



How to manage difficult duodenal defects? Single center experience

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ABSTRACