of 73.4%. The AUC value for AST was 0.736 (p=0.002, cut-off: 147.5 U/L), for CK it was 0.705 (p=0.007, cut-off: 1031.5 U/L), and for CK-MB, the AUC was 0.711 (p=0.006, cut-off: 12.25 μg/L).

The AUC value for NLR, an inflammatory response marker, was 0.725 (p=0.003), and the cut-off value was determined as 9.23, with a sensitivity of 63.2% and specificity of 68.8% at this value (Table 6, Figure 1).

DISCUSSION

Electrical burns predominantly affect young male individuals and are most commonly associated with occupational accidents (9,10). Large series reported in the literature indicate that the vast majority of patients sustaining electrical burn injuries are working-age men, often belonging to high-risk occupational groups. For instance, a study from China demonstrated that 93.8% of patients with high-voltage electrical burns were male, and 73.5% were between 19 and 50 years of age (10). The mean age and sex distribution observed in our cohort are consistent with these findings and reflect the typical demographic pattern of electrical burn injuries. Although comorbidities are generally less prevalent in younger populations, their presence may exacerbate clinical severity; however, data specifically addressing comorbidities in electrical burn patients remain limited. Overall mortality rates are reported to be low, ranging

Table 4. Effect of laboratory and clinical variables on amputation prediction				
Variables		**Amputation present (n=19)**	**No amputation (n=64)**	**p-value**
Age (years)		32 (19-59)	33 (18-66)	*0.700
Length of stay (days)		50 (15-98)	15.5 (7-77)	***0.001**
Total burn surface area (%)		12 (2-47)	7 (1-45)	*0.114
Total number of operations		11 (3-29)	3 (0-20)	***0.001**
Admission creatinine (mg/dL)		0.73 (0.5-1.01)	0.82 (0.52-1.15)	*0.081
Admission albumin (g/L)		35 (28-46)	42 (26-51)	***0.001**
Admission BUN (mg/dL)		14.47 (7.93-28)	14.93 (7-34.07)	*0.457
Admission CK (U/L)		11720 (31-148906)	480.5 (32-56558)	***0.007**
Admission AST (U/L)		442 (15-4877)	75.5 (10-1290)	***0.002**
Admission ALT (U/L)		173 (11-818)	50.5 (12-781)	***0.001**
Admission LDH (U/L)		819 (144-7784)	365 (164-1878)	***0.001**
Admission CK-MB (μg/L)		30.2 (1.52-300)	5.57 (0.23-300)	***0.005**
Admission myoglobin (μg/L)		1000 (100-1000)	376 (13-1000)	***0.047**
Admission troponin (ng/L)		21 (5-2030)	7.5 (1-12087)	***0.008**
Admission WBC ($x10^9$/L)		17.95 (6.34-35.24)	13.16 (4.57-35.05)	***0.023**
Admission neutrophil ($x10^9$/L)		15.15 (3.88-32.42)	10.5 (2.87-31.43)	***0.013**
Admission lymphocyte ($x10^9$/L)		1.2 (0.16-2.72)	1.7 (0.27-6.02)	***0.004**
Admission NLR		10 (2.3-97.81)	5.7 (0.94-48.59)	***0.003**
Admission Hb (g/dL)		14.6 (7.9-19.6)	15.1 (8.1-18.9)	*0.725
Admission PLT ($x10^9$/L)		274 (101-905)	270.5 (133-474)	*0.422
Admission CRP (mg/L)		90 (1-274)	21 (1-296)	***0.015**
Admission HALP		2.18 (0.53-6.32)	3.81 (0.45-22.29)	***0.001**
Gender	**Female**	1 (14.3%)	6 (85.7%)	**0.493
	Male	18 (23.7%)	58 (76.3%)	
Upper extremity burn	**Present**	16 (20.5%)	62 (79.5%)	**0.076
	Absent	3 (60%)	2 (40%)	
Lower extremity burn	**Present**	18 (31.6%)	39 (68.4%)	****0.012**
	Absent	1 (3.8%)	25 (96.2%)	
Burns in the joint areas	**Present**	17 (26.2%)	48 (73.8%)	**0.221
	Absent	2 (11.1%)	16 (88.9%)	
Electrical voltage	**Low voltage**	4 (20%)	16 (80%)	**0.493
	High voltage	15 (23.8%)	48 (76.2%)	
Fasciotomy status	**Present**	13 (54.2%)	11 (45.8%)	****0.001**
	Absent	6 (10.2%)	53 (89.8%)	

*: Mann-Whitney U test, **: Chi-square test, BUN: Blood urea nitrogen, CK: Creatine kinase, AST: Aspartate aminotransferase, ALT: Alanine aminotransferase, LDH: Lactate dehydrogenase, WBC: White blood cell, NLR: Neutrophil-to-lymphocyte ratio, Hb: Hemoglobin, PLT: Platelet, CRP: C-reactive protein, HALP score: hemoglobin (g/dL) × albumin (g/L) × lymphocyte count ($\times10^9$/L) / platelet count ($\times10^9$/L).

between 0.2% and 0.5% in large cohorts (9,10). The mortality rate of 2.4% observed in our study may be attributable to the severity of cases managed at a tertiary referral center.

In electrical burns, the anatomical regions most commonly affected are the extremities, with current entry and exit points frequently located in distal segments. Previous studies have reported that a substantial proportion of amputations involve the hand and upper extremities; in a large series, 43.9% of amputations affected the hand and 39.3% involved the upper extremity (10). These findings support the propensity of electrical current to cause profound deep tissue injury at contact points. Similarly, the distribution of affected body regions in our study was consistent with the existing literature.

Table 5. Univariate and multivariable logistic regression analyses for predictors of amputation

Variables	Univariate analysis			Multivariate analysis		
	B	p	OR (95% CI)	B	p	OR (95% CI)
Age (years)	-0.004	0.872	0.996 (0.953-1.041)			
Length of stay (days)	0.054	**0.001**	1.056 (1.028-1.084)			
Total burn surface area (%)	0.027	0.240	1.027 (0.982-1.074)			
Total number of operations	0.257	**0.001**	1.293 (1.143-1.464)			
Admission creatinine (mg/dL)	-2.945	0.103	0.053 (0.002-1.821)			
Admission albumin (g/L)	-0.171	**0.001**	0.842 (0.763-0.930)			
Admission BUN (mg/dL)	0.031	0.540	1.031 (0.935-1.137)			
Admission CK (U/L)	0.001	**0.013**	1.000 (1.000-1.000)			
Admission AST (U/L)	0.002	**0.004**	1.002 (1.001-1.003)			
Admission ALT (U/L)	0.004	**0.016**	1.004 (1.001-1.008)			
Admission LDH (U/L)	0.002	**0.001**	1.002 (1.001-1.003)	0.001	0.074	1.001 (1.000-1.002)
Admission CK-MB (μg/L)	0.004	0.054	1.004 (1.000-1.009)			
Admission myoglobin (μg/L)	0.001	0.085	1.001 (1.000-1.003)			
Admission troponin (ng/L)	0.001	0.814	1.000 (1.000-1.000)			
Admission WBC ($x10^9$/L)	0.097	**0.021**	1.101 (1.015-1.195)			
Admission neutrophil ($x10^9$/L)	0.104	**0.013**	1.109 (1.022-1.204)			
Admission lymphocyte ($x10^9$/L)	-1.090	**0.008**	0.336 (0.150-0.754)			
Admission NLR	0.057	**0.008**	1.059 (1.015-1.105)			
Admission Hb (g/dL)	-0.522	**0.001**	0.593 (0.444-0.793)			
Admission PLT ($x10^9$/L)	0.006	**0.025**	1.006 (1.001-1.010)			
Admission CRP (mg/L)	0.007	**0.010**	1.007 (1.002-1.013)			
Admission HALP	-0.509	**0.005**	0.601 (0.423-0.854)	-0.381	0.056	0.683 (0.462-1.010)
Gender	-0.622	0.577	0.537 (0.061-4.761)			
Upper extremity burn	-1.760	0.065	0.172 (0.026-1.118)			
Lower extremity burn	-2.446	**0.021**	0.087 (0.011-0.690)			
Burns in the joint areas	-1.041	0.194	0.353 (0.073-1.698)			
Electrical voltage	-0.223	0.724	0.800 (0.232-2.763)			
Fasciotomy status	-2.346	**0.001**	0.096 (0.030-0.307)	-1.141	0.118	0.319 (0.076-1.335)
Constant				-0.794	0.333	

*: Amputation was coded as 1 and absence of amputation as 0. For categorical predictors, the last category was used as the reference category (simple contrast): Male for gender, present for upper extremity burn, lower extremity burn, burns in the joint areas, and fasciotomy status, and high voltage for electrical voltage. Therefore, ORs represent the odds of amputation for the non-reference category relative to the reference category. Odds ratios (Ors) >1 indicate increased odds of amputation, whereas ORs <1 indicate decreased odds of amputation relative to the reference category. BUN: Blood urea nitrogen, CK: Creatine kinase, AST: Aspartate aminotransferase, ALT: Alanine aminotransferase, LDH: Lactate dehydrogenase, WBC: White blood cell count, NLR: Neutrophil-to-lymphocyte ratio, Hb: Hemoglobin, PLT: Platelet count, CRP: C-reactive protein, HALP score: Hemoglobin (g/dL) × albumin (g/L) × lymphocyte count ($\times10^9$/L) / platelet count ($\times10^9$/L).

Aggressive surgical management in the early phase is a cornerstone of electrical burn treatment. Rapid debridement, escharotomy, and fasciotomy are critical interventions aimed at reducing compartment pressure and limiting progressive necrosis. In one series, escharotomy was performed in 40.5% of patients and fasciotomy in 24.7%, with most procedures undertaken on the day of admission (11). Following surgical excision of full-thickness necrosis, wound closure is commonly achieved using split-thickness skin grafts or flap reconstructions. A large cohort study reported the use of skin grafts in 83.2%

Table 6. ROC curve for amputation					
Risk factor(s)	**AUC (95% CI)**	**Cut-off**	**p**	**Sensitivity (%) (95% CI)**	**Specificity (%) (95% CI)**
Admission CK (U/L)	0.705 (0.560-0.850)	1031.5	**0.007**	63.2% (38.4-83.7)	64.1% (51.1-75.7)
Admission AST (U/L)	0.736 (0.604-0.867)	147.5	**0.002**	68.4% (43.4-87.4)	68.8% (55.9-79.8)
Admission ALT (U/L)	0.766 (0.637-0.894)	96	**0.001**	68.4% (43.4-87.4)	67.2% (54.3-78.4)
Admission LDH (U/L)	0.761 (0.613-0.909)	570.5	**0.001**	73.7% (48.8-90.9)	73.4% (60.9-83.7)
Admission CK-MB (µg/L)	0.711 (0.590-0.831)	12.25	**0.006**	63.2% (38.4-83.7)	62.5% (49.5-74.3)
Admission NLR	0.725 (0.596-0.855)	9.23	**0.003**	63.2% (38.4-83.7)	68.8% (55.9-79.8)
Admission HALP	0.772 (0.656-0.888)	2.67	**0.001**	68.4% (43.4-87.4)	68.8% (55.9-79.8)

*: Sensitivity and specificity are presented with exact binomial 95% confidence intervals (Clopper-Pearson method), CK: Creatine kinase, AST: Aspartate aminotransferase, ALT: Alanine aminotransferase, LDH: Lactate dehydrogenase, NLR: Neutrophil-to-lymphocyte ratio, CI: Confidence interval, ROC: Receiver operating characteristic, AUC: Area under the curve, HALP score: Hemoglobin (g/dL) × albumin (g/L) × lymphocyte count (×10⁹/L) / platelet count (×10⁹/L).

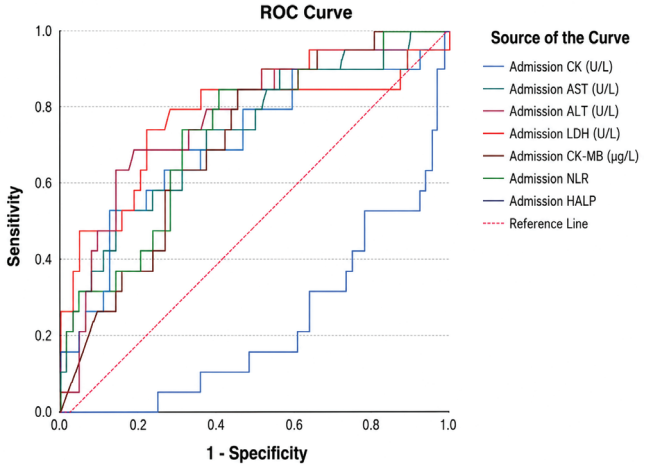

Figure 1. ROC curves of admission biomarkers for predicting amputation.

ROC: Receiver operating characteristic, CK: Creatine kinase, AST: Aspartate aminotransferase, ALT: Alanine aminotransferase, LDH: Lactate dehydrogenase, NLR: Neutrophil-to-lymphocyte ratio.

and flap reconstruction in 49.3% of cases (10). In addition, experimental approaches involving stem cell-based therapies, cell-derived products, and biomaterial scaffolds have demonstrated significant improvements in wound healing in preclinical studies (12). Although these techniques have not yet entered routine clinical practice, they represent promising strategies for addressing the severe tissue loss associated with electrical burns. In the future, such regenerative approaches may also contribute to reducing amputation rates by improving tissue viability and supporting early reconstruction in severe electrical burn injuries. In our series, rates of escharotomy, fasciotomy, and grafting were comparable to those reported in the literature.

Amputation surgery is often an unavoidable component of treatment in electrical burn injuries. Pedrazzi et al. (11) reported an amputation rate of 13.5% in their cohort. The amputation rate of 22.9% observed in our study is consistent with values reported in the literature. For example, a tertiary referral center in another country reported an amputation rate of approximately 22% among electrical burn patients (1), whereas a large cohort from India documented rates as high as 38% (8). These findings suggest that limb loss following electrical injury constitutes a comparable clinical burden across different geographic regions.

Delayed demarcation resulting from microvascular thrombosis and progressive tissue necrosis in electrical injuries increases the likelihood of revision amputations following initial surgery (13). Dash et al. (8) reported a revision amputation rate of 23.9% in a series of 209 patients. This trend aligns with studies emphasizing the need for staged debridement in electrical burns and highlighting the failure of early reconstruction or closure due to ongoing necrosis (14). In our cohort, revision amputations were required in 36.8% of cases. The timing and recurrence of amputations are closely related to the unique pathophysiology of progressive tissue loss in electrical injuries (15). Although large database studies have reported overall amputation rates of approximately 30% in electrical burn patients, the temporal distribution of amputations has rarely been detailed (6). In our series, the mean time to first amputation was 15.58 days, further supporting the concept of delayed tissue demarcation.

Laboratory parameters provide valuable insight into the pathophysiology of electrical burns. Markers of muscle injury, such as CK, CK-MB, myoglobin, and LDH, rise markedly in the early phase due to rhabdomyolysis and deep muscle necrosis. In a prospective study of high-voltage electrical contact burns, Babu et al. (16) demonstrated that CK, CK-MB, and LDH levels were significantly higher in patients requiring amputation, supporting the prognostic value of muscle injury biomarkers in this setting. Inflammatory markers, including CRP and WBC count, typically rise early after burn injury; however, persistently elevated values beyond the first week often suggest secondary infection or systemic inflammation. A meta-analysis of burn patients demonstrated that elevated CRP and neutrophil levels were associated with sepsis and mortality (17). In our study, higher WBC and CRP levels in the amputation group were

consistent with these findings and support a contributory role of systemic inflammation and infection in amputation risk.

Cardiac involvement in electrical burns is generally mild and transient. In a series of 480 patients reported by Pilecky et al. (18), the most common electrocardiographic findings were sinus bradycardia (10.4%) and sinus tachycardia (4.4%), while severe arrhythmias were rare. Similarly, Ahmed et al. (19). reported ECG abnormalities in 18% of patients following electrical injury, whereas no serious arrhythmias were detected. In our cohort, ECG abnormalities were predominantly benign and showed no significant association with voltage level. Moreover, significant associations were observed between ECG changes and CK, CK-MB, and troponin levels. These findings suggest that voltage exposure alone is not a reliable predictor of clinically relevant cardiac injury.

An important observation in our study was the lack of a linear relationship between TBSA and amputation risk. Even when a limited skin area is affected in high-voltage injuries, severe deep tissue damage may necessitate amputation. Conversely, limb preservation may be possible in low-voltage injuries involving larger surface areas. Dash et al. (8) similarly reported higher amputation rates in electrical burn patients with TBSA <25% compared with those with TBSA >25%. These findings indicate that, in electrical burns, deep tissue injury rather than surface area involvement is a more critical determinant of prognosis.

Although high-voltage exposure has traditionally been considered a major risk factor for amputation (20), we did not observe a statistically significant association between voltage level and amputation in our cohort. Instead, muscle injury enzymes (CK, CK-MB, LDH), liver enzymes (AST, ALT), inflammatory markers (CRP, WBC), and composite indices such as the HALP score and neutrophil-to-lymphocyte ratio (NLR) were significantly associated with amputation risk. In a similar study, patients undergoing amputation after high-voltage electrical injury exhibited significantly higher CK, CK-MB, and LDH levels (16). In our analysis, ROC curves demonstrated meaningful discriminatory power of these parameters for predicting amputation. However, none of the variables remained independent predictors in the multivariable analysis, which may be related to the limited number of amputation events and the restricted statistical power of the study. Although the HALP score demonstrated significant discriminatory performance in ROC analysis and was associated with amputation risk in univariate analysis, it did not remain an independent predictor in the multivariable model. Additionally, in our study, the observed association between fasciotomy and amputation should not be interpreted as a causal relationship. Fasciotomy is generally performed in the setting of severe compartment syndrome and extensive ischemic tissue injury; therefore, its association with amputation likely reflects the severity of the underlying injury rather than an independent adverse effect of the procedure itself. Similarly, variables such as length of hospital stay and total number of operations may reflect the clinical consequences of severe injury and amputation rather than direct causal predictors. Therefore, these findings should be interpreted with caution.

The originality of this study lies in emphasizing a biomarker-based approach for prognostic assessment in electrical burn patients. While previous studies have primarily focused on clinical parameters such as voltage level and TBSA, our findings suggest that simple, readily available laboratory markers may facilitate early risk stratification. This approach may enable timely identification of patients at high risk for amputation and support the early implementation of more aggressive therapeutic strategies. Given the multisystem involvement characteristic of electrical burns, a multidisciplinary approach incorporating surgery, intensive care, nephrology, rehabilitation, and psychosocial support is likely to improve patient outcomes.

Study Limitations

This study has several limitations. Its retrospective and single-center design limits control over patient selection and treatment heterogeneity, and the relatively small sample size may restrict generalizability. In addition, the limited number of amputation events (n=19) constrained the number of variables that could be included in the multivariable logistic regression model and increased the risk of overfitting. Therefore, the loss of statistical significance observed in the multivariable analysis may partly reflect limited statistical power and a potential type II error, and borderline associations should be interpreted with caution. Consequently, multicenter prospective studies are warranted to validate these findings. In conclusion, biochemical and hematological parameters in adult electrical burn patients are significantly associated with the development of amputation, and early assessment of these biomarkers may provide substantial support to clinical decision-making processes.

CONCLUSION

This study demonstrates the clinical value of a biomarker-based approach for predicting the development of amputation in adult patients with electrical burns. Voltage exposure alone was not a decisive determinant; rather, parameters reflecting muscle injury and systemic inflammation—including AST, ALT, LDH, CK, CK-MB, the HALP score, and NLR—were strongly associated with amputation risk. Although logistic regression and ROC curve analyses indicated meaningful predictive performance for these variables, none remained independently associated with amputation in multivariable analysis. Admission LDH levels and HALP score showed borderline associations with amputation risk in the multivariable analysis.

These findings underscore the importance of incorporating early biochemical and inflammatory markers, in addition to clinical assessment, into decision-making regarding amputation. Electrocardiographic abnormalities were generally benign and did not show a significant correlation with voltage level. Despite early escharotomy, fasciotomy, and appropriate reconstructive procedures, the frequent need for revision amputation highlights the progressive tissue injury characteristic of electrical burns.

Overall, within a multidisciplinary framework, early risk stratification based on admission laboratory data may facilitate timely identification of high-risk patients, support tissue-preserving strategies, and help prevent complications. Prospective, multicenter studies are warranted to further clarify the integration of these biomarkers into routine clinical practice.

Ethics

Ethics Committee Approval: The study was conducted with the approval of the Local Ethics Committee of University of Health Sciences Türkiye, Ankara Bilkent City Hospital (approval no: TABED 2-25-1618, date: 12.11.2025) and was carried out in accordance with the principles of the Declaration of Helsinki.

Informed Consent: Due to the retrospective design of the study and the use of anonymized patient data, the requirement for informed consent was waived by the local ethics committee.

Footnotes

Author Contributions

Concept - A.Y., A.E.S.; Design - A.Y., A.E.S.; Data Collection or Processing - A.Y., A.E.S.; Analysis or Interpretation - A.Y., M.A.; Literature Search - A.Y., A.E.A., M.A.; Writing - A.Y., A.E.A., M.A.

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REFERENCES

1. *Arumugam PK, Thakur P, Sarabahi S. Changing trends in electrical burns from a tertiary care centre - epidemiology and outcome analysis. Ann Burns Fire Disasters. 2021;34:351-359.*
2. *Bounds EJ, Khan M, Kok SJ. Electrical burns. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025. Available from: https://www.ncbi.nlm.nih.gov/books/NBK519514/*
3. *Shih JG, Shahrokhi S, Jeschke MG. Review of adult electrical burn injury outcomes worldwide: an analysis of low-voltage versus high-voltage electrical injury. J Burn Care Res. 2017;38:e293-e298.*
4. *Mobayen M, Sadeghi M. Prevalence and related factors of electrical burns in patients referred to Iranian medical centers: a systematic review and meta-analysis. World J Plast Surg. 2022;11:3-11.*
5. *Koumbourlis AC. Electrical injuries. Crit Care Med. 2002;30(Suppl 11):S424-S430.*
6. *Kim E, Wan B, Solis-Beach KJ, Kowalske K. Outcomes of patients with amputation following electrical burn injuries. Eur Burn J. 2023;4:318-329.*
7. *Králík D. Electrical burns in adults. Acta Chir Plast. 2023;65:66-69.*
8. *Dash S, Arumugam PK, Muthukumar V, Kumath M, Sharma S. Study of clinical pattern of limb loss in electrical burn injuries. Injury. 2021;52:1925-1933.*
9. *Ding H, Huang M, Li D, Lin Y, Qian W. Epidemiology of electrical burns: a 10-year retrospective analysis of 376 cases at a burn centre in South China. J Int Med Res. 2020;48:300060519891325.*
10. *Li H, Tan J, Zhou J, Yuan Z, Zhang J, Peng Y, et al. Wound management and outcome of 595 electrical burns in a major burn center. J Surg Res. 2017;214:182-189.*
11. *Pedrazzi N, Klein H, Gentzsch T, Kim BS, Waldner M, Giovanoli P, et al. Predictors for limb amputation and reconstructive management in electrical injuries. Burns. 2023;49:1103-1112.*
12. *Abdul Kareem N, Aijaz A, Jeschke MG. Stem cell therapy for burns: story so far. Biologics. 2021;15:379-397.*
13. *Jeschke MG, van Baar ME, Choudhry MA, Chung KK, Gibran NS, Logsetty S. Burn injury. Nat Rev Dis Primers. 2020;6:11.*
14. *Mene A, Biswas G, Parashar A, Bhattacharya A. Early debridement and delayed primary vascularized cover in forearm electrical burns: a prospective study. World J Crit Care Med. 2016;5:228-234.*
15. *Khor D, AlQasas T, Galet C, Barrash J, Granchi T, Bertellotti R, et al. Electrical injuries and outcomes: a retrospective review. Burns. 2023;49:1739-1744.*
16. *Babu VS, Sharma S, Manas RK, Kaur C, R R. Study of serum creatine kinase and lactate dehydrogenase levels and their correlation in high-voltage electric contact burns. Eur J Plast Surg. 2021;44:103-110.*
17. *Nourigheimasi S, Yazdani E, Ghaedi A, Khanzadeh M, Lucke-Wold B, Dioso E, et al. Association of inflammatory biomarkers with overall survival in burn patients: a systematic review and meta-analysis. BMC Emerg Med. 2024;24:76.*
18. *Pilecky D, Vamos M, Bogyi P, Muk B, Stauder D, Racz H, et al. Risk of cardiac arrhythmias after electrical accident: a single-center study of 480 patients. Clin Res Cardiol. 2019;108:901-908.*
19. *Ahmed J, Stenkula C, Omar S, Ghanima J, Bremtun FF, Bergan J, et al. Patient outcomes after electrical injury: a retrospective study. Scand J Trauma Resusc Emerg Med. 2021;29:114.*
20. *Arnoldo BD, Purdue GF, Kowalske K, Helm PA, Burris A, Hunt JL. Electrical injuries: a 20-year review. J Burn Care Rehabil. 2004;25:479-484.*

ORIGINAL ARTICLE
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Turkish version of the Carolinas comfort scale: Validation and long-term clinical outcomes after mesh-based inguinal hernia repair

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ABSTRACT

Objective: Mesh-based inguinal hernia repair has reduced recurrence rates; however, long-term postoperative symptoms remain clinically relevant. The Carolinas comfort scale (CCS) is a disease-specific tool developed to assess these outcomes. This study aimed to validate the Turkish version of the CCS and evaluate long-term quality of life.

Material and Methods: The CCS was translated and culturally adapted using standardized procedures. A retrospective cohort of patients who underwent elective inguinal hernia repair with mesh between 2018 and 2020 was analyzed. Reliability, validity, and factor structure were evaluated using established statistical methods.

Results: A total of 85 patients were included, with a median follow-up of 79 months. The Turkish CCS demonstrated excellent internal consistency (Cronbach's α=0.952), strong convergent validity with VAS (ρ=0.952, $p<0.001$), and significant discriminative validity for chronic pain ($p<0.001$). The recurrence and chronic pain rates were 10.6% and 35.3%, respectively.

Conclusion: The Turkish version of the CCS is a valid and reliable instrument for assessing long-term outcomes after mesh-based inguinal hernia repair and can be used in both clinical practice and research.

Keywords: Carolinas comfort scale, chronic pain, inguinal hernia, quality of life, validation

INTRODUCTION

Inguinal hernia accounts for approximately 75% of all abdominal wall hernias, with a reported lifetime risk of 27% in men and 3% in women (1). With the routine adoption of mesh-based repair techniques, a substantial and dramatic reduction in recurrence rates has been achieved (2,3). However, because mesh materials remain permanently within the body, long-term complications that may adversely affect patient comfort such as foreign body sensation, chronic pain, physical limitation, and psychological impact can occur (4). Consequently, patient-centered assessment of quality of life following mesh-based inguinal hernia repair has gained increasing importance (5).

While generic instruments like the short form-36 (SF-36) and the visual analog scale (VAS) are staples in assessing quality of life and pain following hernia repair, they often struggle to capture the full clinical picture (6). The SF-36, being a broad health measure, frequently lacks the sensitivity required to pinpoint hernia-specific or mesh-related issues. Similarly, the VAS is restricted to pain intensity alone, overlooking critical factors such as foreign body sensation and mobility restrictions that are common after mesh-based procedures (7). To address these gaps, the Carolinas comfort scale (CCS) was developed specifically to evaluate pain, movement limitation, and the sensation of the mesh itself (8). The CCS has been extensively evaluated in the literature, validated across multiple clinical settings, and shown to be a sensitive instrument for assessing postoperative outcomes after mesh repair (8-11).

To date, the CCS has been translated into 25 languages and is currently used in 48 countries worldwide (4). However, a validated Turkish version of the scale is not yet

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available. The present study aims to evaluate long-term quality of life after inguinal hernia repair using the CCS in our cohort and to complete the Turkish cultural adaptation and validation process of the scale.

MATERIAL and METHODS

Translation and Cross-cultural Adaptation

The Turkish adaptation of the CCS was conducted in accordance with internationally accepted guidelines for cross-cultural validation and followed a three-step process. In the first stage, the original English version of the scale was independently translated into Turkish by two translators. One translator was a medical doctor with expertise in surgical terminology, while the other was a professional with advanced proficiency in both English and Turkish but without a medical background. The two forward translations were reviewed and compared by a four-member expert committee consisting of the principal investigator and three additional researchers. Based on linguistic equivalence, semantic integrity, and cultural relevance, a consensus Turkish version was developed. The study was conducted at a medical faculty hospital that provides medical education entirely in English. The principal investigator is a graduate of this institution and currently serves as a faculty member. The research team also included a general surgery specialist and senior medical students from the same faculty. This academic background facilitated careful evaluation of both linguistic accuracy and clinical relevance during the translation process.

The preliminary Turkish version underwent back-translation into English by two independent bilingual individuals. One was an educational counselor who had lived for many years in an English-speaking country (Ireland) and possessed native-level bilingual proficiency, and the other was a professional translator with extensive experience in English-Turkish translation. The back-translated English version was compared with the original scale by the same expert committee. Structural, semantic, and conceptual equivalence between the back-translated and original versions was evaluated by the expert committee in accordance with the original developer's criteria. In the third stage, the finalized Turkish CCS was administered to a pilot group of 10 patients. During the pilot testing, participants were asked to evaluate the clarity of the items, whether any statements led to ambiguity or misinterpretation, and the extent to which the items reflected their personal perceptions. Based on patient feedback, items with limited clarity or potential cultural inadequacy were revised. After these revisions, the final Turkish version of the CCS was formally approved for use in the study (Figure 1). The final Turkish version of the CCS is provided as Supplementary Material.

Study Design and Participants

This study was designed as a retrospective cohort study evaluating long-term outcomes in patients who underwent elective inguinal hernia repair with mesh between 2018 and 2020. In the same cohort, long-term quality of life was assessed cross-sectionally using the Turkish version of the CCS.

Inclusion criteria were age ≥18 years, elective inguinal hernia repair with mesh, and adequate proficiency in the Turkish language. Exclusion criteria included cognitive, auditory,

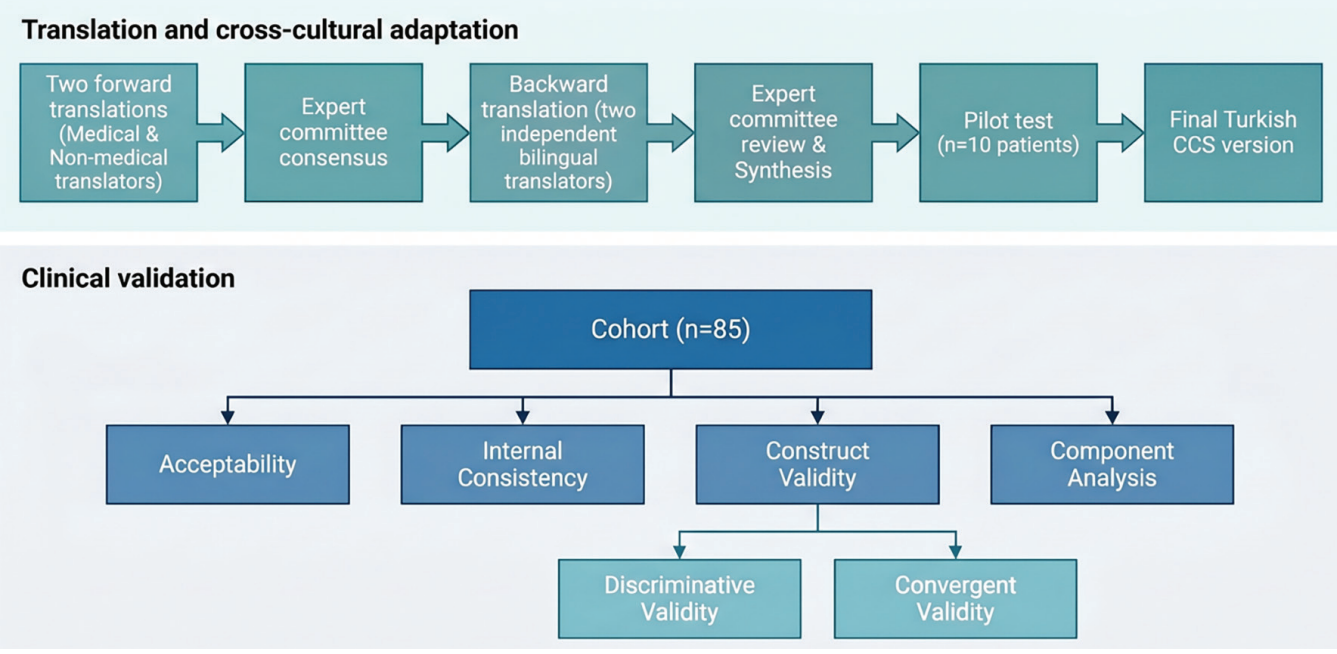

Figure 1. Schematic representation of the study workflow for translation and validation of the Carolinas comfort scale (CCS).

or communication impairments that could interfere with questionnaire completion, surgery for recurrent inguinal hernia, femoral hernia repair using a mesh plug technique, and emergency hernia surgery. The study was conducted in accordance with the principles of the Declaration of Helsinki. Approval was granted by the Marmara University Clinical Research Ethics Committee (reference number: 09.2026.26-0066, date: 16.01.2026). As data collection was performed via telephone interviews, verbal informed consent was obtained from all participants at the beginning of each call after providing a detailed explanation of the study. The obtained consent was documented by the investigator conducting the interview and recorded in the study forms with signature confirmation.

Data Collection and Follow-up

Demographic variables [age, sex, body mass index (BMI)], clinical parameters [American Society of Anesthesiologists (ASA) score, comorbidities and smoking status], and operative characteristics (open or laparoscopic approach, operative time, and length of hospital stay) were obtained from electronic medical records.

Eligible patients were contacted by telephone and were provided with detailed information regarding the study. Verbal informed

consent was obtained from patients who agreed to participate, and the consent form was signed by the interviewing researcher in accordance with institutional regulations. During the interview, patients were asked about the presence of postoperative recurrence, including any swelling at the repair site or history of reoperation for hernia at the same location. All telephone interviews were conducted by four researchers who had received standardized training prior to data collection. The response rate was defined as the proportion of eligible patients who participated in the study out of the total number of patients meeting the inclusion criteria. In accordance with the CCS scoring guidelines, questionnaires with no more than two missing items per subscale were considered acceptable and eligible for analysis. The acceptability of the scale was evaluated based on the proportion of completed questionnaires and the extent of missing data.

The CCS and Pain Assessment

The CCS is a disease-specific patient-reported outcome measure developed to assess quality of life following hernia repair with mesh, particularly focusing on mesh-related symptoms. Permission for the academic use of the CCS and its Turkish linguistic validation was formally obtained from the original developer, B. Todd Heniford, and the Atrium Health Department of Surgery.

The CCS evaluates three domains: pain, sensation of mesh, and movement limitation. Each item is rated on a 6-point Likert scale ranging from 0 to 5, where higher scores indicate greater symptom severity. In addition, a "not applicable" (N/A) option is available for situations not experienced by the patient; such responses were treated as missing data and handled according to the CCS scoring guidelines. The total CCS score is calculated by summing all item responses, with higher scores indicating poorer postoperative comfort and reduced quality of life.

Pain severity was also assessed using the VAS, ranging from 0 (no pain) to 10 (worst imaginable pain). The VAS was used to evaluate convergent validity by examining its correlation with CCS scores.

Outcomes of the Study

The primary outcome of this study was to evaluate the validity and reliability of the Turkish version of the CCS in patients who underwent mesh-based inguinal hernia repair. Secondary outcomes were the presence of chronic pain and hernia recurrence during follow-up.

Statistical Analysis

Statistical analyses were performed using appropriate methods based on the distribution characteristics of the data. The normality of continuous variables was assessed using the Shapiro-Wilk test. Continuous variables were presented as mean ± standard deviation for normally distributed data and as median [interquartile range (IQR)] for non-normally distributed data. Categorical variables were expressed as frequencies and percentages. Internal consistency was assessed using Cronbach's alpha coefficient. Item-total correlations were calculated to evaluate the contribution of each item to the overall scale. Construct validity was evaluated through convergent and discriminative validity analyses. Convergent validity was assessed by examining the correlation between CCS scores and VAS scores using Spearman correlation analysis. Discriminative validity was evaluated by comparing CCS scores between patients with and without chronic pain using the Mann-Whitney U test. Principal component analysis (PCA) with Varimax rotation was performed to examine the factor structure of the CCS. All statistical analyses were performed using Jamovi (version 2.6.44.0). A p-value <0.05 was considered statistically significant.

RESULTS

Patient Characteristics and Clinical Outcomes

A total of 167 patients who underwent elective inguinal hernia repair between January 2018 and December 2020 were initially assessed. After applying the inclusion and exclusion criteria, 85 patients were included in the final analysis (Figure 2). The study population was predominantly male (96.5%). The mean age of the cohort was 54.8±14.9 years. The median BMI was 25.7 (IQR: 4.65), and most patients were classified as ASA II (71.4%). The majority of patients underwent inguinal hernia repair using

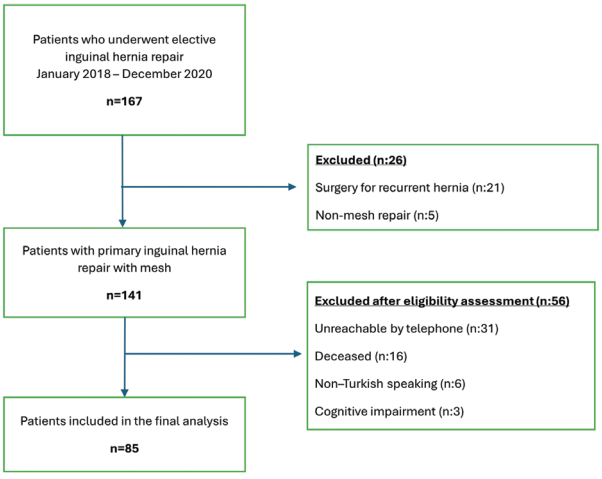

Figure 2. Flowchart of patient inclusion and study design.

the Lichtenstein technique (87.1%), followed by laparoscopic transabdominal preperitoneal repair (11.8%) and intraperitoneal onlay mesh repair (1.2%). The median operative time was 45 minutes (IQR: 29.25). The median long-term follow-up duration was 79 months (IQR: 9). At the time of evaluation, the prevalence of chronic pain was 35.3%, and the recurrence rate was 10.6%. Comprehensive demographic and clinical characteristics are summarized in Table 1.

Acceptability and Internal Consistency

The Turkish version of the CCS was administered via standardized telephone interviews, achieving an acceptability rate of 100%, as all 85 participants fully completed the 23 items with no missing data. The scale demonstrated excellent internal consistency, with an overall Cronbach's alpha coefficient of 0.952. All subscales exceeded the 0.70 reliability threshold: Sensation (α=0.907), pain (α=0.912), and movement limitation (α=0.890). Corrected item-total correlations ranged from 0.351 to 0.862, and the "alpha if item deleted" analysis confirmed the stability of the scale, with coefficients remaining between 0.947 and 0.954 (Table 2).

Construct Validity

Convergent validity was assessed by examining the relationship between CCS scores and VAS scores using Spearman's correlation analysis. A very strong positive correlation was observed between the total CCS score and VAS (ρ=0.952, p<0.001). This association was even stronger for the pain domain (ρ=0.977, p<0.001). In addition, significant moderate correlations were observed between VAS and the sensation (ρ=0.580, p<0.001) and movement limitation domains (ρ=0.599, p<0.001). Discriminative validity was evaluated by comparing CCS scores between clinically distinct groups. Patients with chronic pain

Table 1. Baseline demographic and clinical characteristics of the study population (n=85)

Variable	Value
Age (years), mean ± SD	54.8±14.9
Sex, n (%)	
Male	82 (96.5%)
Female	3 (3.5%)
BMI (kg/m^2), median (IQR)	25.7 (4.65)
ASA score, n (%)	
I	19 (22.6%)
II	60 (71.4%)
III	5 (6.0%)
Hernia side, n (%)	
Right	40 (47.1%)
Left	37 (43.5%)
Bilateral	8 (9.4%)
Surgical technique, n (%)	
Lichtenstein	74 (87.1%)
Laparoscopic (TAPP)	10 (11.8%)
Laparoscopic (IPOM)	1 (1.2%)
Operation time (minutes), median (IQR)	45 (29.25)
Recurrence, n (%)	
No	76 (89.4%)
Yes	9 (10.6%)
Chronic pain, n (%)	
No	55 (64.7%)
Yes	30 (35.3%)
Follow-up duration (months), median (IQR)	79 (9)

SD: Standard deviation, BMI: Body mass index, IQR: Interquartile range, ASA: American Society of Anesthesiologists, TAPP: Transabdominal preperitoneal repair, IPOM: Intraperitoneal onlay mesh.

Table 2. Internal consistency and reliability analysis of the Turkish version of the CCS

Scale/domain	Number of items	Median (range)	Cronbach's α	Corrected item-total correlation (min-max)	α if item deleted (range)
Total CCS	23	0 (0-83)	0.952	0.351-0.862	0.947-0.954
Sensation	8	0 (0-26)	0.907	0.427-0.889	0.877-0.918
Pain	8	0 (0-31)	0.912	0.402-0.941	0.879-0.923
Movement	7	0 (0-26)	0.890	0.434-0.900	0.848-0.900

CCS: Carolinas comfort scale, SD: Standard deviation, IQR: Interquartile range.

reported significantly higher total CCS scores (median: 6.0 vs. 0.0, p<0.001) and pain domain scores (median: 3.0 vs. 0.0, p<0.001) compared to those without chronic pain. Significant differences were also observed in the sensation and movement limitation domains, with higher scores in patients with chronic pain (sensation: p<0.001; movement limitation: p<0.001) (Table 3).

Factor Structure

The PCA was performed to evaluate the underlying factor structure of the Turkish CCS. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.50, indicating borderline adequacy. Bartlett's test of sphericity was significant (p<0.001); however, an exact chi-square statistic could not be estimated because of perfect linear dependence among several items. PCA identified a three-component structure with eigenvalues greater than 1. The three components explained 75.0% of the total variance, with the first component accounting for 52.7%. Following Varimax rotation, several items demonstrated strong loadings (>0.40); however, multiple items exhibited cross-loadings across components. Items related to pain and movement limitation tended to cluster within Component 1, while sensation-related items were distributed across Components 2 and 3. Cross-loadings were particularly observed for items Q4, Q6, and Q16. Several items demonstrated cross-loadings across multiple components. The rotated component matrix is presented in Table 4.

DISCUSSION

The present study aimed to evaluate the validity and reliability of the Turkish version of the CCS, a disease-specific patient-reported outcome measure designed to assess quality of life following hernia repair with mesh (11). With the widespread adoption of mesh-based techniques and the consequent reduction in recurrence rates, postoperative quality of life has emerged as a key outcome in hernia surgery (12). In this context, our findings confirm that the Turkish version of the CCS is a valid and reliable tool for assessing postoperative quality of life.

In terms of internal consistency, the Turkish CCS demonstrated excellent reliability, with a Cronbach's alpha coefficient of 0.952 for the total scale. This finding is highly consistent with the original validation studies, where Cronbach's alpha values exceeded 0.95, confirming the robustness of the scale. Subsequent validation studies in different languages have reported similar findings, including the Lithuanian (α=0.953), Dutch (α=0.948), and Brazilian Portuguese (α=0.94) versions (4,9,13). These results indicate that the CCS maintains consistently high internal reliability across diverse populations. Convergent validity was strongly supported by the very high correlation between CCS and VAS scores (ρ=0.952). As expected, the strongest association was observed for the pain domain (ρ=0.977), reflecting the fact that VAS primarily measures pain intensity. In addition, moderate correlations were observed between VAS and the sensation (ρ=0.580) and movement limitation domains (r=0.599), further supporting the multidimensional nature of the CCS. The ability of the CCS to reflect symptom severity, especially pain, has been emphasized in the original CCS studies, where strong associations were observed between CCS scores and patient-reported symptom burden (11). Comparable relationships have also been demonstrated in studies examining correlations with broader health measures such as SF-36 domains, including physical functioning and bodily pain (4,13), supporting the construct validity of the scale. Discriminative validity was also clearly demonstrated in our cohort. Patients with chronic pain exhibited significantly higher CCS scores compared to those without chronic pain, indicating that the scale effectively distinguishes between clinically relevant groups. This finding is consistent with earlier studies showing that CCS scores correlate with patient satisfaction, symptom severity, and functional outcomes (8-10,13). These findings reinforce the clinical

Table 3. Assessment of construct validity of the Turkish version of the CCS

Analysis type	Variables	Statistical test	Coefficient/statistic	p-value
Convergent validity	CCS total vs. VAS	Spearman	ρ=0.952	<0.001
Convergent validity	Pain domain vs. VAS	Spearman	ρ=0.977	<0.001
Convergent validity	Sensation domain vs. VAS	Spearman	ρ=0.580	<0.001
Convergent validity	Movement domain vs. VAS	Spearman	ρ=0.599	<0.001
Discriminative validity	CCS total (with vs. without chronic pain)	Mann-Whitney	U=12	<0.001
Discriminative validity	Pain domain (with vs. without chronic pain)	Mann-Whitney	U=0.0	<0.001
Discriminative validity	Sensation domain (with vs. without chronic pain)	Mann-Whitney	U=455.5	<0.001
Discriminative validity	Movement domain (with vs. without chronic pain)	Mann-Whitney	U=467.5	<0.001

CCS: Carolinas comfort scale, VAS: Visual analog scale.

Table 4. Rotated component loadings of the CCS items based on principal component analysis (varimax rotation)			
Item	**Component 1**	**Component 2**	**Component 3**
Q1 (lying down-sensation)	—	0.764	—
Q2 (lying down-pain)	0.777	—	—
Q3 (bending over-sensation)	—	0.810	—
Q4 (bending over-pain)	0.560	0.532	—
Q5 (bending over-movement)	0.658	—	—
Q6 (sitting up-sensation)	0.590	0.567	—
Q7 (sitting up-pain)	0.650	—	—
Q8 (sitting up-movement)	0.763	—	—
Q9 (ADL-sensation)	—	—	0.931
Q10 (ADL-pain)	0.732	—	—
Q11 (ADL-movement)	—	—	0.931
Q12 (coughing/breathing-sensation)	—	—	0.712
Q13 (coughing/breathing-pain)	—	—	0.534
Q14 (coughing/breathing-movement)	—	—	0.931
Q15 (walking-sensation)	—	0.845	—
Q16 (walking-pain)	0.524	0.453	0.431
Q17 (walking-movement)	0.828	—	—
Q18 (stairs-sensation)	—	0.871	—
Q19 (stairs-pain)	0.781	—	—
Q20 (stairs-movement)	0.724	—	—
Q21 (exercise-sensation)	—	0.844	—
Q22 (exercise-pain)	0.694	—	—
Q23 (exercise-movement)	0.730	—	—

ADL: Activities of daily living, CCS: Carolinas comfort scale. Principal component analysis with Varimax rotation was used. Loading weights below 0.40 are omitted (—) for clarity. Loadings below 0.30 were suppressed.

applicability of the CCS in identifying patients with impaired postoperative quality of life.

The factor structure of the Turkish CCS was evaluated using principal component analysis. A three-component structure was identified, consistent with the conceptual domains of the original scale. However, several items demonstrated cross-loadings across components, and a clear separation between components was not observed, particularly for the sensation domain. In the original CCS reappraisal study, a dominant component explaining a large proportion of variance was reported, suggesting a more compact structure (8). Similarly, the Lithuanian validation study identified three components, with the first accounting for 56% of the variance (4). In our analysis, the first three components explained 75.0% of the total variance, with the first component alone accounting for 52.7%. The KMO value (0.50) was at the threshold of adequacy, likely reflecting the sample size relative to the number of items, while the significant Bartlett's test confirmed the suitability of the data for factor analysis. The presence of cross-loadings for certain items (Q4, Q6 and Q16) may reflect the overlapping nature of postoperative symptoms. In long-term follow-up settings, such as in our cohort with a median follow-up of 79 months, pain and movement limitation often coexist during complex physical activities, leading to shared variance between domains. This is consistent with previous clinical observations that mesh-related symptoms frequently overlap in real-world settings (14). Despite these overlaps, the extraction of three components and the overall distribution of items remained broadly aligned with the conceptual framework of the CCS, suggesting that the Turkish version generally reflects the intended domain structure.

In our cohort, with a relatively long median follow-up of 79 months, the recurrence rate was 10.6%. The majority of patients (87%) underwent open Lichtenstein repair. In a large study by Murphy et al. (15), which analyzed three major United States databases (Premier, NSQIP, and Mayo Clinic), operations performed for recurrent groin hernia were found to account for at least 10% of all groin hernia repairs. In that study, earlier small-scale reports suggesting recurrence rates of 1-5% were considered overly optimistic. Although the analysis was not limited to a single operative technique, it included both open

and minimally invasive repairs, with open repairs comprising the majority of cases, similar to our cohort. The same study also noted that recurrence rates reported in United States studies ranged from 0% to 15%, while national hernia registry data from Denmark and Sweden showed that approximately 13-15% of hernia operations were performed for recurrence. Moreover, another review has reported studies describing recurrence rates of up to 16% (6). In this context, the recurrence rate observed in our study appears acceptable and consistent with real-world long-term data.

Chronic pain was observed in 35% of patients in our study. Notably, this rate also included patients with minimal pain (VAS score of 1), which may have contributed to the relatively higher prevalence. Previous studies have reported chronic pain rates ranging from approximately 21% to 36.7% following mesh-based inguinal hernia repair, particularly after open techniques (14). In the randomized study by Eklund et al. (16), the prevalence of chronic pain decreased over time, from 24.8% at 2 years to 18.8% at 5 years of follow-up. The same study also noted that some reports in the literature have described chronic pain rates as high as 75% after open hernia repair. Considering that even patients with very mild symptoms were classified as having chronic pain in our analysis, our results can be regarded as acceptable and in line with the existing literature.

Study Limitations

This study has some limitations must be acknowledged. The sample size of 85 patients, while sufficient for preliminary validation, was relatively small for a comprehensive factor analysis. This is reflected in the KMO value of 0.50, which sits at the threshold of adequacy for sampling. Consequently, the factor structure observed in our PCA may be sensitive to sample size, and larger multicenter studies are needed to confirm these findings. Second, test-retest reliability was not performed in this study, which limits our ability to assess the stability of the Turkish CCS over time. Third, the data were collected via standardized telephone interviews rather than the traditional self-administration method. While this approach ensured a 100% completion rate, it may have introduced interviewer bias or social desirability bias, where patients might feel inclined to report better outcomes than they truly experience. Finally, the single-center and retrospective nature of the study may limit the generalizability of the results to the broader Turkish population or different clinical settings. However the study has several notable strengths. First, the linguistic and cultural adaptation process was conducted with high methodological rigor. Formal permission was obtained from the original developer of the scale, ensuring that the Turkish version remained faithful to the intended conceptual framework. The translation process benefited from a multidisciplinary approach, involving both surgical experts and professional linguists. Furthermore, the study was conducted within an academic environment where medical education is entirely in English, which facilitated a more precise evaluation of linguistic equivalence and clinical relevance. A major strength of our study is the exceptionally long follow-up duration, with a median of 79 months. This period is significantly longer than many existing validation studies and provides valuable insights into real-world long-term outcomes following mesh-based hernia repair. Additionally, we proactively addressed the common challenge of loss to follow-up in long-term cohorts. By utilizing public directory services and institutional identity verification systems to locate patients whose contact information had changed, we were able to minimize attrition and maintain a representative sample of our original cohort.

CONCLUSION

The Turkish version of the CCS is a valid and reliable instrument for assessing quality of life following mesh-based inguinal hernia repair. The long-term follow-up further supports the applicability of the CCS in evaluating persistent postoperative symptoms in real-world clinical settings. These findings suggest that the Turkish CCS can be effectively used in both clinical practice and future research to assess patient-reported outcomes after inguinal hernia repair.

Ethics

Ethics Committee Approval: The study was conducted in accordance with the principles of the Declaration of Helsinki. Approval was granted by the Marmara University Clinical Research Ethics Committee (reference number: 09.2026.26-0066, date: 16.01.2026).

Informed Consent: Verbal informed consent was obtained from all participants, as approved by the ethics committee due to the retrospective design and telephone-based follow-up. Consent was documented by the investigators during telephone interviews.

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Artificial intelligence-based tools were used solely to assist with language editing and translation. No AI tools were used for study design, data collection, data analysis, interpretation of results, or manuscript authorship. All scientific content, analyses, and conclusions are the sole responsibility of the authors.

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Footnotes

Author Contributions

Surgical and Medical Practices - A.B., D.C.E., Ö.G.; Concept - A.B., Ö.F.A., B.E., Ö.G.; Design - A.B., D.C.E., I.M.E.Q., M.S.; Data Collection or Processing - A.B., Ö.F.A., B.E., M.S.; Analysis or Interpretation - A.B., D.C.E., Ö.F.A., I.M.E.Q., N.M., Ö.G.; Literature Search - A.B., B.E., I.M.E.Q., N.M., M.S.; Writing - A.B., D.C.E., Ö.F.A., B.E., I.M.E.Q., M.S., N.M., Ö.G.

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REFERENCES

1. *Kingsnorth A, LeBlanc K. Hernias: inguinal and incisional. Lancet. 2003;362:1561-1571.*
2. *Ujiki MB, Gitelis ME, Carbray J, Lapin B, Linn J, Haggerty S, et al. Patient-centered outcomes following laparoscopic inguinal hernia repair. Surg Endosc. 2015;29:2512-2519.*
3. *HerniaSurge Group. International guidelines for groin hernia management. Hernia. 2018;22:1-165.*
4. *Parseliunas A, Paskauskas S, Simatoniene V, Vaitekunas J, Venskutonis D. Adaptation and validation of the Carolinas comfort scale: a questionnaire-based cross-sectional study. Hernia. 2022;26:735-744.*
5. *Campanelli G. Quality of life is the most important outcome measure of hernia repair. Hernia. 2022;26:685.*
6. *Gram-Hanssen A, Jessen ML, Christophersen C, Zetner D, Rosenberg J. Trends in the use of patient-reported outcome measures for inguinal hernia repair: a quantitative systematic review. Hernia. 2021;25:1111-1120.*
7. *Christoffersen MW, Rosenberg J, Jorgensen LN, Bytzer P, Bisgaard T. Health-related quality of life scores changes significantly within the first three months after hernia mesh repair. World J Surg. 2014;38:1852-1859.*
8. *Heniford BT, Lincourt AE, Walters AL, Colavita PD, Belyansky I, Kercher KW, et al. Carolinas comfort scale as a measure of hernia repair quality of life: a reappraisal utilizing 3788 international patients. Ann Surg. 2018;267:171-176.*
9. *Nielsen K, Poelman MM, den Bakker FM, van der Ploeg T, Bonjer HJ, Schreurs WH. Comparison of the Dutch and English versions of the Carolinas comfort scale: a specific quality-of-life questionnaire for abdominal hernia repairs with mesh. Hernia. 2014;18:459-464.*
10. *Cox TC, Huntington CR, Blair LJ, Prasad T, Lincourt AE, Heniford BT, et al. Predictive modeling for chronic pain after ventral hernia repair. Am J Surg. 2016;212:501-510.*
11. *Heniford BT, Walters AL, Lincourt AE, Novitsky YW, Hope WW, Kercher KW. Comparison of generic versus specific quality-of-life scales for mesh hernia repairs. J Am Coll Surg. 2008;206:638-644.*
12. *Miller HJ. Inguinal hernia: mastering the anatomy. Surg Clin North Am. 2018;98:607-621.*
13. *Seabra MK, Cavazzola LT. Cross-cultural adaptation and validation of Carolinas comfort scale to Brazilian Portuguese for inguinal hernia. Langenbecks Arch Surg. 2024;409:253.*
14. *Jalil O, Rowlands C, Ruddle A, Hassn A, Morcous P. Medium-term recurrence and quality of life assessment using the hernia-specific Carolinas comfort scale following laparoscopic inguinal hernia repair. J Laparoendosc Adv Surg Tech A. 2015;25:477-480.*
15. *Murphy BL, Ubl DS, Zhang J, Habermann EB, Farley DR, Paley K. Trends of inguinal hernia repairs performed for recurrence in the United States. Surgery. 2018;163:343-350.*
16. *Eklund A, Montgomery A, Bergkvist L, Rudberg C; Swedish Multicentre Trial of Inguinal Hernia Repair by Laparoscopy (SMIL) study group. Chronic pain 5 years after randomized comparison of laparoscopic and Lichtenstein inguinal hernia repair. Br J Surg. 2010;97:600-608.*

ORIGINAL ARTICLE
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Evaluating trauma burden and predictive value of reverse shock index Glasgow Coma scale (rSIG) in need for early transfusion and mortality: The largest prospective study from India

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ABSTRACT

Objective: Trauma remains a leading cause of death and disability worldwide, with hemorrhage and traumatic brain injury being major contributors. The reverse shock index (SI) multiplied by Glasgow Coma scale (rSIG) is a novel scoring tool with potential for early identification of high-risk trauma patients. This study, the largest and first of its kind in India, aimed to assess the predictive value of rSIG for in-hospital mortality and early transfusion requirements in trauma patients.

Material and Methods: This was a prospective, hospital-based study conducted at Government Medical College, Kozhikode, Kerala, from December 2022 to December 2023. A total of 536 trauma patients admitted under the department of general surgery were enrolled. Data on demographics, mechanism of injury, vital signs, GCS score, transfusion requirements, and outcomes were collected. rSIG, SI, and revised trauma score (RTS) were calculated. Receiver operating characteristic analysis was used to assess predictive performance.

Results: A total of 536 trauma patients were analyzed (mean age 44.49±15.81 years; 80% males), with road traffic accidents (RTAs) accounting for 68% of cases. RTAs were significantly linked to head and multisystem injuries and contributed to 94% of deaths. Overall mortality was 11.9% (64 patients), exclusively among those with head injury. RTS showed marginally better mortality prediction than rSIG [area under the curve (AUC) 96% vs. 92%; p<0.001], while rSIG best predicted early transfusion need (AUC 91.8%; p<0.01).

Conclusion: This study demonstrates that RTAs are the predominant cause of trauma, with head injury as the principal determinant of mortality. While rSIG effectively predicted early transfusion requirements, RTS showed slightly higher accuracy than rSIG in predicting mortality. rSIG remains a practical and reliable triage tool in resource-limited settings.

Keywords: Reverse shock index multiplied by Glasgow Coma scale (rSIG), revised trauma score (RTS), trauma, road traffic accidents, early blood transfusion

INTRODUCTION

Trauma is the sixth leading cause of death worldwide and stands as the primary cause of death in individuals under 45 years of age. It significantly contributes to both mortality and morbidity, primarily due to conditions such as hemorrhagic shock and traumatic brain injuries (1,2). Trauma patients with elevated injury severity scores (ISS) and increased transfusion requirements are at a heightened risk of in-hospital mortality within the first 24 hours. Therefore, early recognition of trauma patients at high-risk of death is essential to facilitate prompt resuscitation and appropriate medical management (1-3).

Hemorrhage is responsible for approximately 40% of deaths within the first 24 hours following trauma and represents the most preventable cause of death in severely injured individuals (3). The implementation of Massive Transfusion Protocols has proven effective in managing severe bleeding; however, the timely identification of patients with massive hemorrhage remains critical (4).

The shock index (SI), defined as the ratio of heart rate (HR) to systolic blood pressure (SBP), was first introduced by Allgower and Burri (5) in 1967 to identify trauma patients experiencing hypovolemic shock. A SI value of ≥1 has been associated with uncompensated shock and increased mortality risk (5).

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Clinicians often perceive hemodynamic instability as a situation where SBP is lower than HR, rather than the reverse. Reflecting this clinical observation, researchers in Taiwan introduced the reverse (or inverse) shock index (rSI), calculated as SBP divided by HR. They found that an rSI <1 was predictive of poor outcomes, offering a potential tool for identifying high-risk trauma patients—even in the absence of hypotension (6,7).

The Glasgow Coma scale (GCS), a standardized tool for evaluating consciousness, has shown a strong correlation with mortality in patients suffering from traumatic brain injury (TBI) (8). Building on this, a Japanese study group developed the rSIG (rSI multiplied by GCS), a novel scoring system based on a multicenter retrospective study. By combining rSI and GCS, the rSIG has demonstrated comparable performance to existing methods that rely solely on age and vital signs for predicting in-hospital mortality (9).

Despite these promising findings, the utility of rSIG in predicting early transfusion requirements and mortality risk among adult patients with severe trauma remains underexplored. Hence, this study aims to evaluate the predictive value of rSIG in assessing both in-hospital mortality and the need for early transfusions in adult trauma patients.

MATERIAL and METHODS

Study Setting: Government Medical College, Kozhikode, Kerala, India.

Study Design: This was a hospital-based prospective study carried out in the department of general surgery using a convenience sampling technique.

Study Subjects: Patients presenting to the casualty with a history of trauma and admitted to the department of general surgery between December 2022 and December 2023. Each patient was followed until discharge or death.

Inclusion Criteria: Include trauma patients admitted during the study period and willingness to participate.

Exclusion Criteria: Missing data for HR, SBP, age, GCS, or hospital mortality, unrealistic vitals (SBP <50 or HR <30), unwillingness to participate or follow up.

Sample Size: Based on the study by Wan-Ting et al. (10), assuming a mortality proportion of 24%, sensitivity of 80%, and a precision of 15%, the minimum calculated sample size was 119. However, this study analyzed data from a total of 536 patients.

Data Collection and Analysis: Following approval from the Institutional Ethics Committee, data were prospectively collected from 536 trauma patients admitted to the Department of General Surgery, Government Medical College, Kozhikode, between December 2022 and December 2023. After obtaining informed consent, details regarding patient demographics, mechanism of injury, vital signs at presentation (HR, SBP, respiratory rate), GCS score, comorbidities, requirement for blood transfusion within 24 hours, and clinical outcomes were recorded using a structured proforma.

Statistical Analysis

The SI, rSI, and rSI multiplied by GCS (rSIG) were calculated for all patients. Data entry was performed using Microsoft Excel and statistical analysis was conducted using IBM SPSS Statistics version 26.0.

Continuous variables such as age, vital signs, hemoglobin, platelet count, ICU stay duration, and ventilator support days were summarized using mean ± standard deviation (SD) and ranges. Categorical variables including sex, mode of trauma, helmet usage, injury patterns, transfusion requirement, and mortality were expressed as frequencies and percentages.

Comparisons between groups (e.g., survivors vs. non-survivors) were made using the independent samples t-test for continuous variables and chi-square test or Fisher's exact test for categorical variables. Receiver operating characteristic (ROC) curves were plotted for SI, rSI, rSIG, and revised trauma score (RTS) to assess their predictive performance for in-hospital mortality and early transfusion needs. The area under the ROC curve (AUC), optimal cut-off values (based on the Youden index), sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated. Subgroup analyses were also performed for patients with isolated head injuries. A p-value of <0.05 was considered statistically significant.

Ethical Considerations: Approval was obtained from the Institutional Ethics Committee prior to the initiation of the study (IEC number: GMCKKD/RP2023/IEC/10 approved by Government Medical College Kozhikode, India on 09/01/2023). Written informed consent was obtained from all participants. The research process did not interfere with the clinical management of patients.

RESULTS

A total of 536 trauma patients were enrolled in the study. The mean age of the cohort was 44.49±15.81 years, ranging from 14 to 85 years. Most patients (43%) belonged to the 41-60-year age group, followed by 33% aged 21-40 years, 16% above 60 years, and 8% below 20 years. Males comprised 80% of the study population with a mean age of 43.64±15.78 years, while females accounted for 20%, with a slightly higher mean age of 47.89±15.56 years. Road traffic accidents (RTAs) were the predominant mode of injury, reported in 364 patients (68%), followed by non-RTA trauma in 120 patients (22%) and assault in 52 cases (10%). The mean age of RTA victims was 43.42±15.27 years, while those involved in non-RTA trauma were older on average (50.67±15.53 years). Assault victims had a lower

mean age of 37.77±15.96 years, with this difference being statistically significant (p<0.001). Among RTA patients, the male-to-female ratio was 288:76, highlighting the predominance of male involvement. Assault cases were predominantly male (48 males vs. 4 females), and non-RTA trauma also showed male predominance with a ratio of 92:28 (Table 1).

The mechanisms of injury were varied, with 54 cases of assault, 2 cases of animal attack, 22 falls from less than 2 meters, 96 falls from a height greater than 2 meters, 24 pedestrian versus car collisions, 4 pedestrian versus bus, 24 pedestrian versus bike, 8 pedestrian versus auto, 4 car versus truck, 24 car versus car, 12 car versus bus, 64 slip and fall from bikes, 4 bike versus pedestrian, 12 bike versus truck, 76 bike versus car, 48 bike versus bus, and 60 bike versus bike incidents.

Multiple systemic involvement was most commonly observed in RTA cases (132), followed by trauma (76) and assault (8), with a highly significant association (p<0.001). Head injuries were predominantly seen in RTA patients (292), compared to trauma (80) and assault (20), which was also statistically significant (p<0.001). Chest injuries were significantly associated with mode of injury, being highest in RTA (108) followed by trauma (72) and assault (20) (p<0.001). Abdominal injuries showed a significant distribution across groups, with RTA accounting for 52 cases and both trauma and assault contributing 16 cases each (p=0.007). Spine injuries were more frequently observed in trauma cases (40) compared to RTA (28) and assault (4), and this association was highly significant (p<0.001). Overall, the pattern of systemic involvement varied significantly with the mode of injury (Table 2).

The mean physiological parameters at admission included a pulse rate of 97.9 bpm, SBP of 118.54 mmHg, and a respiratory rate of 17.76 breaths per minute. The average hemoglobin level was 12.05 g/dL (range: 7.1-15.2), and the mean platelet count was 2.52±0.85 lakh/μL. ICU stay averaged 1.48 days overall, being highest in RTA patients (1.70 days), followed by non-RTA trauma (1.20 days), and lowest in assault cases (0.54 days). The longest ICU stay recorded was 17 days. A total of 140 patients required ventilator support, with the majority (124) belonging to the RTA group and 16 to the trauma group, showing a statistically significant difference (p<0.001). The mean duration of ventilator use was 1.11 days. However, no statistically significant association was noted between mode of injury and history of procedures performed (p=0.661) (Table 3).

A total of 172 patients required early blood transfusion. Among them, the majority were due to RTA (132; 77%), followed by trauma (32; 19%) and assault (8; 5%), and this distribution was statistically significant (p<0.014). Patients requiring transfusion were significantly older (46.88±13.88 years) compared to those

Table 1. Demographics of the study population

Category	Subcategory	Number (n)	Percentage (%)	Mean age ± SD (years)
Age	Overall	536		44.49±15.81 (range: 14-85)
	≤20 years	44	8%	
	21-40 years	176	33%	
	41-60 years	232	43%	
	>60 years	84	16%	
Gender	Male	428	80%	43.64±15.78
	Female	108	20%	47.89±15.56
Mode of injury	RTA	364 (M: F=288:76)	68%	43.42±15.27
	Non-RTA trauma	120 (M: F=92:28)	22%	50.67±15.53
	Assault	52 (M: F=48:4)	10%	37.77±15.96

RTA: Road traffic accident, SD: Standard deviation.

Table 2. Distribution between mode of injury and the affected regions

Systemic involvement (multiple responses present)	Mode of injury			
	Trauma (n=120)	Assault (n=52)	RTA (n=364)	p-value
Multiple system	76	8	132	<0.001
Head injury	80	20	292	<0.001
Chest injury	72	20	108	<0.001
Abdomen injury	16	16	52	0.007
Spine injury	40	4	28	<0.001

RTA: Road traffic accident.

who did not require transfusions (43.36±16.54 years, p=0.016). Male patients were more likely to require transfusions (128 cases, p=0.02). The number of transfused units per patient averaged 0.77±1.32, with a range from 0 to 4 units (Table 4).

There were 64 deaths recorded in the study population. Mortality was predominantly observed among RTA patients (60; 94%), compared to trauma (4; 6%), which showed a highly significant association with mode of injury (p<0.001). All deceased patients had sustained head injuries, and this association was statistically significant (p<0.001). The mean age of deceased patients was significantly higher (56.8±12.83 years) compared to survivors (42.82±15.44 years, p<0.01). Although mortality was higher among males (52; 81%) compared to females (12; 19%), this difference was not statistically significant (p=0.45). Similarly, the presence of a surgical procedure post-admission was not significantly associated with mortality, with 28 (44%) deaths occurring in patients who underwent surgery and 36 (56%) in those managed without surgery (p=0.32) (Table 4).

Table 3. Details on patient parameters and course in hospital stay

Parameter	Mean	Standard deviation	Range
Vital signs			
Pulse rate (beats/min)	97.9	16.96	65-134
Systolic BP (mmHg)	118.54	21.05	74-170
Diastolic BP (mmHg)	72.37	10.84	45-100
Respiratory rate (/min)	17.76	4.42	9-30
Laboratory parameters			
Haemoglobin (g/dL)	12.05	1.74	7.1-15.2
Platelet count (L/μL) (in lacs)	2.52	0.85	0.98-5.2
ICU stay & injury duration (days)			
Overall	1.48	2.84	0-17
RTA	1.70	2.91	0-15
Assault	0.54	0.64	0-2
Trauma	1.20	3.12	0-17
Ventilator use duration (days)			
Overall	0.90	2.53	0-17
RTA	1.11	2.49	0-14
Trauma	0.67	3.06	0-17
History of ventilator usage (n)		**p-value**	
RTA	124	<0.001	
Trauma	16		
History of procedure done (n)			
RTA	144	0.661	
Trauma	48		
Assault	24		

ICU: Intensive care unit, BP: Blood pressure, RTA: Road traffic accident.

ROC curve analysis was performed to determine the optimal cut-off values of RTS, rSI, and rSIG for predicting mortality and the need for early blood transfusion within 24 hours.

For mortality prediction, RTS demonstrated excellent discriminatory power. At a cut-off value of 7.37, RTS showed 100% sensitivity and 91.5% specificity in all patients, with a PPV of 61.5% and a NPV of 100%. The AUC was 97.2% (p<0.01), with a high Youden index of 0.915, indicating outstanding predictive accuracy (Figure 1). Similar results were observed in the head injury subgroup, with an AUC of 96% (Figure 2). The rSIG also showed good predictive ability for mortality at a cut-off of 14.45, with sensitivity of 87.5%, specificity of 75.4%, and an AUC of 93.6% in all patients (p<0.01). In head injury patients, the AUC was 92%, indicating strong performance. The rSI, at a cut-off of 0.99, showed comparatively lower predictive accuracy, with an AUC of 82.6% in all patients and 80.9% in the head injury subgroup, although the association remained statistically significant (p<0.01). Overall, the RTS demonstrated the highest accuracy in predicting mortality among the three scoring systems, with rSIG showing comparable predictive performance (Table 5).

For predicting the need for early transfusion, rSIG demonstrated the highest overall predictive accuracy. At a cut-off of 15.73 in all patients, rSIG showed a sensitivity of 83.7%, specificity of 87.9%, PPV of 76.6%, NPV of 92%, and an AUC of 91.8% (p<0.01; Youden index 0.716) (Figure 3A). In the head injury subgroup, a similar cut-off (15.85) yielded an AUC of 93%, confirming its strong predictive performance (Figure 3B). The rSI also showed good

Table 4. Details on need for early transfusions and in-hospital mortality

Category		Number	Percentage (%)	p-value
Details on need for early transfusions				
Total patients receiving transfusions		172		
Mode of injury	RTA	132	77%	<0.014
	Trauma	32	19%	
	Assault	8	5%	
Gender	Male	128	74%	0.02
	Female	44	26%	
Details on mortality				
Total deaths		64		
Mode of injury	RTA	60	94%	<0.001
	Trauma	4	6%	
Gender	Male	52	81%	0.45
	Female	12	19%	
Surgical procedure (post-admission)	Present	28	44%	0.32
	Absent	36	56%	

RTA: Road traffic accident.

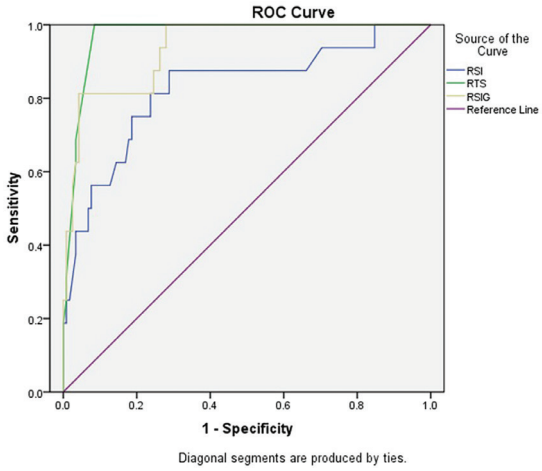

Figure 1. Area under the curve of rSIG, rSI and RTS in predicting the mortality of patients with all types of trauma.

rSIG: Reverse shock index Glasgow Coma scale, rSI: Reverse shock index, RTS: Revised trauma score, ROC: Receiver operating characteristic.

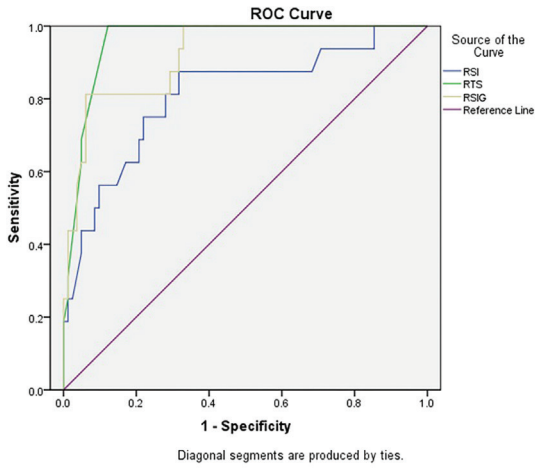

Figure 2. Area under the curve of rSIG, rSI and RTS in predicting the mortality of patients with head trauma.

rSIG: Reverse shock index Glasgow Coma scale, rSI: Reverse shock index, RTS: Revised trauma score.

Table 5. Details on various scoring systems and their respective cut-off, sensitivity, specificity, positive predictive value, negative predictive value, Youden index and area under the curve

Cut-off to predict the mortality									
Variable		**Best cut-off**	**Sensitivity**	**Specificity**	**PPV**	**NPV**	**AUC (%)**	**p-value**	**Youden index**
RTS	All patients	7.37	100	91.5	61.5	100	97.2%	<0.01	0.915
	Head injury	7.37	100	87.8	61.5	100	96%	<0.01	0.878
rSI	All patients	0.99	81.3	76.3	31.7	91.8	82.6%	<0.01	0.576
	Head injury	0.99	81.3	72	36.1	95.2	80.9%	<0.01	0.533
rSIG	All patients	14.45	87.5	75.4	32.6	97.8	93.6%	<0.01	0.629
	Head injury	14.45	87.5	70.7	36.8	96.7	92%	<0.01	0.582
Cut-off to predict the need for early transfusion									
RTS	All patients	7.37	52.5	96.7	88.5	81.5	75.4%	<0.01	0.492
	Head injury	7.37	63.9	95.2	88.5	81.9	80.1%	<0.01	0.591
rSI	All patients	1.19	83.7	86.8	75	91.9	87.5%	<0.01	0.705
	Head injury	1.23	88.9	80.6	72.7	92.6	88%	<0.01	0.695
rSIG	All patients	15.73	83.7	87.9	76.6	92	91.8%	<0.01	0.716
	Head injury	15.85	88.9	83.9	76.2	92.9	93%	<0.01	0.728

rSIG: Reverse shock index Glasgow Coma scale, rSI: Reverse shock index, RTS: Revised trauma score, AUC: Area under the curve, PPV: Positive predictive value, NPV: Negative predictive value.

predictive ability, with an AUC of 87.5% in all patients and 88% in head injury cases. In contrast, RTS demonstrated lower sensitivity (52.5%) despite high specificity (96.7%) for transfusion prediction, with an AUC of 75.4% (Table 5). rSI multiplied by GCS (rSIG) was found to be the most effective indicator for identifying the need for early blood transfusion. However, in assessing mortality risk, the RTS showed the highest accuracy, followed closely by rSIG.

DISCUSSION

This study provides a comprehensive evaluation of the demographic profile, injury patterns, and clinical outcomes among trauma patients. Comparable demographic trends were reported in a multicenter study by Kashid et al. (11), which analyzed 2,466 patients. Their mean age of 42.45±15.7 years was similar to our observed mean age of 44.49±15.81 years. A greater male predominance was noted in their study (91%) compared to ours (80%). Furthermore, RTAs constituted the leading cause of trauma in both cohorts, with 68% of cases in our study attributable to RTAs, demonstrating a consistent pattern (11).

These findings highlight the marked gender disparity in trauma incidence and reflect the increased susceptibility of individuals

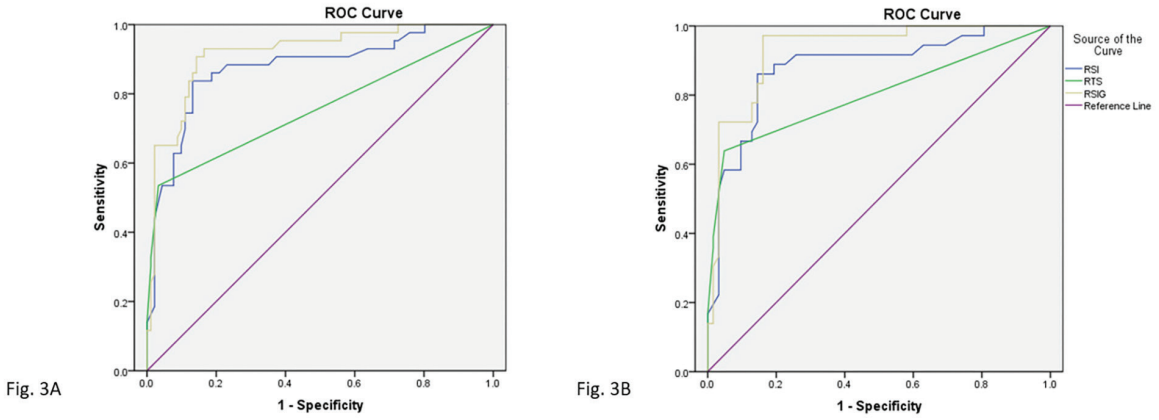

Figure 3. 3A) Area under the curve of rSIG, rSI and RTS in predicting the need for early transfusions in patients with all types of trauma; 3B) Area under the curve of rSIG, rSI and RTS in predicting the need for early transfusions in patients with head injury.

rSIG: Reverse shock index Glasgow Coma scale, rSI: Reverse shock index, RTS: Revised trauma score, ROC: Receiver operating characteristic.

in the economically productive age group, many of whom are engaged in occupations requiring frequent vehicular travel, to traumatic injuries (11). In our study, the mean age of patients involved in RTAs was 43.42±15.27 years, whereas patients sustaining non-RTA injuries were relatively older, with a mean age of 50.67±15.53 years. Victims of assault were significantly younger, with a mean age of 37.77±15.96 years ($p<0.001$). Similarly, Wui et al. (12) observed that falls were more prevalent among the elderly population, while RTAs predominated in younger individuals.

In our study, RTAs accounted for 68% of injuries and were significantly associated with multiple system involvement, head injuries, and chest trauma. All mortality cases in our cohort had sustained head injuries, underscoring TBI as the principal determinant of fatal outcomes. This finding aligns with prior studies demonstrating that severe TBI remains the leading cause of death in polytrauma patients (13). The strong association between head injury and mortality in our cohort likely explains the excellent predictive performance of scoring systems incorporating neurological parameters, particularly RTS and rSIG.

While most trauma patients had stable vital signs upon admission, many required intensive care. RTA victims had the longest ICU stays (mean 1.7 days), and 124 patients required ventilator support. These findings likely reflect the higher severity and complexity of injuries associated with high-speed collisions, particularly involving the head and multiple systems (14).

The demand for early transfusion was higher in RTA patients (77%), with older age and male sex being significant predictors. A large registry-based study involving 13,596 trauma patients at a Level I trauma center reported that males received significantly more packed red blood cell (PRBC) transfusions—consistent with our results. However, in contrast to our findings, they found that older patients received fewer transfusions (15). In our cohort, the higher transfusion rates in older patients may reflect reduced physiological reserve and a greater susceptibility to hemorrhagic shock. Differences in study design and population characteristics—such as an RTA-focused sample—may account for the variation.

Head injuries were observed in all deceased patients in our study, reaffirming their critical role in trauma-related mortality. Previous studies have also established head trauma as a major prognostic factor in both blunt and penetrating injuries (16).

rSIG was first introduced by Kimura and Tanaka (17), who reported an AUROC of 90.1% for in hospital mortality, closely comparable to our finding of 93.6%. Wu et al. (18) subsequently performed external validation of rSIG in a Taiwanese trauma center and documented an AUROC of 83%, which, although slightly lower than our results, still supports its good predictive accuracy.

We further compared the predictive performance of rSIG with other established trauma scoring systems. In our study, the RTS showed the highest accuracy for mortality prediction, with an AUC of 97.2%, marginally exceeding that of the rSI multiplied by the GCS (rSIG), which had an AUC of 93.6% (Figure 1). Among patients with isolated head injuries, RTS continued to demonstrate slightly superior predictive ability for mortality compared to rSIG (AUC 96% vs. 92%; $p<0.001$) (Figure 2), in line with its well recognized application in emergency care settings (19). In our analysis, rSIG demonstrated better performance than the conventional rSI, which showed an AUC of 82.6%.

Importantly, rSIG demonstrated superior performance in predicting transfusion requirements (AUC =91.8%), whereas RTS showed limited sensitivity (52.5%) for this outcome (Figure 3A, 3B). This finding indicates that rSIG may be more effective for the early identification of patients who require aggressive

resuscitation, a feature that is particularly valuable in resource limited settings.

Although most previous studies have primarily examined the association between rSIG and mortality, relatively few have evaluated its utility in predicting transfusion needs. Lee et al. (20) reported an AUROC of 84.2% for rSIG in predicting transfusion, compared to 91.8% observed in our study. The improved predictive performance in our cohort may be explained by the integration of both hemodynamic and neurological parameters within rSIG. For example, TBI may be associated with substantial blood loss from scalp lacerations or oronasal trauma even in the absence of overt intracranial injury, while profound shock can itself lead to a reduction in GCS. By combining SI and GCS, rSIG offers a more comprehensive evaluation of trauma severity.

Although rSI alone demonstrated moderate predictive capability, it was clearly inferior to rSIG. The superior accuracy of rSIG was particularly evident among patients with head injuries (AUC =93%). Collectively, these findings reinforce the emerging role of rSIG as a reliable tool for early triage and informed decision making in trauma care.

In resource-limited emergency settings, rapid, accurate, and easily calculable scoring systems are essential for effective triage and appropriate resource allocation. Our results indicate that rSIG is a highly reliable and practical tool, particularly for predicting early transfusion requirement. While RTS demonstrates the strongest performance in mortality prediction, rSIG follows closely and shows comparable predictive ability. Considering its strong performance across both mortality prediction and early transfusion requirement, rSIG emerges as an effective overall scoring system in the trauma setting. Its simplicity, reliance on readily available parameters (SBP, pulse rate, and GCS), and strong predictive performance make it particularly attractive for use in high-volume trauma centers in developing countries. Incorporating rSIG into primary trauma assessment protocols may facilitate early identification of patients at risk of hemorrhagic shock and guide timely activation of transfusion protocols.

This study's strengths include its large prospective design, comprehensive data collection, and subgroup analysis in head injury patients.

Study Limitations

However, this study has certain limitations that must be recognized. Firstly, it was carried out at a single tertiary care center, which may restrict the generalizability of the results to other institutions with different patient demographics, trauma profiles, and resource availability. Secondly, mortality within the study cohort was largely attributable to head injuries, leading to a head injury–predominant mortality pattern. Long-term functional outcomes were not assessed, and anatomical scoring systems such as ISS or TRISS were not compared directly with rSIG. Therefore, larger multicenter studies involving more diverse trauma populations are necessary to externally validate these findings and to further assess the utility of rSIG across different injury patterns and healthcare environments.

CONCLUSION

This study represents the largest and first-of-its-kind investigation from India assessing the predictive utility of the rSIG in trauma patients for early transfusion requirements and mortality. The rSIG score demonstrated superior predictive accuracy for identifying patients requiring early blood transfusion and showed performance comparable to the RTS in predicting mortality. Integration of rSIG into routine trauma triage protocols may facilitate early risk stratification, optimize resource allocation, and support timely clinical decision-making, particularly in high-volume and resource-limited emergency settings.

Ethics

Ethics Committee Approval: Approval was obtained from the Institutional Ethics Committee prior to the initiation of the study (IEC number: GMCKKD/RP2023/IEC/10 approved by Government Medical College Kozhikode, India on 09/01/2023).

Informed Consent: Written informed consent was obtained from all participants. The research process did not interfere with the clinical management of patients.

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The authors would like to state that Dr. Yadukrishna S and Dr. Sherine EK have contributed equally to this work and should be considered co-first authors. Both authors were involved in the conception, design, data acquisition, analysis, and manuscript preparation to an equal extent.

Footnotes

Author Contributions

Surgical and Medical Practices - Y.S., S.E.K., D.J., C.S.; Concept - Y.S.; Design - Y.S., C.S.; Data Collection or Processing - Y.S., S.E.K., A.D., D.J.; Analysis or Interpretation - Y.S., D.J., C.S.; Literature Search - Y.S., S.E.K., A.D.; Writing - Y.S.

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REFERENCES

1. *Johansson PI, Stensballe J, Ostrowski SR. Current management of massive hemorrhage in trauma. Scand J Trauma Resusc Emerg Med. 2012;20:47.*
2. *Shere-Wolfe RF, Galvagno SM Jr, Grissom TE. Critical care considerations in the management of the trauma patient following initial resuscitation. Scand J Trauma Resusc Emerg Med. 2012;20:68.*
3. *Cheng P, Yin P, Ning P, Wang L, Cheng X, Liu Y, et al. Trends in traumatic brain injury mortality in China, 2006-2013: a population-based longitudinal study. PLoS Med. 2017;14:e1002332.*
4. *Taylor CA, Bell JM, Breiding MJ, Xu L. Traumatic brain injury-related emergency department visits, hospitalizations, and deaths - United States, 2007 and 2013. MMWR Surveill Summ. 2017;66:1-16.*
5. *Allgöwer M, Burri C. "Schockindex" ["Shock index"]. Dtsch Med Wochenschr. 1967;92:1947-1950. German.*

6. *Rady MY, Nightingale P, Little RA, Edwards JD. Shock index: a re-evaluation in acute circulatory failure. Resuscitation. 1992;23:227-234.*
7. *Sloan EP, Koenigsberg M, Clark JM, Weir WB, Philbin N. Shock index and prediction of traumatic hemorrhagic shock 28-day mortality: data from the DCLHb resuscitation clinical trials. West J Emerg Med. 2014;15:795-802.*
8. *Mitra B, Fitzgerald M, Chan J. The utility of a shock index ≥ 1 as an indication for pre-hospital oxygen carrier administration in major trauma. Injury. 2014;45:61-65.*
9. *Chuang JF, Rau CS, Wu SC, Liu HT, Hsu SY, Hsieh HY, et al. Use of the reverse shock index for identifying high-risk patients in a five-level triage system. Scand J Trauma Resusc Emerg Med. 2016;24:12.*
10. *Wan-Ting C, Chin-Hsien L, Cheng-Yu L, Cheng-Yu C, Chi-Chun L, Keng-Wei C, et al. Reverse shock index multiplied by Glasgow Coma scale (rSIG) predicts mortality in severe trauma patients with head injury. Sci Rep. 2020;10:2095.*
11. *Kashid M, Rai SK, Nath SK, Gupta TP, Shaki O, Mahender P, et al. Epidemiology and outcome of trauma victims admitted in trauma centers of tertiary care hospitals - a multicentric study in India. Int J Crit Illn Inj Sci. 2020;10:9-15.*
12. *Wui LW, Shaun GE, Ramalingam G, Wai KM. Epidemiology of trauma in an acute care hospital in Singapore. J Emerg Trauma Shock. 2014;7:174-179.*
13. *van Wessem KJP, Benders KEM, Leenen LPH, Hietbrink F. TBI related death has become the new epidemic in polytrauma: a 10-year prospective cohort analysis in severely injured patients. Eur J Trauma Emerg Surg. 2024;50:3083-3094.*
14. *Lopes MCBT, Bustillo RA, Whitaker IY. In-hospital complications after trauma due to road traffic accidents. Eur J Trauma Emerg Surg. 2023;49:1855-1862.*
15. *Papa L, Maguire L, Thundiyil JG, Ladde JG, Miller SA. Age and sex differences in blood product transfusions and mortality in trauma patients at a level I trauma center. Heliyon. 2023;9:e18890.*
16. *Tan Chor Lip H, Tan JH, Mohamad Y, Ariffin AC, Imran R, Azmah Tuan Mat TN. Clinical characteristics of 1653 injured motorcyclists and factors that predict mortality from motorcycle crashes in Malaysia. Chin J Traumatol. 2019;22:69-74.*
17. *Kimura A, Tanaka N. Reverse shock index multiplied by Glasgow Coma scale score (rSIG) is a simple measure with high discriminant ability for mortality risk in trauma patients: an analysis of the Japan Trauma Data Bank. Crit Care. 2018;22:87.*
18. *Wu SC, Rau CS, Kuo SCH, Chien PC, Hsieh HY, Hsieh CH. The reverse shock index multiplied by Glasgow Coma scale score (rSIG) and prediction of mortality outcome in adult trauma patients: a cross-sectional analysis based on registered trauma data. Int J Environ Res Public Health. 2018;15:2346.*
19. *Manoochehry S, Vafabin M, Bitaraf S, Amiri A. A comparison between the ability of revised trauma score and kampala trauma score in predicting mortality; a meta-analysis. Arch Acad Emerg Med. 2019;7:e6.*
20. *Lee YT, Bae BK, Cho YM, Park SC, Jeon CH, Huh U, et al. Corrigendum to "reverse shock index multiplied by Glasgow coma scale as a predictor of massive transfusion in trauma". Am J Emerg Med. 2024;82:218. Erratum for: Am J Emerg Med. 2021;46:404-409.*

VIDEO ARTICLE
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Reconstruction for esophageal cancer after previous sleeve gastrectomy technical challenges in a case report

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ABSTRACT

Obesity is a major risk factor for cancer. While bariatric surgery reduces obesity-related risks, it may introduce challenges in surgical oncology. We report a case of esophageal carcinoma in a patient with a history of laparoscopic sleeve gastrectomy (LSG), successfully managed with a completely laparoscopic-thoracoscopic Ivor-Lewis esophagectomy using the remnant stomach for reconstruction. Despite LSG-related vascular alterations, collateral circulation appeared sufficient to support conduit perfusion, suggesting that this approach is feasible in selected patients.

Keywords: Sleeve gastrectomy, esophageal carcinoma, Ivor-Lewis esophagectomy

INTRODUCTION

Obesity is associated with an increased risk of several malignancies, including esophageal carcinoma. Laparoscopic sleeve gastrectomy (LSG) is an effective bariatric procedure for the management of obesity and metabolic comorbidities (1). However, LSG alters gastric anatomy and vascularization, potentially complicating esophagogastric reconstruction. In addition, LSG has been associated with gastroesophageal reflux, Barrett's esophagus, and esophageal carcinoma (2). Although esophageal carcinoma following LSG has been reported, experience with a completely laparoscopic-thoracoscopic Ivor-Lewis esophagectomy using the remnant stomach remains limited. The altered vascular anatomy raises concerns regarding conduit perfusion and anastomotic safety, making surgical planning particularly challenging in this patient population.

CASE REPORT

A 58-year-old woman (body mass index 35 kg/m^2) had undergone LSG eight years earlier for type 2 diabetes. She presented with progressive dysphagia. Endoscopy revealed a squamous cell carcinoma located 26 cm from the incisors. Staging computed tomography demonstrated no distant metastasis. After multidisciplinary tumor board evaluation, neoadjuvant chemoradiotherapy was administered. Following restaging, a completely laparoscopic-thoracoscopic Ivor-Lewis esophagectomy was planned.

The abdominal phase was performed laparoscopically using four ports, followed by a three-port thoracoscopic approach. Adhesions related to the prior LSG were carefully lysed. The left gastric vessels were divided, and standard lymphadenectomy was completed. During gastric mobilization, particular attention was paid to preserving potential collateral blood supply. The remnant stomach was assessed for length and perfusion and was deemed suitable as a conduit. Conduit perfusion was evaluated by visual assessment of color, pulsation, and bleeding from the staple line. Following transection, mucosal color was also assessed to further estimate tissue perfusion. Indocyanine green fluorescence imaging was not used; although it could have provided a more objective evaluation of perfusion, indocyanine green imaging

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was not available under the existing institutional conditions. Thoracoscopic esophageal mobilization proceeded to the level of the azygos vein, and a side-to-side esophagogastric anastomosis was created using a circular stapler.

The postoperative course was uneventful, and the patient was discharged on postoperative day 13. Final pathology revealed adenosquamous carcinoma, staged as T3N1.

DISCUSSION

LSG substantially modifies gastric anatomy and vascular supply, which may complicate esophageal cancer surgery. Consequently, colonic or jejunal interposition is often considered. However, reports describing successful use of the remnant stomach after LSG remain scarce (3-5). Most available data consist of isolated case reports or small series, limiting the generalizability of current evidence. Previous cases have demonstrated feasibility using different surgical approaches and methods to assess conduit perfusion.

Although LSG disrupts the short gastric and gastroepiploic vessels, long-term vascular adaptation and collateral circulation may preserve adequate perfusion. In the present case, collateral circulation was evident intraoperatively and supported safe reconstruction. These findings suggest that the remnant stomach may remain a viable conduit in carefully selected patients. Careful intraoperative assessment of conduit viability is therefore essential.

CONCLUSION

With careful preoperative planning and meticulous intraoperative assessment of conduit perfusion, the remnant stomach can be safely used for esophageal reconstruction following Ivor-Lewis esophagectomy in selected patients with prior LSG. To the best of our knowledge, reports of completely laparoscopic-thoracoscopic Ivor-Lewis esophagectomy following LSG are extremely limited, and this case adds to the emerging experience in this setting. This Video 1 demonstrates the key technical steps and intraoperative decision-making process required to safely perform this complex reconstruction.

Video Link: https://drive.google.com/file/d/1aLsXhUMPQZgGVbaIBT0wyD94yp4pl4Ps/view?usp=sharing

Ethics

Informed Consent: Written informed consent was obtained from the patient for publication of this case report and accompanying video/images. No identifiable patient information is included.

Footnotes

Authorship Contributions

Surgical and Medical Practices: G.O., M.A.U., H.T.; Concept: G.O., M.A.U., H.T.; Design: G.O., M.A.U.; Data Collection or Processing: G.O, M.A.U., K.C.C.; Analysis or Interpretation: G.O.; Literature Search: G.O., K.C.C.; Writing: G.O., M.A.U., H.T.

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REFERENCES

1. *Plat VD, Kasteleijn A, Greve JWM, Luyer MDP, Gisbertz SS, Demirkiran A, et al. Esophageal cancer after bariatric surgery: increasing prevalence and treatment strategies. Obes Surg. 2021;31:4954-4962.*
2. *Jain DH, Vlahu TS, Kemmeter PR, Onesti JK. Laparoscopic transhiatal esophagectomy after biliopancreatic diversion with duodenal switch. Surg Obes Relat Dis 2018;14:123-124.*
3. *Pallabazzer G, Santi S, Solito B, D'Imporzano S, Belluomini MA. 0212 Ivor Lewis esophagectomy after sleeve gastrectomy: the use of gastric conduit is still possible. Diseases of the Esophagus. 2019;32.*
4. *Pines G, Khalayleh H, Mashni I, Bar I. Feasibility of hybrid Ivor-Lewis oesophagectomy after sleeve gastrectomy. Interact Cardiovasc Thorac Surg. 2022;34:1155-1156.*
5. *Zhuo ZG, Shen X, Song TN, Xu ZJ, Alai GH, Yao P, et al. The efficacy of ischemic conditioning in the prevention of gastroesophageal anastomotic complications: a meta-analysis. Ann Palliat Med. 2020;9:1586-1595.*

VIDEO ARTICLE
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Thiersch's operation for rectal prolapse management

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ABSTRACT

Thiersch's operation is a kind of suture technique to narrow the patulous anus for the treatment of rectal prolapse. It can be applied under local anaesthesia to elderly patients who can not tolerate major surgery. It also can be used as a temporary treatment untill the definitive treatment is planned. We demonstrated a simple way of the Thiersch operation with a video presentation. We also report the follow-up results of the patients who were operated on with this technique.

Keywords: Proctology, surgery, technique, cerclage

Diagnosis

Thiersch's operation, as originally described by Thiersch (1) in 1891, was devised to treat rectal prolapse. It consists of the insertion of a non-absorbable suture material around the anal canal (cerclage) to narrow of the patulous anus. Silver malleable wire was used initially but later on various materials were used for this purpose (2). Although the results of this method are not as good as desired, it still has an indication for some patients. We demonstrated a simple way of the Thiersch operation (Video 1). We also report the follow-up results of patients who were operated on with this technique.

Surgical Technique

Between 2010 and 2020, ten patients, nine of whom were women treated for rectal prolapse. The median age of the patients were 74.5 (range, 45-82). The operation was performed in the lithotomy position under the local anesthesia in 7 patients and spinal anesthesia in three patients. Number two atraumatic non-absorbable suture material is placed deeply via minor skin incisions outside of the external anal sphincter muscle around the anal canal. Broad spectrum antibiotics were used for the cases and no bowel preparation was done in any of the patients. Preoperative anal manometry is not required in these patients because of the patulous anus. The patients were followed up for median 8 months (range, 7 days-11 months). Sutures were removed in two patients (20%) due to perianal abscess development in a week. Cerclage was performed again in three patients due to suture migration to anal canal in two patients and suture rupture in one patient (30%) (Table 1). Patients were followed up almost one year without any problems. Although clinical improvements were detected in the sphincter tone of the patients, fecal incontinence problems were persisted to some degree. Their standardized incontinence levels were not evaluated before or after the surgery.

Outcome

Thiersch procedure is a simple surgical management option for rectal prolapse in high-risk patients. The advantages of this technique are that it is inexpensive, can be applied under local anesthesia, and can be repeated in case of recurrence. It can be combined with other abdomino-perineal techniques in suitable patients. It also can be used as a temporary treatment until the definitive treatment is planned. The disadvantage of this technique is the high infection and recurrence rates that we encountered in our series and in the literature (3). However, if the suture material remains without complication, both the internal and external sphincter tones improves in time.

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Table 1. Patient characteristics and complications		
	N	**%**
Female	9	90.0
Male	1	10.0
Age (year) mean; SD (median; min-max)	71.6±10.8	(74.5;45-82)
Local anesthesia	7	70.0
Spinal anesthesia	3	30.0
Followed up period (days) mean; SD (median; min-max)	198.7±105.5	(240.0;7-330)
Suture removal due to anal abscess	2	20.0
Re-do cerclage due to suture migration and rupture	3	30.0
Total complications	5	50.0
SD: Standard deviation.		

Video Link: https://youtu.be/XDs7SqhIlvc

Footnotes

Presented at the Turkish Colorectal Surgery Congress in Antalya, 2023.

Author Contributions

Concept - G.N., F.A., M.K.G.; Design - G.N., F.A., M.K.G.; Data Collection or Processing - G.N., F.A.; Analysis or Interpretation - G.N.; Literature Search - G.N., F.A.; Writing - G.N., M.K.G.

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REFERENCES

1. *Thiersch C. Carl Thiersch 1822-1895. Concerning prolapse of the rectum with special emphasis on the operation by Thiersch. Dis Colon Rectum. 1988;31:154-155.*
2. *Gabriel WB. Thiersch's operation for anal incontinence. Proc R Soc Med. 1948;41:467.*
3. *Barfield LR. Perineal approaches to rectal prolapse. Clin Colon Rectal Surg. 2017;30:12-15.*

CASE REPORT
Turk J Surg 2026;42(3):370-373

Right colic artery pseudoaneurysm in a patient with rheumatoid arthritis: A case report

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ABSTRACT

To describe the clinical presentation, diagnosis, and endovascular treatment of a right colic artery (RCA) pseudoaneurysm in a patient with rheumatoid arthritis, highlighting its rarity as a complication of rheumatoid vasculitis. A woman in her early 50s with rheumatoid arthritis presented with a three-day history of epigastric pain, vomiting, and melena. Examination revealed anemia, purpuric rashes, and mild abdominal tenderness. Computed tomography (CT) angiography identified an RCA pseudoaneurysm. Following resuscitation and blood transfusion, selective superior mesenteric artery angiography and transarterial coil embolization were performed. The procedure was successful, leading to symptom resolution. RCA pseudoaneurysms are rare, usually resulting from trauma or pancreatitis, but can also arise from rheumatoid vasculitis. This is the first reported case of a RCA pseudoaneurysm due to rheumatoid arthritis. CT angiography is the preferred diagnostic tool, and coil embolization is an effective treatment for hemodynamically stable patients.

Keywords: Endovascular treatment, pseudoaneurysm, rheumatoid arthritis, superior mesenteric artery, vasculitis

INTRODUCTION

Pseudoaneurysms from branches of the superior mesenteric artery (SMA) are rare, accounting for only 5.5% to 8% of all visceral artery pseudoaneurysms, with an incidence of 0.01% (1). Trauma and inflammation, such as pancreatitis, are the primary causes, but other factors like hypertension, infections, or medication use also contribute (2,3). While pulmonary artery and aortic artery pseudoaneurysms associated with rheumatoid arthritis have been reported, no prior cases of right colic artery pseudoaneurysms exist in the literature (4,5). Computed tomography (CT) angiography is the diagnostic modality of choice, but selective arterial embolization of the pseudoaneurysm is the treatment modality of choice in hemodynamically stable patients (1,6).

CASE REPORT

A woman in her early 50s presented to our department with a 3-day history of epigastric pain, accompanied by the passage of black stools. The pain was sharp and non-radiating, and its intensity was not associated with food intake. She also experienced nausea and recurrent episodes of non-bilious vomiting. She had no prior history of upper abdominal pain or heartburn, and there was no history of fever, jaundice, or trauma. The patient had a known history of rheumatoid arthritis, for which she had been taking oral methotrexate and methylprednisolone for the past two months. She had no other comorbidities and no history of alcohol consumption or smoking. On general examination, she exhibited pallor, non-blanching purpuric skin lesions on the lower extremities, and abdominal palpation revealed mild tenderness in the epigastric region without a palpable mass.

On admission, laboratory tests revealed a low hemoglobin level of 6.6 g/dL and a white blood cell count of 12,800/µL. Her C-reactive protein level was elevated to 15 mg/L, and her erythrocyte sedimentation rate was raised to 30 mm/hr. Liver function tests, kidney function tests, prothrombin time/international normalized ratio, and serum amylase and lipase levels were all within normal limits. Chest X-ray was normal. Abdominal ultrasonography showed no evidence of gallstones, biliary

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dilation, or pancreatitis. Upper gastrointestinal endoscopy was unremarkable, but colonoscopy revealed clotted blood throughout the colon without an identifiable bleeding source. A contrast-enhanced CT scan of the abdomen with angiography revealed a 17x15 mm saccular outpouching (Figure 1A, B) from a branch of the SMA with a surrounding hematoma. Three-dimensional reconstruction of the CT angiography (CTA) demonstrated that the pseudoaneurysm was originating from the right colic artery (Figure 2).

The differential diagnosis for epigastric pain with gastrointestinal bleeding includes peptic ulcer disease and acute pancreatitis with a splenic artery pseudoaneurysm. In peptic ulcer disease, the pain is typically chronic, often associated with heartburn, and tends to change in intensity with meals. However, the endoscopy showed normal mucosa of the gastric and duodenal walls. In acute pancreatitis, common causes include alcohol consumption and gallstones, neither of which was present in this case. Ultrasonography showed no gallstones, and the pancreas was not enlarged. Furthermore, serum amylase and lipase levels were within normal limits. All of the above features were absent in our case, leading to a radiological diagnosis of right colic artery pseudoaneurysm, and the systemic inflammatory signs suggested the case of rheumatoid vasculitis.

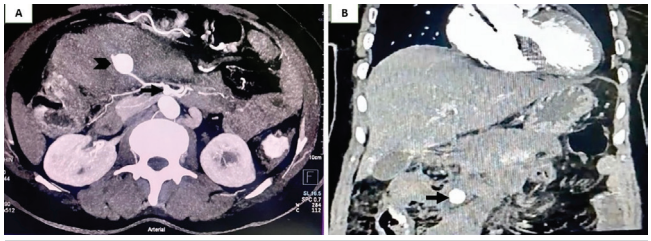

Figure 1. (A) Axial section CT angiography showing a saccular outpouching (arrowhead) from a branch of the superior mesenteric artery (arrow) with a surrounding hematoma. (B) Coronal section showing the pseudoaneurysm (arrow).

CT: Computed tomography.

Figure 2. 3D reconstruction of a CT angiogram showing the pseudoaneurysm (arrow) arising from a branch of the superior mesenteric artery (arrowhead).

CT: Computed tomography.

The patient was initially resuscitated with intravenous fluids, broad-spectrum antibiotics, antiemetics, and analgesics. Three units of packed red blood cells (PRBCs) were transfused due to anemia. After achieving normal hemoglobin levels, the patient underwent selective SMA angiography via the right femoral arterial route, which localized the pseudoaneurysm to the right colic artery (Figure 3A, B). Additionally, the pseudoaneurysm received blood supply from another collateral branch of the SMA. Despite several attempts, gaining direct access to the pseudoaneurysm was difficult. Consequently, transarterial coil embolization was carried out using multiple titanium micro-coils (2 mm and 3 mm in size), targeting both the right colic artery (Figure 4A) and another collateral branch from the SMA (Figure 4B). This procedure resulted in complete occlusion and the absence of filling in the pseudoaneurysm. For the vasculitis, the patient was started on an intravenous corticosteroid along with oral methotrexate.

The abdominal pain was relieved within two days of conservative treatment. Vomiting also subsided, and an oral diet was tolerated post-procedure. Blood counts showed no further drop in hemoglobin (12 g/dL), and white blood cell levels returned to normal (6.500/µL). No recurrence of lower gastrointestinal bleeding was observed. The patient was discharged in stable condition on day 4 post-procedure. At her two-month follow-up, she remained asymptomatic and was doing well.

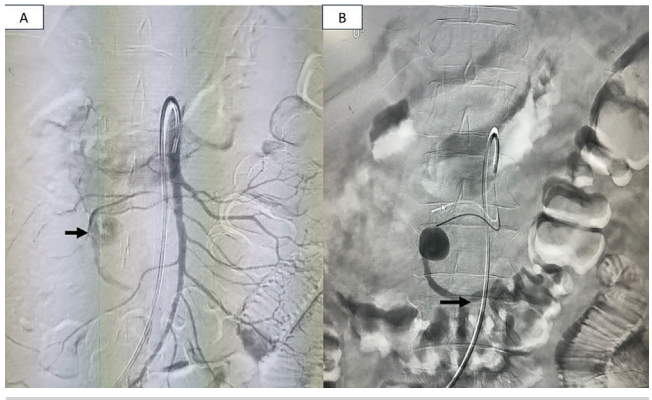

Figure 3. (A) Selective superior mesenteric artery angiography showing the pseudoaneurysm (arrow) arising from the right colic artery, a branch of the superior mesenteric artery. (B) Angiography demonstrates a pseudoaneurysm arising from the right colic artery, which supplies the transverse colon (arrow).

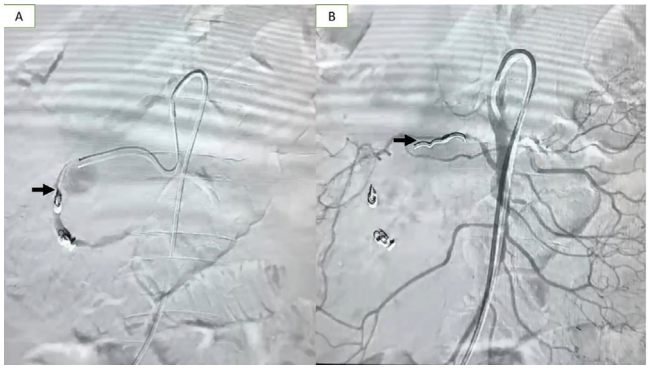

Figure 4. (A) Transarterial coil embolization of the right colic artery pseudoaneurysm (arrow). (B) Another coil embolization of an additional blood supply (arrow) from a collateral branch of the superior mesenteric artery, resulting in complete occlusion of the pseudoaneurysm without contrast filling.

DISCUSSION

Visceral artery pseudoaneurysms are extremely rare, with splenic artery pseudoaneurysms being the most frequently observed. Pseudoaneurysms arising from the branches of the SMA have a prevalence ranging from approximately 5.5% to 8% of all visceral artery pseudoaneurysms, and an overall incidence of 0.01%. However, nearly half of the patients with these pseudoaneurysms are at risk of rupture (1,7-10).

The most common causes of pseudoaneurysms in branches of the SMA are trauma and inflammatory conditions, such as pancreatitis. Less common causes include uncontrolled hypertension, infective endocarditis, anticoagulation medications (e.g., apixaban), iatrogenic factors, or idiopathic origins (3,6,11-14). While autoimmune diseases like rheumatoid arthritis can cause pseudoaneurysms in the pulmonary and aortic arteries, no prior cases of right colic artery pseudoaneurysms associated with rheumatoid arthritis have been reported. The probable underlying cause was rheumatoid vasculitis, which leads to vessel wall weakness (4,5). In our case, the diagnosis was established after ruling out other potential causes of the right colic artery pseudoaneurysm through comprehensive history taking, skin lesions, biochemical tests, and CT angiography.

The usual presentations of pseudoaneurysms are gastrointestinal bleeding or intraperitoneal hemorrhage. Massive gastrointestinal hemorrhage, which can be life-threatening, may present as hematemesis, hematochezia, or melena. Intraperitoneal hemorrhage can occur due to the rupture of a pseudoaneurysm into the peritoneum, typically presenting with acute abdominal symptoms such as epigastric pain in association with fever and recurrent vomiting (2,6,11). In our case, the patient presented with intraperitoneal hemorrhage, which was manifested as a localized hematoma, and melena.

CTA of the abdomen is the preferred diagnostic tool for detecting pseudoaneurysms originating from abdominal arteries. It distinguishes between true aneurysms and pseudoaneurysms. It also identifies underlying causes, such as pancreatitis, or vascular abnormalities, as well as intraperitoneal hemorrhage. Beyond confirming the diagnosis, CTA provides essential information for selecting between endovascular procedures and surgery (1,2,14). In the present case, CTA confirmed the diagnosis and provided crucial information for guiding therapy.

Selective arterial angiography is considered the gold standard investigation for diagnosing vascular-related diseases, offering the additional benefit of therapeutic intervention (14). In hemodynamically stable patients, the preferred treatment options are endovascular coil embolization or covered stent placement. However, endovascular embolization is the preferred method due to better outcomes and lower morbidity. Coils, thrombin, gel foam, cyanoacrylate glue, or combinations of these agents are used in the embolization process (11). Limitations of endovascular techniques include occasional difficulties in accessing target vessels and managing tortuous arteries (3,9). Hemodynamically unstable patients are optimally managed with emergency abdominal exploration, and in some cases, bowel resection with mesenteric vessel ligation may be required to control the bleeding (6,11). In this case, selective angiography of the SMA was performed, followed by successful coil embolization of the pseudoaneurysm, eliminating the need for surgical exploration. This study has limitations. It is a single case, which limits generalizability. Long-term follow-up data are lacking, making it difficult to assess recurrence risk and treatment durability. While endovascular embolization was successful, its long-term efficacy for pseudoaneurysms due to rheumatoid vasculitis remains uncertain. Larger studies with extended follow-up are needed to establish optimal management strategies for this rare condition.

CONCLUSION

Right colic artery pseudoaneurysm is extremely rare among visceral artery pseudoaneurysms. Autoimmune disorders, such as rheumatoid arthritis, can be contributing factors to conditions like rheumatoid vasculitis. CTA is crucial for diagnosing pseudoaneurysms, as it reveals the vascular origin and helps guide the treatment plan. Selective arterial angiography followed by endovascular coil embolization is an effective treatment for right colic artery pseudoaneurysms.

Ethics

Informed Consent: Informed consent was obtained from the patient who participated in this study.

Footnotes

Author Contributions

Concept - S.B.; Design - S.B., R.K.; Data Collection or Processing - B.S.; Writing - B.S.

Conflict of Interest: No conflict of interest was declared by the authors.

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REFERENCES

1. *Kochar S, Sharparis Y, Banerjee B, Karasek M, Brennan S. Endovascular coil embolization of superior mesenteric artery branch pseudoaneurysm. Cureus. 2021;13:e18014.*
2. *Chowdary PB, Maheshwari G, Haynes M, Amaechi I, Dickson-Lowe R. Intraperitoneal haemorrhage secondary to rupture of right colic artery pseudoaneurysm: a case report and literature review. Cureus. 2023;15:e44634.*
3. *Guirgis M, Xu JH, Kaard A, Mwipatayi BP. Spontaneous superior mesenteric artery branch pseudoaneurysm: a rare case report. EJVES Short Rep. 2017;37:1-4.*
4. *Mohakud S, Singh A, Naik S, Deep N. Pulmonary artery pseudoaneurysm in a patient of rheumatoid arthritis. Indian J Rheumatol. 2018;13:202. doi*
5. *Anstadt MA, House CM, Smalley SJ, Raikar GV, Nelson WB, Dahiya R. Aortic pseudoaneurysm in a patient with rheumatoid arthritis. Tex Heart Inst J. 2011;38:202-203.*
6. *Wang J, Cao D, Tong Q. Superior mesenteric artery branch pseudoaneurysm rupture mimicking acute pancreatitis in a patient with acute type B aortic dissection: a case report. Medicine (Baltimore). 2019;98:e16442.*
7. *Tulsyan N, Kashyap VS, Greenberg RK, Sarac TP, Clair DG, Pierce G, et al. The endovascular management of visceral artery aneurysms and pseudoaneurysms. J Vasc Surg. 2007;45:276-283.*
8. *Schatz RA, Schabel S, Rockey DC. Idiopathic splenic artery pseudoaneurysm rupture as an uncommon cause of hemorrhagic shock. J Investig Med High Impact Case Rep. 2015;3:232470961557781.*
9. *Teixeira PG, Thompson E, Wartman S, Woo K. Infective endocarditis associated superior mesenteric artery pseudoaneurysm. Ann Vasc Surg. 2014;28:1563.e1-1563.e5.*
10. *Messina LM, Shanley CJ. Visceral artery aneurysms. Surg Clin North Am. 1997;77:425-442.*
11. *Guo H, Stach J, Belletrutti PJ. A rare cause of life-threatening upper gastrointestinal bleeding. Gastroenterology. 2023;165:1118-1121.*
12. *Yan SL, Wu HS, Chou DA, Kuo CL, Huang HT, Lee YT, et al. Pseudoaneurysm of superior mesentery artery branch after renal extracorporeal shock wave lithotripsy: case report and review. J Trauma. 2007;62:770-774.*
13. *Marone EM, Mascia D, Kahlberg A, Brioschi C, Tshomba Y, Chiesa R. Is open repair still the gold standard in visceral artery aneurysm management? Ann Vasc Surg. 2011;25:936-946.*
14. *Zia Z, Thurley PD, Pollock JG, DeNunzio M, Bungay P, Whitaker SC. The diagnosis and endovascular management of superior mesenteric artery (SMA) branch pseudoaneurysms after appendicectomy. Vasc Endovascular Surg. 2012;46:54-57.*

CASE REPORT
Turk J Surg 2026;42(3):374-377

Gastric volvulus and a myriad of anomalies: Asplenia, jejunal diverticulosis and absent colonic attachments: A rare case report

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ABSTRACT

Gastric volvulus is a rare cause of acute abdomen, and its complexity increases when associated with congenital anomalies. We report an exceptional case of gastric volvulus with perforation in a female patient, which was accompanied by asplenia, jejunal diverticulosis, and absent colonic attachments. To our knowledge, this combination has not been previously documented. This case highlights the need for further research into the mechanisms behind such rare anatomical associations.

Keywords: Gastric volvulus, asplenia, jejunal diverticulosis, absent colonic attachments

INTRODUCTION

Acute abdomen is one of the most frequently encountered surgical emergencies, caused by a diverse range of pathologies, including some that are exceedingly rare. Among these, gastric volvulus, a condition characterized by the abnormal rotation of the stomach on its transverse or longitudinal axis, represents a particularly challenging condition (1). In addition, congenital asplenia, another extremely rare condition, may either present in isolation or coexist with other congenital anomalies (2). Similarly, jejunal diverticulosis, yet another uncommon condition, can manifest with a variety of non-specific abdominal symptoms or complications, including perforation, volvulus, or obstruction (3). The concurrence of these infrequent conditions is an extraordinarily rare phenomenon. We report a case in which incidental findings of asplenia, jejunal diverticula, and absent attachments of the large intestine to the abdominal wall were noted during surgical exploration for an acute abdomen caused by gastric volvulus complicated by perforation. After performing an extensive review of available literature across PubMed, Google Scholar, and Scopus using relevant keywords and combinations, we are confident in stating that, to date, no case demonstrating the simultaneous occurrence of these anomalies has been reported.

CASE REPORT

A 35-year-old female, with no past medical or surgical history, presented to the emergency department with a complaint of severe abdominal pain for one day. The pain had worsened over the last eight hours and was associated with nausea and retching. On further inquiry, she revealed that there had been no flatus or bowel movement over the last 24 hours. However, there was no history of vomiting, urinary retention, and menstrual irregularities.

On examination, the patient was conscious, oriented, and in visible distress. The following vitals were recorded: Blood pressure 80/60 mmHg, pulse 116 bpm, temperature 100.2 °F, and oxygen saturation 97% at room air. Abdominal examination revealed gross distension with a firm to hard mass palpable in the upper quadrants, extending down to the level of the umbilicus. Diffuse tenderness to palpation

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was noted. Bowel sounds were absent on auscultation. Digital rectal examination was unremarkable. Given the hemodynamic instability, immediate resuscitation was initiated, and steps were taken towards stabilization, including administration of analgesia and nasogastric decompression.

Initial investigations showed raised markers of inflammation (Table 1) and a negative urine pregnancy test. Abdominal X-ray showed a large gas-filled viscus occupying the upper abdomen (Figure 1). Urgent ultrasound imaging showed excessive gas shadows obscuring the viscera, resulting in a limited study; however, non-visualisation of spleen was reported. Keeping in view the worsening abdominal distension and deteriorating hemodynamic status despite the attempts at resuscitation, a decision was made for emergency surgical intervention. The possible risks were explained in detail and informed consent was obtained.

Under general anaesthesia, exploratory laparotomy was performed. Intraoperatively, gross peritoneal contamination with approximately 2300 mL of foul-smelling purulent fluid was noted. After adequate exposure, the grossly distended stomach was appreciated with a 180° rotation on its longitudinal axis (Figure 2). The stomach wall had a dusky appearance (Figure 3) and an approx. 4 cm perforation was noted along the lesser curvature (Figure 4). However, after administration of 100% oxygen and application of sponges soaked in warm saline, the stomach wall showed signs of viability with visibly improved colour. Interestingly, further exploration revealed a freely mobile large gut lacking attachments to the abdominal wall and multiple jejunal diverticula (non-inflamed, broad-based at the mesenteric border) (Figure 5). After meticulous examination, the absence of the spleen was confirmed as reported in the initial ultrasound report. The volvulus was reduced, and gastric perforation repaired in a double layer. Anterior gastropexy was performed. This was followed by colopexy; however, as the jejunal diverticula showed no signs of inflammation, they were left *in situ*. Postoperatively, the patient was shifted to the surgical intensive care unit on ventilatory support, where she was diagnosed with septic shock, and died on the first postoperative day despite persistent resuscitation.

Table 1. Laboratory findings of the patient

Parameters	Measured values	Normal values
Hematocrit	38.1%	35-49%
Hemoglobin	13.0 g/dL	12.0-15.0 g/dL
Platelets	235x10^3/mL	150-400 x10^3/mL
WBC	20.1x10^3/mL	4-11.0 x10^3/mL
Neutrophils	84.2%	40-70%
CRP	86.4 mg/dL	<0.7 mg/dL

CRP: C-reactive protein, WBC: White blood cell.

Figure 1. Abdominal X-ray showing a large gas filled viscus occupying the upper abdomen.

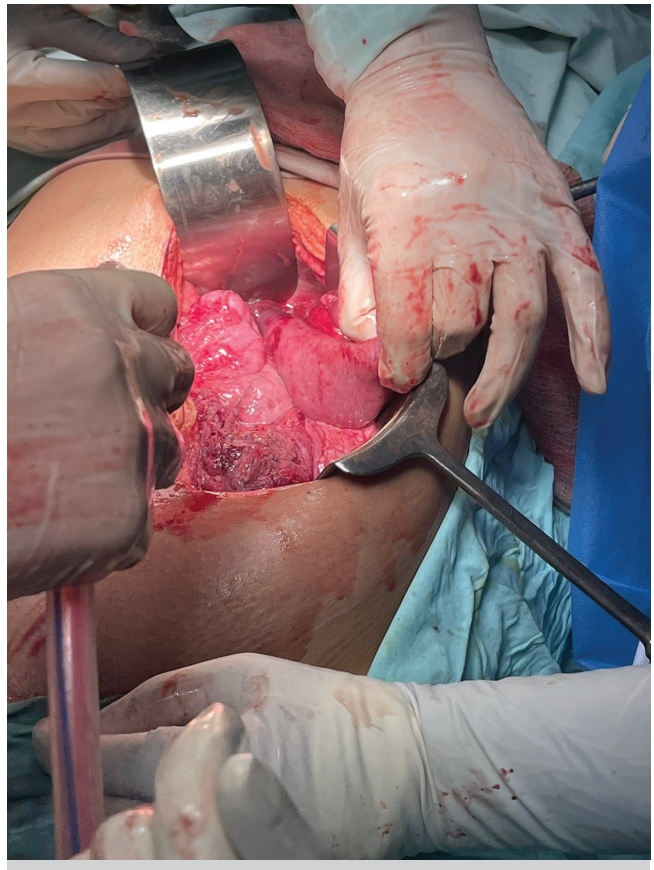

Figure 2. Intra-operative photograph demonstrating gastric volvulus.

DISCUSSION

Acute gastric volvulus is an exceedingly rare condition, and its exact incidence remains unknown (4). The highest incidence of gastric volvulus is observed in individuals during the fifth decade of life, with no significant gender predilection (5). In approximately 30% of cases, it occurs as a primary event, while in the majority of instances, it is secondary to an underlying condition (4). Organoaxial volvulus, accounting for about 60% of cases, involves rotation of the stomach along its long axis between the gastroesophageal junction and the pylorus. In contrast, mesenteroaxial volvulus entails rotation around the short axis between the greater and lesser curvatures. A more complex pattern may occur, combining features of both organoaxial and mesenteroaxial rotations (6).

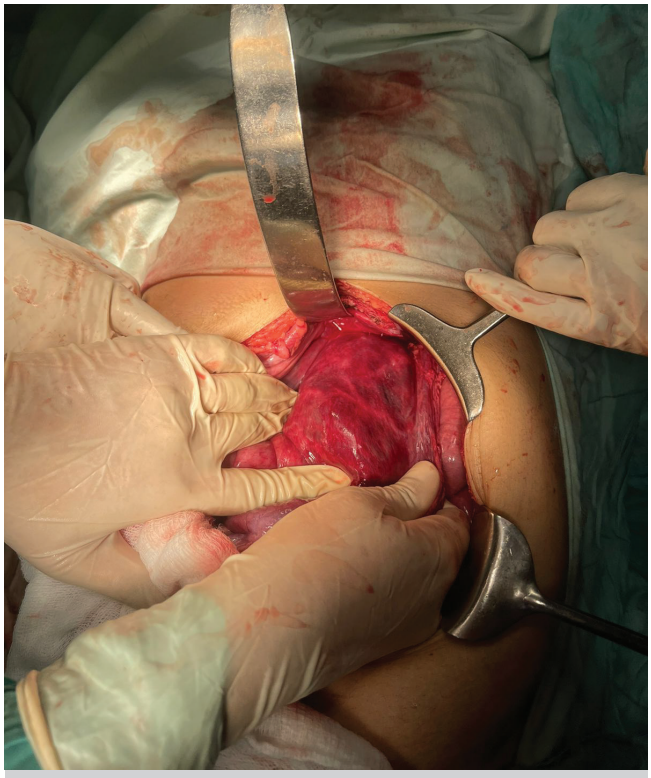

Figure 3. Intra-operative photograph demonstrating dusky stomach wall.

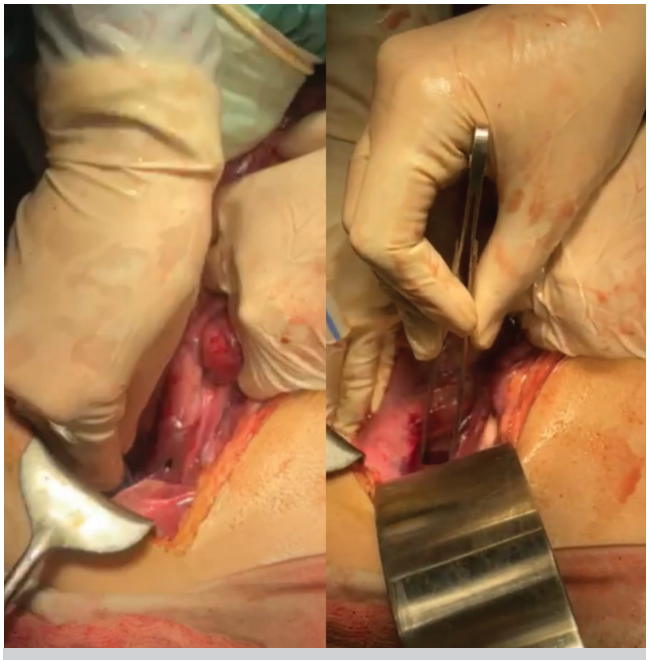

Figure 4. Intra-operative photograph showing gastric perforation.

The clinical presentation of gastric volvulus varies depending on the extent of rotation, the degree of obstruction, and the type of volvulus. It typically presents with a classic triad of symptoms; epigastric pain, retching, and an inability to pass a nasogastric (NG) tube (referred to as Borchardt's triad), which is observed in approximately 70% of adults with gastric volvulus (7). Complications associated with gastric volvulus include ulceration, intestinal obstruction, perforation, hemorrhage, pancreatic necrosis, and omental avulsion. The mortality rate for acute gastric volvulus ranges between 30% and 50%. The management typically involves initial nasogastric decompression, followed by surgery to assess gastric viability, resect any gangrenous tissue, and perform de-rotation, along with gastropexy. Although emergent laparotomy remains the most widely used surgical approach, laparoscopic techniques have also been described (8).

Jejunal diverticulosis is another rare medical entity with incidence documented up to 1.25%. Jejunal diverticula are

Figure 5. Intra-operative photograph showing one of the many jejunal diverticula.

typically multiple, located in the upper jejunum, and most commonly found along the mesenteric border, where the blood vessels enter the bowel. The surgical complications associated with these diverticula include diverticulitis, which may lead to perforation, abscess formation, band adhesions, and intestinal obstruction. Hemorrhage and volvulus are also recognized as potential complications (9).

Congenital anomalies affecting colon fixation, resulting in absent or incomplete peritoneal attachments, predispose individuals to vague abdominal symptoms. Interestingly, the literature suggests that it may be associated with colonic motility disorders, potentially mediated by a deficiency of interstitial cells of Cajal, the gut's pacemaker cells responsible for coordinating peristalsis (10). Currently, no standardized clinical guidelines exist for the long-term management or screening of colonic malfixation, and treatment strategies remain individualized, focusing on symptomatology and the presence of complications.

The association between gastric volvulus and asplenia is well-documented in the literature, with multiple studies reporting gastric volvulus and other anomalies in patients with an absent spleen. Aoyama and Tateishi (11) described three children with asplenic syndrome who presented with gastric volvulus. Similarly, Marhuenda et al. (12) reported a case of acute gastric volvulus in an 18-month-old child with asplenic syndrome. In another case, Ibáñez et al. (13) described a 10-year-old boy with Smith-Lemli-Opitz syndrome who presented with organoaxial volvulus associated with asplenia. However, to the best of our knowledge, there has not been a single reported case documenting the synchronous presence of gastric volvulus, asplenia, jejunal diverticula, and absent colonic attachments to the abdominal wall. This makes our case a unique and exceptional presentation, contributing valuable insights into complex gastrointestinal malformations and raising the possibility of a common embryological origin rooted in developmental abnormalities. During embryogenesis, failure of proper rotation and fixation of the embryonic gut, along with anomalies in splenic development, may point toward a broader spectrum of congenital malformations—possibly part of a subtle heterotaxy or visceral malposition syndrome. Although isolated cases such as this are extremely rare, they underscore the need for a deeper investigation into potential genetic or syndromic associations that may predispose individuals to such combined anomalies. Further research and accumulation of case studies are necessary to develop evidence-based recommendations for both the management and potential screening of patients and at-risk relatives.

CONCLUSION

This case represents a unique presentation of the concurrent occurrence of gastric volvulus, asplenia, jejunal diverticulosis, and absent colonic attachments to the abdominal wall. While each of these conditions may have been documented individually in the literature, their simultaneous presentation in a single patient is unprecedented. Further research and detailed case reports are needed to better understand the pathophysiological mechanisms underlying such rare associations.

Ethics

Informed Consent: The possible risks were explained in detail and informed consent was obtained.

Footnotes

Author Contributions

Concept - M.N.K., M.W., A.I.; Data Collection or Processing - M.N.K.; Literature Search - M.W., S.Y., A.I.; Writing - M.N.K., S.Y.

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REFERENCES

1. *Akhtar A, Siddiqui FS, Sheikh AAE, Sheikh AB, Perisetti A. Gastric volvulus: a rare entity case report and literature review. Cureus. 2018;10:e2312.*
2. *Borsani O, Asano T, Boisson B, Fraticelli S, Braschi-Amirfarzan M, Pietra D, et al. Isolated congenital asplenia: an overlooked cause of thrombocytosis. Am J Hematol. 2022;97:1110-1115.*
3. *Vuorinen P. Jejunal diverticula. Br Med J. 1963;2:762-763.*
4. *El Mouhafid F, Yaka M, Bounaim A, Moujahid M. Gastric volvulus: a challenge to diagnosis and management. World J Surg Surgical Res. 2020;3:1236.*
5. *Jacob CE, Lopasso FP, Zilberstein B, Bresciani CJ, Kuga R, Cecconello I, et al. Gastric volvulus: a review of 38 cases. ABCD. Arquivos Brasileiros de Cirurgia Digestiva (São Paulo). 2009;22:96-100.*
6. *Pandey S, Paudel M, Parajuli A, Ghimire R, Neupane A. Mesenteroaxial gastric volvulus: a case report. JNMA J Nepal Med Assoc. 2021;59:506-509.*
7. *Parkash O, Gill RC, Qaiser I, Rabbani MS, Chawala T, Zafar H. Gastric volvulus in adults in a tertiary care hospital Karachi, Pakistan: a case series. J Pak Med Assoc. 2021;71:1277-1281.*
8. *Rashid F, Thangarajah T, Mulvey D, Larvin M, Iftikhar SY. A review article on gastric volvulus: a challenge to diagnosis and management. Int J Surg. 2010;8:18-24.*
9. *Hunt EL, Cook PH. Jejunal diverticula. Ann Surg. 1921;74:746-750.*
10. *Chen H, Isozaki K, Nakahara M, Kinoshita K, Shinomura Y, Matsuzawa Y, et al. Possible relationship between deficiency of interstitial cells of Cajal and colonic inertia in a patient with colon malfixation. J Gastroenterol. 2002;37:483-484.*
11. *Aoyama K, Tateishi K. Gastric volvulus in three children with asplenic syndrome. J Pediatr Surg. 1986;21:307-310.*
12. *Marhuenda C, Mir I, Perez A, Yeste D, Carreño JC, Gil-Vernet JM, Boix-Ochoa J. Vólvulo gástrico agudo en un paciente con síndrome de asplenia [Acute gastric volvulus in a patient with asplenic syndrome]. Cir Pediatr. 1993;6:44-45. Spanish.*
13. *Ibáñez V, Montalvo JA, Pérez R, Centelles I, Tosca R, Sancho V. Vólvulo gástrico agudo por asplenia en un paciente con síndrome de Smith-Lemli-Opitz [Acute gastric volvulus secondary to asplenia in a child with Smith-Lemli-Opitz syndrome]. Cir Pediatr. 2001;14:129-131. Spanish.*

REVIEW
Turk J Surg 2026;42(3):378-387

Role of artificial intelligence in head and neck surgery - A narrative review

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ABSTRACT

The advent of artificial intelligence (AI) in the field of head and neck surgery has remarkably impacted in various domains, including investigation, diagnosis, pre-operative decision making, surgical planning, rehabilitation, and so on. Head and neck surgery is a field that is practiced worldwide by otolaryngologists, maxillofacial surgeons, plastic surgeons and general surgeons. It has a number of challenging aspects. This review highlights the current advancements and future prospects in the field and its different applications in cancer detection, peri-operative care, and surgical planning. Deep learning and machine learning (ML) are the pillars of AI, by which huge datasets can be analyzed with precision. This can help to enhance the accuracy and meanwhile minimizing the chances of errors in making clinical decisions. On the other hand, there have been numerous ethical concerns regarding AI. Patient privacy, data security, element of empathy in complex decision making are a few concerns at the top. Like any other advancement, the decision is always taken after weighing risks and benefits. Therefore, instead of abandoning AI as a whole, we must come up with certain regulatory authorities that can keep these issues in check. And this can only happen with worldwide collaborative approach. We conducted this narrative review to summarize recent advancements in head and neck cancer surgery by searching PubMed, Scopus, and Google Scholar from January 2000 to July 2025 using predefined terms related to AI, ML, and head and neck surgery.

Keywords: Cancer, endocrine surgery, excision, parathyroid, parathyroid surgery, robotic surgery, thyroid surgery

INTRODUCTION

Artificial intelligence (AI) has captivated medical researchers and practitioners since the advent of machine learning (ML) and deep learning (DL) in 1990 and 2010, respectively. The current abundance of health data and the desire to predict outcomes based on this data have sparked significant interest in ML. It allows computers to learn from information and past experiences, enabling them to make decisions without explicit programming for each task (Figure 1) (1). DL is a subset of ML that involves learning from hundreds of representative layers using neural networks, ultimately providing non-linear predictions.

AI encompasses the capacity of machines to replicate human intelligence autonomously without direct programming. As such, AI is expected to revolutionize healthcare because of its ability to handle data on a massive scale. Currently, AI-based medical platforms support diagnosis, treatment, and prognostic assessments in head and neck surgery at many healthcare facilities worldwide (1). Since the early 1990s, AI has been increasingly used to analyze radiological and pathological images and predict clinical outcomes based on these images, histology, and other clinical variables (2).

Surgery is all about precision, and now, with the help of AI, it is reaching new heights. Due to better computers, the explosion of health data, and the development of massive datasets, AI is rapidly advancing in healthcare. It has the potential to significantly aid medical decision-making and reduce cognitive biases and, ultimately, medical errors (3). This article will examine the current applications of AI-based solutions in head and neck surgery. Given the breadth and rapid evolution of

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the field, we conducted a narrative review rather than a formal systematic review, emphasizing recent clinical applications and translational advances (Table 1). This is a narrative review and is therefore susceptible to selection and publication bias. We mitigated these risks through multi-database searching, explicit inclusion and exclusion criteria, and prioritization of peer-reviewed primary studies; however, we did not adapt protocol registration, quantitative synthesis.

METHODOLOGY

A comprehensive search of the electronic online databases PubMed, Scopus, and Google Scholars was performed and relevant articles published from January 2000 to July 2025 on the applications of AI in head and neck surgery were identified. The combinations of the keywords "AI", "ML", "deep learning", "neural networks", "head and neck surgery", "otolaryngology", "oncology", "robotic surgery", and "diagnostic imaging". We prioritized the last 10 years and the landmark earlier work.

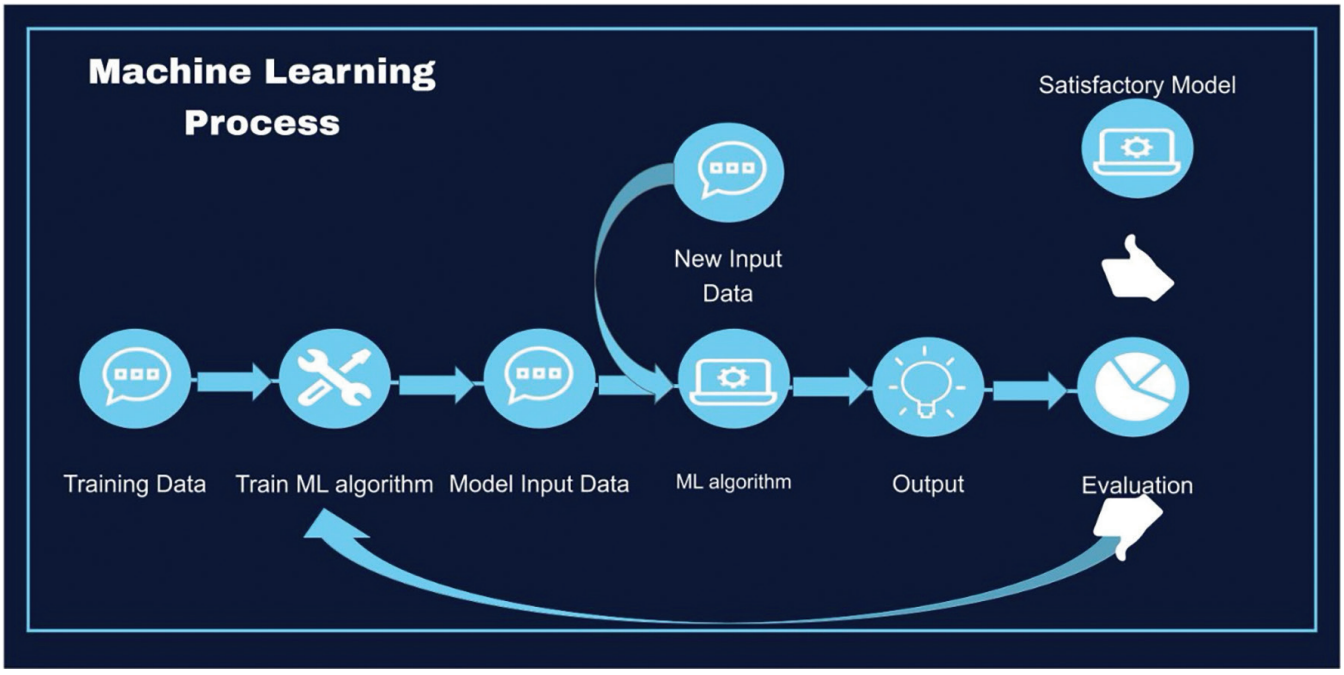

Figure 1. Machine learning process. Stepwise representation of machine learning in surgery. Includes data input, algorithm training, evaluation, and output for clinical use.

ML: Machine learning.

Table 1. Applications of artificial intelligence in head and neck surgery

Clinical stage	AI domain	Applications in head & neck surgery
Diagnosis	Deep learning (CNN)	Detection of oral cancers, precancerous lesions, thyroid nodules, jaw tumors
	Machine learning & radiomics	Prediction of HPV status, lymph node metastasis, periapical pathosis
	Hyperspectral imaging	Early detection of head & neck tumors
Preoperative planning	3D imaging + ML	Surgical planning, cephalometric landmarking, facial reconstruction
	AI-assisted risk prediction	Predicting postoperative complications, hypocalcemia, and major adverse events
Intraoperative	Real-time image analysis	Intraoperative identification of the recurrent laryngeal nerve, parathyroid autofluorescence
	Decision support systems	Guidance for resection margins, anatomical recognition
Postoperative care & monitoring	Predictive analytics (ML)	Prediction of prolonged LOS, surgical site infections, flap failure
	Image & sensor-based monitoring	Flap perfusion monitoring, early detection of complications
	Outcome prediction models	Estimation of complications, readmission, mortality risk

Summary of artificial intelligence applications across different phases of head and neck surgical care. CNN: Convolutional neural network, ML: Machine learning, LOS: Length of stay, HPV: Human papilloma virus.

Studies were included if they reported the use of AI-based tools, algorithms, or platforms in the diagnosis, preoperative surgical planning, intraoperative assistance, or postoperative care of head and neck surgical patients. Only the articles published in English peer-reviewed journals that presented either original research, systematic reviews, meta-analyses, or significant case series with a focus on AI applications were included. Non-English publications, conference abstracts without full-text availability, and studies not specific to head and neck surgery or not involving AI-based technologies were excluded.

Two authors independently screened titles and abstracts for relevance, and full-text articles meeting the inclusion criteria were retrieved for detailed review. The findings from the included literature were synthesized qualitatively, with emphasis on identifying recurring themes, trends, and potential future directions for AI integration in head and neck surgical practice.

AI in Diagnosis of Head and Neck Cancers

The prognosis of head and neck cancers heavily depends on early detection and prompt treatment. Most cases of head and neck cancer are typically diagnosed at an advanced stage, contributing to a pronounced decrease in survival rates even with effective treatment. AI has notable potential for diagnostic and therapeutic management in head and neck oncology. Oral cancers, the 13th most common cancer worldwide, pose a significant disease burden that necessitates early detection (4). Oral cavity cancers are the most common cancers of the upper respiratory digestive tract, with an increasing incidence rate. Detecting pre-malignant lesions can prevent them from developing into cancer, but it is challenging for non-specialists.

Some ML tools enable detection through autofluorescence measurement or photography (5-7). Fu et al. (7) introduced a Conventional Neural Network (CNN) designed to identify oral cavity carcinomas in photographs. They trained it using 6176 images and achieved performance comparable to experts (Figure 2). A study conducted by Birur et al. (8) identified the potential of CNN-enabled m(mobile)health device as a powerful triaging tool for identifying suspicious oral lesions. This approach enhanced the screening proficiency of frontline workers in low-resource settings, leading to better disease outcomes (8). Deep learning-based algorithms were also employed to detect and localize benign and malignant vocal cord lesions during live endoscopies, reducing the need for an invasive diagnostic approach (9).

In pathology, diagnosing prognosis and predicting treatment response often requires additional tests like immunohistochemistry or next-generation sequencing. AI, combined with digital pathology, could transform this process by identifying subvisual structural features that are beyond the human eye's ability to detect, creating new morphology-based biomarkers with prognostic and predictive value. The genotype-phenotype relationship suggests that genetic mutations in tumors often correlate with morphological

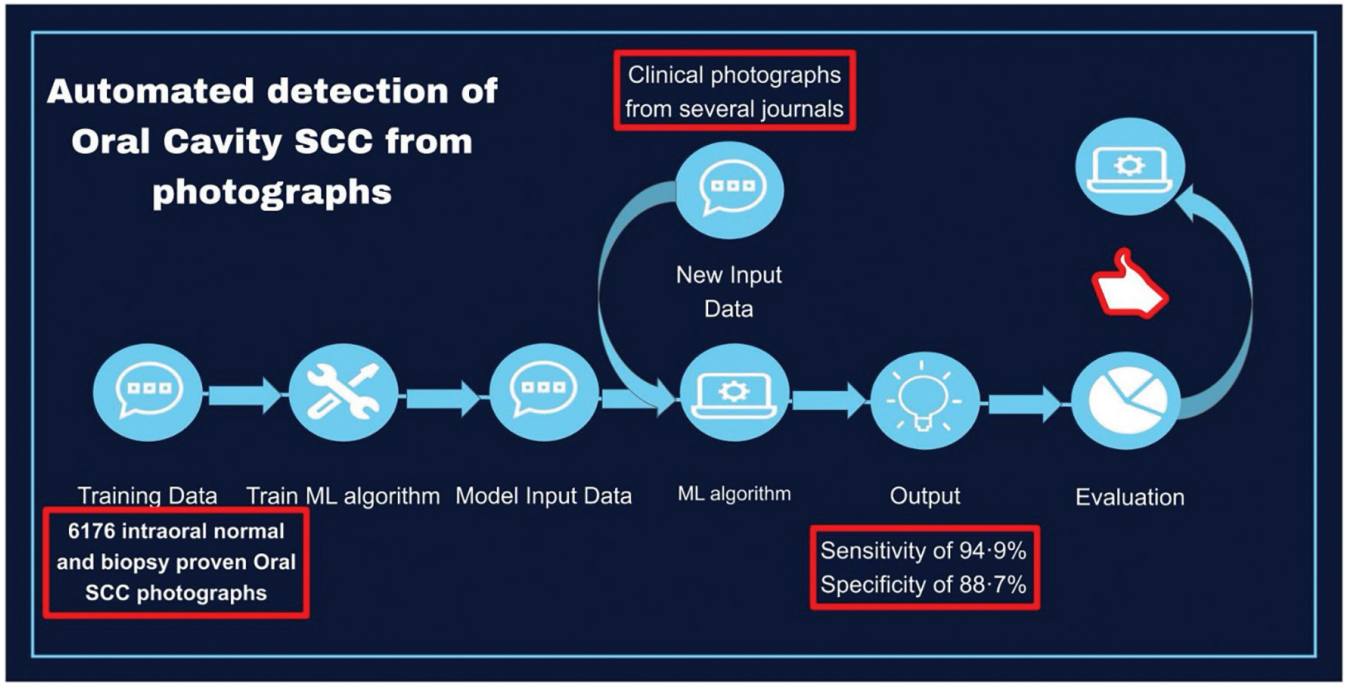

Figure 2. Automated detection of oral cavity squamous cell carcinoma from photographs.
SCC: Squamous cell carcinoma, ML: Machine learning.

changes. AI can predict molecular or clinical outcomes based on histomorphological data and is increasingly important in analyzing molecular pathology, such as using DL to classify DNA methylation profiles in lung squamous cell carcinomas and differentiate metastasis from primary cancer. AI is also becoming crucial in multi-omics-based molecular tumor classifications (10).

Identifying nodal metastasis (NM) and tumor extranodal extension (ENE) is a crucial aspect of head and neck cancer management. Currently, this can only be achieved using post-operative histopathology specimens. While there has been some success in the detection of NM on diagnostic radiological imaging, studies on the detection of radiologic ENE have shown less than satisfactory performance overall, with the area under the curve (AUC) of the receiver operating characteristic plot ranging between 0.65 and 0.69 (11). Kann et al. (12) designed a 3D CNN model and trained it on 2.875 computed tomography (CT)-segmented lymph nodes from 124 samples with corresponding pathology labels. It was later tested on a blinded set of 131 samples, which showed the model's strong performance, achieving an AUC of 0.91 (95% confidence interval: 0.85-0.97) for predicting both ENE and NM (12). Furthermore, Seidler et al. (13) demonstrated that using an AI-based approach, radiomic features of the primary tumor can be used for nodal status prediction. Several studies employed similar models and were proven highly effective in nodal identification (13,14).

Furthermore, the diagnostic utility of AI methods has been extensively explored in all imaging modalities, including ultrasound (US), CT, magnetic resonance, and nuclear medicine (15). Hyperspectral imaging is a non-invasive tool used to detect cancers by analyzing the absorption, fluorescence emission, or reflectance spectrum of tissues (16). CNNs allow the detection and classification of features on panoramic radiographs (17,18) and cone-beam images (19). Among these features, radiolucent bone lesions of the mandible and maxilla are the most studied (17,18). While certain lesions can be treated with simple surgical procedures like enucleation and curettage, others, like ameloblastomas, may necessitate a more aggressive approach. This is to minimize the chances of tissue damage, malignant changes, and recurrence (20). Depending on their architecture, the algorithms used allow the automation of part or all of the process of detection, segmentation, feature extraction, and classification of lesions on imaging. Human papillomavirus (HPV) significantly impacts the development of head and neck cancers, particularly in the oropharynx, leading to distinct clinical characteristics. Patients with HPV-positive disease generally have better outcomes compared to those who are HPV-negative, influencing their treatment approaches. Detecting HPV status typically involves invasive methods such as immunohistochemistry for P16 or direct testing for HPV DNA. However, non-invasive approaches using head and neck imaging combined with ML algorithms have been explored to determine HPV status. The results affirm the practicality of predicting HPV status for head and neck cancers (21-23). Ultrasonography is the investigation of choice for diagnosing thyroid nodules, but its reliance on operator skill makes interpretation subjective. The surge in ultrasonography usage has overwhelmed radiologists, driving the need for automated data processing. Therefore, ML has been extensively trialled and proven effective for thyroid nodule detection and diagnosis (24,25).

AI in Preoperative Planning

AI-enhanced preoperative planning marks a significant change in surgical preparation, providing surgeons with a data-driven method to make informed decisions and improve patient outcomes. Time limitations, decision exhaustion, deductive reasoning, intricacy, and prejudice deter surgical decision-making, contributing to avoidable harm. Conventional decision support systems suffer from time-consuming manual data input and inadequate precision. Automated AI models powered by real-time electronic health record data can overcome these deficiencies. AI-powered algorithms can be helpful in surgical risk assessment because of their ability to compile and interpret large amounts of data. Furthermore, they could also be explored to formulate strategies to reduce patient mortality and morbidity (26,27). Preoperative risk can be calculated from AI-augmented analysis of radiological imaging, which is mainly utilized by surgeons to gather more information about the morphology of tumors and to plan surgical approaches.

Bihorac et al. (28) developed an ML algorithm using electronic health record data that could predict the risk of certain complications and mortality at 1-, 3-, 6-, 12-, and 24 months after surgery (AUCs of 0.82 and 0.94). Researchers also successfully pinpointed patients at higher risk of extended hospitalization and intricate therapeutic management after surgery. This outcome typically relies on factors such as operation duration, ischemia duration, transplantation, American Society of Anesthesiologists score, intensive care duration, and TNM stages, achieving accuracy levels of up to 97.92% (29).

Patients with dentofacial deformity (DFD) receive significant advantages throughout the orthodontic-surgical treatment process by integrating these new technologies, starting from the initial diagnosis and continuing through postoperative monitoring (30). Many studies have suggested using 3D imaging analysis tools to better understand complex DFD. By incorporating AI, these tools can quickly identify and interpret numerous bone and skin landmarks essential for comprehensive 3D analysis. This approach surpasses other computational techniques previously used (31). Most planning software now includes simulations of potential profile alteration to

accommodate the increasing number of patients worried about their post-operative modification of appearance. However, the approximation models and bone-skin displacement ratios used by such software often have limitations when it comes to simulating changes in soft tissue (32).

A few other applications of AI in oral-maxillofacial surgery include computer-aided design and computer-aided manufacturing (CAD/CAM) (33-35). CAD/CAM uses digital imaging, three-dimensional (3D) photography, intraoral scans, and 3D printing to design and fabricate customized implants, prostheses, guides, and plates for reconstructing maxillofacial defects (36). Artificial neural networks (ANN), another domain of AI, can model complex non-linear relationships between inputs and outputs to perform tasks such as image recognition, natural language processing, speech synthesis, and generation. ANNs can be used to recognize facial features, emotions, expressions, and gestures, synthesize realistic speech and faces, generate captions and descriptions for images and videos, and create interactive avatars for maxillofacial surgery (33-35).

Early diagnosis of laryngeal carcinoma is crucial for preserving organ function. A study reviewed five databases for research on AI-based models assessing images of laryngeal lesions from endoscopy. The results showed AI's promising accuracy, sensitivity, and specificity, with values ranging from 0.806 to 0.997, and 0.91 for benign and 0.94 for malignant lesions. AI performance improved with larger image databases and more pre-processing steps. To enhance AI's diagnostic quality, developing image evaluation standards and fostering multi-center collaboration for sharing image databases is essential to create high-performing models (37).

Elliott Range et al. (38) applied ML to thyroid fine needle aspiration biopsy (FNAB) whole-slide images (WSI) to identify regions of interest (ROI) and predict malignancy. Overall performance was comparable to expert assessments. However, the algorithm underperformed with indeterminate Bethesda categories, reinforcing a hybrid pathway where cytopathologist supervision remains crucial and AI assistance is restricted to clearly classifiable cases (Figure 3) (38).

AI Enhanced Surgical Techniques

A study conducted at the University of Pennsylvania, Philadelphia, aimed to develop a minimally invasive robotic surgery technique for treating neoplasms in the parapharyngeal space and infratemporal fossa. Using the da Vinci Surgical System, initial procedures were performed on cadavers and a dog, followed by a trial on a human patient. The robotic approach provided excellent visualization and successful tissue dissection with

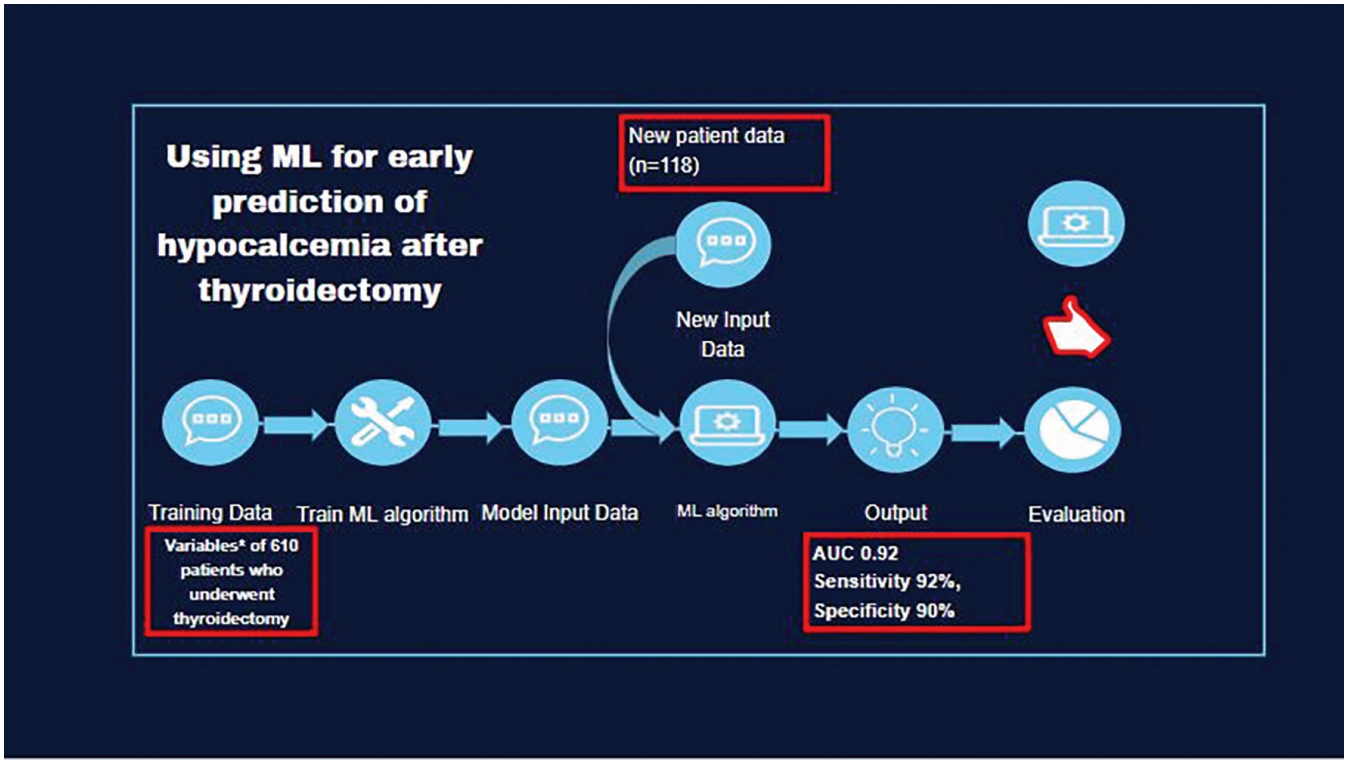

Figure 3. Using machine learning for the early prediction of postoperative hypocalcemia risk after thyroidectomy.

ML: Machine learning, AUC: Area under the curve.

Note: Age, gender, body mass index, intraoperative parathyroid hormone levels.

minimal complications. Similarly, studies have shown that the da Vinci Surgical Robot has been effectively used to excise tongue neoplasms and treat various mediastinal lesions (39-41). Modern robotic platforms increasingly incorporate AI-enabled features (e.g., augmented anatomy recognition, scene interpretation, and intraoperative decision support), highlighting a potential of natural convergence between robotics and surgical AI.

Udelsman et al. (42) used preoperative and intraoperative parathyroid hormone (PTH) levels to predict cure rates in minimally invasive parathyroidectomy. This surgery targets a single adenoma identified through imaging. Sometimes, multiple adenomas go undetected, and PTH levels help ensure that all are removed. They transformed PTH data and used logistic regression to predict cures. Testing on 100 patients showed the model correctly predicted cures in 96.3% of single adenoma cases and 89.4% of multiple adenoma cases (42).

Halicek et al. (43) developed a deep CNN classifier to distinguish benign from malignant head and neck tissue within the excised cutaneous and thyroid specimens. Their model achieved incredible performance with 97% sensitivity, 96% specificity, and 96% accuracy and could be employed to alter resection margins accurately and, in turn, enhance prognostic outcomes (43).

Quellec et al. (44) proposed that automated case retrieval could provide real-time warnings or recommendations during surgery by analyzing live surgical video. André et al. (45) focused on the emerging field of probe-based confocal laser endomicroscopy (pCLE). They noted that the classification of pathologies for pCLE is still being developed by doctors and suggested that accessing cases with existing annotations and matching histopathological diagnoses could assist surgeons in making immediate decisions, such as whether to biopsy tissue (45). They achieved 80.1% accuracy using a weighted k-NN on 1036 images from 54 patients and reported 94.2% accuracy with a similar method on 121 videos from 68 patients. André et al. (46) reached 96.7% AUC for the top concept and 49.4 Kendall τ correlation on 118 videos from 66 patients (46-49). Tafresh et al. (49) obtained 89.9% accuracy and 48.8% Spearman ρ correlation on 118 videos from 66 patients. Gu et al. (50) reported high accuracy (96.6% and 89.2% respectively) on breast tissue datasets. Therefore, automated case retrieval and pCLE, can assist head and neck surgical oncology by providing real-time recommendations and improving diagnostic accuracy during surgery.

AI in Thyroid and Parathyroid Surgery

In endocrine head and neck surgery, AI has rapidly advanced diagnostic imaging, cytopathology, and intraoperative decision support. On US, multiple groups report automated or AI-augmented TI-RADS workflows that improve efficiency and reduce inter-reader variability. DL models have demonstrated a potential to aid nodule detection, feature scoring, and malignancy prediction beyond manual TI-RADS alone (51-53). Beyond B-mode classification, CNNs trained on large US datasets achieve performance approaching expert readers for malignancy prediction and segmentation. Recent meta-analytic efforts continue to confirm the feasibility of such models (54-56).

In cytopathology, AI applied to WSI of thyroid FNAB can identify ROI and assist in diagnoses and risk prediction, with a performance comparable to pathologists. Such applications have potential use in indeterminate Bethesda categories and clinical implementation can help reduce cytopathologists work load (57).

AI-enhanced anatomical recognition during endoscopic thyroidectomy has shown remarkable accuracy for recurrent laryngeal nerve identification and could complement conventional intraoperative nerve monitoring (58). Moreover, during post postoperative course, ML-based risk calculators have been validated to predict early hypocalcemia after total thyroidectomy, enabling selective calcium supplementation pathways (59). For gland preservation, near-infrared autofluorescence—including probe-based systems (e.g., PTeye)—improves parathyroid identification and may reduce hypocalcemia (60).

AI in Post-operative Care and Monitoring

Complications following head and neck surgery can have an impact on both the surgical outcomes and the timely administration of any necessary adjuvant treatment (61). AI is an emerging tool that forecasts survival rates, surgical outcomes, and potential complications, providing tailored strategies for individual patients. When used thoughtfully, AI has the potential to transform postoperative surgical care (62). AI can predict post-operative outcomes and the length of hospital stays (63). Risk analysis is ML to analyze major post-operative events in head and neck surgery, which not only helped to predict but also gave us an indication of the level of care needed for patients after surgery (64). Kordzadeh et al. (65) applied AI to detect life-threatening complications after post-endovascular aneurysm repair .

Using thermal imaging, near-infrared spectroscopy, flow-coupler, and implantable Doppler for free flap viability monitoring in reconstructive surgeries has proven superior to clinical assessment, thus improving salvage rates for the surgery (66). One of the most common complications after surgery is cardiorespiratory events. While inward vital monitoring is done periodically, often at 4-6-hour intervals, using portable wireless monitoring devices for each patient will provide continuous monitoring and timely detection of complications. This benefits patient management and is cost-effective, preventing extended hospital stays secondary to complications (67). Hence, AI uses integrated data and precise calculations that help predict and

monitor post-operative complications and can be utilized for better surgical outcomes.

Challenges and Limitations

The limitations of AI in head and neck surgery, as well as medicine in general, are widely debated. Ethical considerations and patient privacy are the primary challenges in integrating AI into healthcare. Technical limitations related to data and analysis include (a) slight differences in training and testing dataset sizes, (b) varying performance metrics during regression or classification tasks, and (c) different validation methods, with some research lacking data validation (1).

An evident illustration of the ethical issues with AI can be seen in facial recognition software, which has the potential to perpetuate racial bias and pose significant risks in the field of plastic surgery (68). Additionally, there are potential risks, such as cyber-attacks on AI systems and the emergence of bias within the complex digital network. Addressing these challenges may require advanced techniques (69).

There are numerous challenges to the widespread implementation of AI as diagnostic assistance. Interestingly, the Royal College of Surgery released a report highlighting several important issues regarding the widespread adoption (70). There is a growing concern among healthcare professionals and patients about the potential replacement of medical personnel by machines. The thing is the loss of sensitive personal interaction, which generally goes together with a doctor-patient relationship (71). Data governance and ethics remain a significant concern as large amounts of patient data could be exposed to risk (72). Additionally, there is the "Black Box problem", which means people cannot see how AI arrives at its decisions. This lack of transparency adds to some scepticism about AI now (73). The black-box problem is the high dependence of an algorithm on available information. However complex they may be in making determinations, AIs are only supposed to aid humans rather than replace them entirely (74).

Healthcare data segregation and limited access make it difficult to create effective AI systems. Protecting patients' confidential information should be given priority because there is a risk of unauthorized access to this data. Biased AI algorithms over-fitting or poor-quality data can lead to unfair results, worsening health inequities through misleading diagnoses. Many AI systems lack transparency, raising accountability concerns at various levels. Ethical concerns are related to responsibility and standards for making decisions using AI and fear of employees losing jobs within healthcare (75). To face these challenges, we need to improve data sharing, enforce more robust security protocols, employ strategies that can counteract bias in algorithmic decision-making processes, make sure there is transparency in systems where AI is used, create ethical frameworks for AI development, and validate its applications through empirical methods (76).

Future Directions and Opportunities

Advancements in preoperative preparation have streamlined the process from pre-surgery to post-surgery, making it more efficient and effective. While this may lead to higher patient expenses, the benefits include reduced operation times and shorter hospital stays. Future research could focus on a cost-benefit analysis to determine if virtual planning ultimately reduces overall healthcare costs (77).

In otorhinolaryngology and head and neck surgery, image-based AI assists surgeons in identifying disorders in high-demand situations. Enhanced communication among educational institutions will improve AI reliability and broader applicability, moving it from proof-of-concept to clinical use. Challenges include training algorithms on large, diverse datasets, standardizing data exchange to reduce waste, and adopting 3D-based AI in surgical education. Prospective studies are needed to identify practical issues and compare real-world performance to lab studies (78).

DL networks for bone structures in the head and neck primarily focus on skull and mandible segmentation. Skull segmentation networks mainly utilise techniques using US or magnetic resonance imaging. Current research aims to enhance mandibular segmentation accuracy by considering slice layer correlations, multi-scale features, and adding attention mechanisms. However, further advancements are required, especially for mandibular segmentation that is compromised by metal artifacts and tumor erosions. Research on other tissues, such as the maxillary sinus, is limited due to the lack of publicly available data (79).

AI is expected to influence biomedical research and medicine significantly in the future. It is gaining popularity as a potential alternative to human efforts, especially in decision-making and reasoning. This capability could revolutionize its application in surgical procedures by mimicking a surgeon's cognitive abilities and, when paired with robotics, serving as a reliable assistant. Robotic surgery within the field of rhinology will undoubtedly be the subject of further investigation, mainly to reduce surgical morbidity, elevate surgical dissection, and improve patient outcomes (80). Due to safety concerns, unsupervised AI use in surgery is unlikely in the near future. However, AI's widespread implementation can significantly enhance diagnostic and non-invasive surgical aspects, reducing medical professionals' workloads.

The rapid growth of data and AI integration in surgery is becoming increasingly necessary. Utilizing computers during surgery can enhance AI applications, making them more reliable and proficient tools in medicine. Over time, improved outcomes

from AI involvement may further establish their importance in surgery. With ongoing technological advancements, there is optimism about AI integrated with robotics, revolutionizing surgical procedures. This approach could enhance the efficacy and safety of surgeries, with the surgeon acting as a guide.

CONCLUSION

Integrating AI and ML in head and neck surgery represents a significant transformation in the field. We highlighted the potential of AI to improve diagnostic accuracy, treatment planning, intraoperative decision-making, and postoperative care for patients with head and neck cancers. Despite the usefulness of AI in head and neck surgery, several challenges remain to be addressed. Integrating AI into clinical practice requires validation through large-scale clinical trials to ensure accuracy and reliability. Moreover, ethical considerations, including patient privacy and data security, must be addressed to increase trust and acceptance among healthcare professionals and patients. Interdisciplinary collaboration, continued innovation, and the establishing clear regulatory frameworks can catapult the adaptation of AI-enhanced head and neck surgery techniques.

Footnotes

Author Contributions

Concept - S.S., N-H.B., M.A.; Design - S.S., N-H.B., M.A.; Data Collection or Processing - S.S., N-H.B., M.A., N.J., M.H.; Analysis or Interpretation - S.S., N-H.B., M.A.; Literature Search - S.S., N-H.B., M.A., N.J., M.H., S.G.A.K.; Writing - S.S., N-H.B., M.A., M.H., S.G.A.K., S.K.G., R.H.

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REFERENCES

1. *Tama BA, Kim DH, Kim G, Kim SW, Lee S. Recent advances in the application of artificial intelligence in otorhinolaryngology-head and neck surgery. Clin Exp Otorhinolaryngol. 2020;13:326-339.*
2. *Crowson MG, Ranisau J, Eskander A, Babier A, Xu B, Kahmke RR, et al. A contemporary review of machine learning in otolaryngology-head and neck surgery. Laryngoscope. 2020;130:45-51.*
3. *Kaul V, Enslin S, Gross SA. History of artificial intelligence in medicine. Gastrointest Endosc. 2020;92:807-812.*
4. *Comprehensive assessment of evidence on oral cancer prevention released. Accessed June 3, 2024. Available from:https://www.who.int/news/item/29-11-2023-comprehensive-assessment-of-evidence-on-oral-cancer-prevention-released-29-november-2023*
5. *van Staveren HJ, van Veen RL, Speelman OC, Witjes MJ, Star WM, Roodenburg JL. Classification of clinical autofluorescence spectra of oral leukoplakia using an artificial neural network: a pilot study. Oral Oncol. 2000;36:286-293.*
6. *Shamim MZ, Syed S, Shiblee M, Usman M, Zaidi M, Ahmad Z. Detecting benign and precancerous tongue lesions using deep convolutional neural networks for early signs of oral cancer. Basic Clin Pharmacol Toxicol. 2019;125:184-185.*
7. *Fu Q, Chen Y, Li Z, Jing Q, Hu C, Liu H, et al. A deep learning algorithm for detection of oral cavity squamous cell carcinoma from photographic images: a retrospective study. EClinicalMedicine. 2020;27:100558.*
8. *Birur N P, Song B, Sunny SP, G K, Mendonca P, Mukhia N, et al. Field validation of deep learning based point-of-care device for early detection of oral malignant and potentially malignant disorders. Sci Rep. 2022;12:14283.*
9. *BS SM, Baird BJ, Holsinger FC, FACS. Detecting oropharyngeal carcinoma using multispectral, narrow-band imaging and machine learning. The Laryngoscope. 2018.*
10. *Amin A, Cardoso SA, Suyambu J, Abdus Saboor H, Cardoso RP, Husnain A, et al. Future of artificial intelligence in surgery: a narrative review. Cureus. 2024;16:e51631.*
11. *Maxwell JH, Rath TJ, Byrd JK, Albergotti WG, Wang H, Duvvuri U, et al. Accuracy of computed tomography to predict extracapsular spread in p16-positive squamous cell carcinoma. Laryngoscope. 2015;125:1613-1618.*
12. *Kann BH, Aneja S, Loganadane GV, Kelly JR, Smith SM, Decker RH, et al. Pretreatment identification of head and neck cancer nodal metastasis and extranodal extension using deep learning neural networks. Sci Rep. 2018;8:14036.*
13. *Seidler M, Forghani B, Reinhold C, Pérez-Lara A, Romero-Sanchez G, Muthukrishnan N, et al. Dual-energy CT texture analysis with machine learning for the evaluation and characterization of cervical lymphadenopathy. Comput Struct Biotechnol J. 2019;17:1009-1015.*
14. *Chen L, Zhou Z, Sher D, Zhang Q, Shah J, Pham NL, et al. Combining many-objective radiomics and 3D convolutional neural network through evidential reasoning to predict lymph node metastasis in head and neck cancer. Phys Med Biol. 2019;64:075011.*
15. *Mahmood H, Shaban M, Rajpoot N, Khurram SA. Artificial intelligence-based methods in head and neck cancer diagnosis: an overview. Br J Cancer. 2021;124:1934-1940.*
16. *Zhang Y, Wu X, He L, Meng C, Du S, Bao J, et al. Applications of hyperspectral imaging in the detection and diagnosis of solid tumors. Transl Cancer Res. 2020;9:1265-1277.*
17. *Poedjiastoeti W, Suebnukarn S. Application of convolutional neural network in the diagnosis of jaw tumors. Heal Inf Res. 2018;24:236-241.*
18. *Yang H, Jo E, Kim HJ, Cha IH, Jung YS, Nam W. Deep learning for automated detection of cyst and tumors of the jaw in panoramic radiographs. J Clin Med. 2020;9:1-14.*
19. *Orhan K, Bayrakdar IS, Ezhov M, Kravtsov A, Özyürek T. Evaluation of artificial intelligence for detecting periapical pathosis on cone-beam computed tomography scans. Int Endod J. 2020;53:9.*
20. *Effiom OA, Ogundana OM, Akinshipo AO, Akintoye SO. Ameloblastoma: current etiopathological concepts and management. Oral Dis. 2018;24:307-316.*
21. *Yu K, Zhang Y, Yu Y, Huang C, Liu R, Li T, et al. Radiomic analysis in prediction of human papilloma virus status. Clin Transl Radiat Oncol. 2017;7:49-54.*
22. *Vallieres M, Kumar A, Sultanem K, Naqa IE. FDG-PET image-derived features can determine HPV status in head-and-neck cancer. Int J Radiat Oncol Biol Phys. 2013;87:S467.*
23. *Buch K, Fujita A, Li B, Kawashima Y, Qureshi MM, Sakai O. Using texture analysis to determine human papillomavirus status of oropharyngeal squamous cell carcinomas on CT. AJNR Am J Neuroradiol. 2015;36:1343-1348.*
24. *Chi J, Walia E, Babyn P, Wang J, Groot G, Eramian M. Thyroid nodule classification in ultrasound images by fine-tuning deep convolutional neural network. J Digit Imaging. 2017;30:477-486.*
25. *Park VY, Han K, Seong YK, Park MH, Kim EK, Moon HJ, et al. Diagnosis of thyroid nodules: performance of a deep learning convolutional neural network model vs. radiologists. Sci Rep. 2019;9:17843.*
26. *Loftus TJ, Tighe PJ, Filiberto AC, Efron PA, Brakenridge SC, Mohr AM, et al. Artificial intelligence and surgical decision-making. JAMA Surg. 2020;155:148-158.*

27. *Hashimoto DA, Rosman G, Rus D, Meireles OR. Artificial intelligence in surgery: promises and perils. Ann Surg. 2018;268:70-76.*
28. *Bihorac A, Ozrazgat-Baslanti T, Ebadi A, Motaei A, Madkour M, Pardalos PM, et al. MySurgeryRisk: development and validation of a machine-learning risk algorithm for major complications and death after surgery. Ann Surg. 2019;269:652-662.*
29. *Vollmer A, Nagler S, Hörner M, Hartmann S, Brands RC, Breitenbücher N, et al. Performance of artificial intelligence-based algorithms to predict prolonged length of stay after head and neck cancer surgery. Heliyon. 2023;9:e20752.*
30. *Bouletreau P, Makaremi M, Ibrahim B, Louvrier A, Sigaux N. Artificial intelligence: applications in orthognathic surgery. J Stomatol Oral Maxillofac Surg. 2019;120:347-354.*
31. *Dot G, Rafflenbeul F, Arbotto M, Gajny L, Rouch P, Schouman T. Accuracy and reliability of automatic three-dimensional cephalometric landmarking. Int J Oral Maxillofac Surg. 2020;49:78.*
32. *Rasteau S, Sigaux N, Louvrier A, Bouletreau P. Three-dimensional acquisition technologies for facial soft tissues - applications and prospects in orthognathic surgery. J Stomatol Oral Maxillofac Surg. 2020;121:721-728.*
33. *Rokhshad R, Keyhan SO, Yousefi P. Artificial intelligence applications and ethical challenges in oral and maxillo-facial cosmetic surgery: a narrative review. Maxillofac Plast Reconstr Surg. 2023;45.*
34. *Rasteau S, Ernenwein D, Savoldelli C, Bouletreau P. Artificial intelligence for oral and maxillo-facial surgery: a narrative review. J Stomatol Oral Maxillofac Surg. 2022;123:276-282.*
35. *Pereira KR. Harnessing artificial intelligence in maxillofacial surgery. In: Lidströmer N, Ashrafian H, editors. Artificial Intelligence in Medicine. Springer; 2021.*
36. *Cristache CM, Tudor I, Moraru L, Cristache G, Lanza A, Burlibasa M. Digital workflow in maxillofacial prosthodontics –an update on defect data acquisition, editing and design using open-source and commercial available software. Appl Sci. 2021;11:973.*
37. *Żurek M, Jasak K, Niemczyk K, Rzepakowska A. Artificial intelligence in laryngeal endoscopy: systematic review and meta-analysis. J Clin Med. 2022;11:2752.*
38. *Elliott Range DD, Dov D, Kovalsky SZ, Henao R, Carin L, Cohen J. Application of a machine learning algorithm to predict malignancy in thyroid cytopathology. Cancer Cytopathol. 2020;128:287-295.*
39. *BW O 'Malley Jr, GS W. Robotic skull base surgery: preclinical investigations to human clinical application. Arch Otolaryngol Head Neck Surg. 2007; 133:1215-1219.*
40. *BW O 'Malley Jr, GS W, W S, NG H. Transoral robotic surgery (TORS) for base of tongue neoplasms. Laryngoscope. 2006;116:1465-1472.*
41. *Augustin F, Schmid T, Bodner J. The robotic approach for mediastinal lesions. Int J Med Robot. 2006;2:262-270.*
42. *Udelsman R, Donovan P, Shaw C. Cure predictability during parathyroidectomy. World J Surg. 2014;38:525-533.*
43. *Halicek M, Lu G, Little JV, Wang X, Patel M, Griffith CC, et al. Deep convolutional neural networks for classifying head and neck cancer using hyperspectral imaging. J Biomed Opt. 2017;22:60503.*
44. *Quellec G, Lamard M, Cazuguel G, Droueche Z, Roux C, Cochener B. Real-time retrieval of similar videos with application to computer-aided retinal surgery. Annu Int Conf IEEE Eng Med Biol Soc IEEE Eng Med Biol Soc Annu Int Conf. 2011;2011:4465-4468.*
45. *André B, Vercauteren T, Buchner AM, Wallace MB, Ayache N. Endomicroscopic video retrieval using mosaicing and visualwords. IEEE Trans Med Imaging. 2020.*
46. *André B, Vercauteren T, Buchner AM, Wallace MB, Ayache N. Learning semantic and visual similarity for endomicroscopy video retrieval. IEEE Trans Med Imaging. 2012;31:1276-1288.*
47. *André B, Vercauteren T, Perchant A, Buchner A, Wallace M, Ayache N. Endomicroscopic image retrieval and classification using invariant visual features. IEEE Trans Med Imaging. 2009:346-334.*
48. *M KT, N L, B A, N A, T V. Semi-automated query construction for content-based endomicroscopy video retrieval. In: Medical image computing and computer-assisted intervention — MICCAI 2014. Springer International Publishing; 2014:89-96.*
49. *Tafreshi MK, Linard N, André B, Ayache N, Vercauteren T. Semi-automated query construction for content-based endomicroscopy video retrieval. Med Image Comput Comput Assist Interv. 2014;17:89-96.*
50. *Gu Y, Vyas K, Yang J, Yang GZ. Unsupervised feature learning for endomicroscopy image retrieval. In: Medical image computing and computer assisted intervention — MICCAI 2017. Springer International Publishing; 2017:64-71.*
51. *Barinov L, Jairaj A, Middleton WD, D M, Beland, Kirsch J, et al. Improving the efficacy of ACR TI-RADS through deep learning-based descriptor augmentation. J Digit Imaging. 2023;36:2392-2401.*
52. *Hoang JK, Middleton WD, Tessler FN. Update on ACR TI-RADS: successes, challenges, and future directions, from the AJR special series on radiology reporting and data systems. AJR Am J Roentgenol. 2021;216:570-578.*
53. *Kim J, Kim MH, Lim DJ, Lee H, Lee JJ, Kwon HS, et al. Deep learning technology for classification of thyroid nodules using multi-view ultrasound images: potential benefits and challenges in clinical application. Endocrinol Metab. 2025;40:216-224.*
54. *Zhang P, Xu Q, Jiang F. The diagnostic value of convolutional neural networks in thyroid cancer detection using ultrasound images. Front Oncol. 2025;15:1534228.*
55. *Ni J, You Y, Wu X, Chen X, Wang J, Li Y. Performance evaluation of deep learning for the detection and segmentation of thyroid nodules: systematic review and meta-analysis. J Med Internet Res. 2025;27:e73516.*
56. *Yu D, Song T, Yu Y, Zhang H, Gao F, Wang Z, et al Risk assessment of thyroid nodules with a multi-instance convolutional neural network. Front Oncol. 2025;15:1608963.*
57. *Dov D, Kovalsky SZ, Feng Q, Assaad S, Cohen J, Bell J, et al. Use of machine learning-based software for the screening of thyroid cytopathology whole slide images. Arch Pathol Lab Med. 2022;146:872-878.*
58. *Nishiya Y, Matsuura K, Ogane T, Hayashi K, Kinebuchi Y, Tanaka H, et al. Anatomical recognition artificial intelligence for identifying the recurrent laryngeal nerve during endoscopic thyroid surgery: a single-center feasibility study. Laryngoscope Investig Otolaryngol. 2024;9:e70049.*
59. *Muller O, Bauvin P, Bacoeur O, Michailos T, Bertoni MV, Demory C, et al. Machine learning-based algorithm for the early prediction of postoperative hypocalcemia risk after thyroidectomy. Ann Surg. 2024;280:835-841.*
60. *Kiernan CM, Thomas G, Baregamian N, Solórzano CC. Initial clinical experiences using the intraoperative probe-based parathyroid autofluorescence identification system-PTeye™ during thyroid and parathyroid procedures. J Surg Oncol. 2021;124:271-281.*
61. *Mesolella M, Allosso S, M Di Lullo A, Ricciardiello F, Motta G. Postoperative infectious complications in head and neck cancer surgery. Ann Ital Chir. 2022;93:637-647.*
62. *Giannitto C. The use of artificial intelligence in head and neck cancers: a multidisciplinary survey. J Pers Med. 2024;14:341.*

63. Gupta P, Haeberle HS, Zimmer ZR, Levine WN, Williams RJ, Ramkumar PN. Artificial intelligence-based applications in shoulder surgery leaves much to be desired: a systematic review. JSES Rev Rep Tech. 2023;3:189-200.
64. Mascarella MA. Above and beyond age: prediction of major postoperative adverse events in head and neck surgery. Ann Otol Rhinol Laryngol. 2021;131:697-703.
65. Kordzadeh A, Hanif M, Ramirez M, Railton N, Prionidis I, Browne TR. Prediction, pattern recognition and modelling of complications post-endovascular infra renal aneurysm repair by artificial intelligence. Vascular. 2020;29:171-182.
66. Knoedler S. Postoperative free flap monitoring in reconstructive surgery—man or machine? Front Surg. 2023;10:1130566.
67. Khanna AK, Ahuja S, Weller RS, Harwood TN. Postoperative ward monitoring – why and what now?," Baillière's best practice and research in clinical anaesthesiology/Bailliere's best practice & research. Clin Anaesthesiol. 2019;33:229-245.
68. Gumbs AA, Perretta S, d'Allemagne B, Chouillard E. What is artificial intelligence surgery. Art Int Surg. 2021;1:1-10.
69. Kiener M. Artificial intelligence in medicine and the disclosure of risks. AI Soc. 2021;36:705-713.
70. R.C.S. RCS: future of surgery 2018. Available from: https://futureofsurgery.rcseng.ac.uk/?_ga=2.134153868.344240087.1578048159-1041599817.1578048159
71. Haan M, Ongena YP, Hommes S, Kwee TC, Yakar D. A qualitative study to understand patient perspective on the use of artificial intelligence in radiology. J Am Coll Radiol. 2019;16:1416-1419.
72. Jones LD, Golan D, Hanna SA, Ramachandran M. Artificial intelligence, machine learning and the evolution of healthcare: a bright future or cause for concern? Bone Jt Res. 2018;7:223-225.
73. Miragall MF, Knoedler S, Kauke-Navarro M, Saadoun R, Grabenhorst A, Grill FD, et al. Face the future-artificial intelligence in oral and maxillofacial surgery. J Clin Med. 202;12:6843.
74. Devabalan Y. The use and challenges of artificial intelligence in otolaryngology. Authorea Preprints; 2020.
75. Mithany RH, Aslam S, Abdallah S, Abdelmaseeh M, Gerges F, Mohamed MS, et al. Advancements and challenges in the application of artificial intelligence in surgical arena: a literature review. Cureus. 2023;15:e47924.
76. Khan B, Fatima H, Qureshi A, Kumar S, Hanan A, Hussain J, et al. Drawbacks of artificial intelligence and their potential solutions in the healthcare sector. Biomed Mater Devices. 2023:1-8.
77. Jandali D, Barrera JE. Recent advances in orthognathic surgery. Curr Opin Otolaryngol Head Neck Surg. 2020;28:246-250.
78. Wu Q, Wang X, Liang G, Luo X, Zhou M, Deng H, et al. Advances in image-based artificial intelligence in otorhinolaryngology-head and neck surgery: a systematic review. Otolaryngol Head Neck Surg. 2023;169:1132-1142.
79. Xu J, Zeng B, Egger J, Wang C, Smedby Ö, Jiang X, et al. A review on AI-based medical image computing in head and neck surgery. Phys Med Biol. 2022;67.
80. Amanian A, Heffernan A, Ishii M, Creighton FX, Thamboo A. The evolution and application of artificial intelligence in rhinology: a state of the art review. Otolaryngol Head Neck Surg. 2023;169:21-30.

LETTER TO THE EDITOR
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Comments and suggestions on the article "the effects of preoperative anaemia on postoperative complications in patients undergoing thoracic surgery"

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Keywords: Perioperative outcomes, postoperative complications, preoperative anaemia, thoracic surgery

Dear Editor,

I am writing in response to the recently published article entitled "The Effects of Preoperative Anaemia on Postoperative Complications in Patients Undergoing Thoracic Surgery" (1). This study provides important insights into the association between preoperative anaemia and adverse postoperative outcomes in thoracic surgery patients, including increased intraoperative blood loss, prolonged chest drainage duration, higher postoperative transfusion requirements, and extended hospital stays. The authors have contributed valuable evidence to the understanding of anaemia as a perioperative risk factor. However, as a reader, I would like to offer several comments and suggestions that may help strengthen the robustness and interpretability of future research in this area.

First, the study included a total of 104 patients, with only 29 in the anaemia group. The relatively small sample size, particularly in the anaemic subgroup, may reduce the statistical power and limit the stability and reliability of the findings (2). Increasing the sample size in future studies would help to better elucidate the association between preoperative anaemia and postoperative complications and improve the robustness of statistical inference.

Second, although the authors noted that patients in the anaemia group were older—potentially introducing confounding—other important confounding factors were not accounted for. Variables such as diabetes, hypertension, cardiovascular disease, and baseline pulmonary function have all been shown to significantly influence postoperative outcomes in thoracic surgery (3,4). Incorporating and adjusting for these variables in the analysis would allow for a more accurate assessment of the independent effect of preoperative anaemia on postoperative complications.

Furthermore, intraoperative blood loss was included as a key outcome measure; however, the method of its estimation is subject to considerable uncertainty. Previous studies have demonstrated that visual estimation may result in errors as high as 52-85% (5), with a consistent pattern of systematic underestimation in real surgical settings, particularly in patients who require transfusion (6). This measurement bias may compromise the reliability of intraoperative blood loss as a study variable.

Lastly, while the study primarily focused on short-term postoperative outcomes such as chest drainage duration and length of hospital stay, long-term outcomes also warrant attention. These may include recovery trajectory, postoperative quality of life, and long-term complications. Including such outcomes in future analyses would offer a more comprehensive evaluation of the impact of preoperative anaemia on overall patient recovery and prognosis.

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In summary, this study makes an important contribution to understanding the role of preoperative anaemia in thoracic surgical outcomes. Addressing the aforementioned limitations in future research will help strengthen the evidence base and provide more precise guidance for clinical practice. I look forward to seeing further studies building upon this work to enhance perioperative management and improve the prognosis of patients undergoing thoracic surgery.

Footnotes

Author Contributions

Concept - Y.C., J.W.; Design - Y.C., J.W.; Data Collection or Processing - Y.C.; Analysis or Interpretation - Y.C., J.W.; Literature Search - Y.C.; Writing - Y.C., J.W.

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REFERENCES

1. *Saraçoğlu A, Çakmak G, Abdallah BM, Yamansavcı E, Çakar Yılmaz K, Yıldızeli B, et al. The effects of preoperative anaemia on postoperative complications in patients undergoing thoracic surgery: a prospective descriptive study. Turk J Surg. 2025. Epub ahead of print.*
2. *Schönbrodt FD, Perugini M. At what sample size do correlations stabilize? Journal of Research in Personality. 2013;47:609-612.*
3. *Benker M, Citak N, Neuer T, Opitz I, Inci I. Impact of preoperative comorbidities on postoperative complication rate and outcome in surgically resected non-small cell lung cancer patients. Gen Thorac Cardiovasc Surg. 2022;70:248-256.*
4. *Deng T, Song J, Tuo J, Wang Y, Li J, Ping Suen LK, et al. Incidence and risk factors of pulmonary complications after lung cancer surgery: a systematic review and meta-analysis. Heliyon. 2024;10:e32821.*
5. *Rothermel LD, Lipman JM. Estimation of blood loss is inaccurate and unreliable. Surgery. 2016;160:946-953.*
6. *Solon JG, Egan C, McNamara DA. Safe surgery: how accurate are we at predicting intra-operative blood loss? J Eval Clin Pract. 2013;19:100-105.*

LETTER TO THE EDITOR
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Letter to the editor regarding "Novel self-reversing tube ileostomy as an alternative for conventional loop ileostomy for fecal diversion"

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Keywords: Gastrointestinal surgery, general surgery, minimally invasive surgery

Dear Editor,

We read with great interest the article by Antony et al. (1) entitled "Novel self-reversing tube ileostomy as an alternative for conventional loop ileostomy for fecal diversion." The authors should be commended for addressing the clinically significant issue of ileostomy- and stoma closure-related morbidity and for proposing an alternative technique. Given the well-recognized burden of stoma-related complications and their impact on patient outcomes, the search for safer and more effective diversion techniques remains highly relevant (1).

However, several methodological aspects of the study may limit the interpretation of the findings.

First, the heterogeneity between the comparison groups is noteworthy. In particular, the markedly higher proportion of emergency procedures in the loop ileostomy group [40.9% (18/44) vs. 9.1% (4/44)] raises concern that the observed outcomes may be influenced not only by the diversion technique but also by baseline patient characteristics and surgical context. It is well established that factors such as elevated body mass index, comorbidities, and operative urgency significantly affect postoperative outcomes. For instance, obesity has been associated with a significantly increased risk of stoma-related morbidity (odds ratio≈2.01) (2).

Second, complications following ileostomy closure are inherently multifactorial, yet these variables do not appear to be adequately balanced or controlled. Previous studies have demonstrated that postoperative complication rates after ileostomy closure may reach 37.4% (3). Moreover, overall morbidity rates as high as 45.7% have been reported, including clinically significant adverse events such as adhesion-related small bowel obstruction, need for reoperation, and prolonged hospitalization (3). These findings underscore the critical importance of proper patient selection and group comparability in studies evaluating diversion techniques.

Third, the relatively short follow-up duration of six months limits the assessment of late complications, particularly adhesive small bowel obstruction. Adhesions are responsible for approximately 60% of small bowel obstruction cases, and only around 30% of these events occur within the first year after surgery, with a substantial proportion developing later (4). Therefore, longer follow-up is essential, especially for techniques such as tube ileostomy, which involve fixation of the bowel to the abdominal wall and may theoretically influence adhesion formation.

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Finally, although tube ileostomy appears to be a promising alternative, the relatively high rates of technical complications—such as tube obstruction (40.9%) and peritubal leakage (15.9%) raise concerns regarding its reliability and generalizability. Additionally, delayed stoma closure has been associated with significantly increased complication and readmission rates (26.3% vs. 8.2%), further emphasizing the importance of timing and patient selection in optimizing outcomes (5).

In conclusion, while this study provides valuable preliminary insights, its methodological limitations necessitate cautious interpretation. Therefore, before advocating routine clinical adoption, these findings should be validated through well-designed randomized controlled trials with adequate patient stratification and long-term follow-up.

Sincerely,

Footnotes

Author Contributions

Surgical and Medical Practices - E.T.; Concept - E.T.; Design - E.T.; Data Collection or Processing - E.T., O.C.; Analysis or Interpretation - E.T., O.C.; Literature Search - E.T.; Writing - E.T., O.C.

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REFERENCES

1. *Antony A, Yadukrishna S, Kumar RS, Jayan NP, Henna I. Novel self-reversing tube ileostomy as an alternative for conventional loop ileostomy for fecal diversion: a cohort tertiary care center study. Turk J Surg. 2026;42:35-41.*
2. *Sadiq KO, Lakshminarayanan S, Ruiz Cota P, Marquez Castillo E. Higher BMI increases risk of stoma-site incisional hernia and other complications following diverting loop ileostomy and reversal: a systematic review and meta-analysis. Surg Endosc. 2025;39:5198-5213.*
3. *Goswami H, Dharap SB, Mohare DK, Navgale SS, Kirange P, Singh S. The risk factors for complications following intestinal stoma reversal. Cureus. 2025;17:e97018.*
4. *Ghimire P, Maharjan S. Adhesive small bowel obstruction: a review. J Nepal Med Assoc. 2023;61:390-396.*
5. *Cai J, Denison M, Sharp H, Edelson M, Kwok J, Scarbro M, et al. Complications associated with loop ileostomy reversal delayed greater than twelve months. Sci Rep. 2024;14:24470.*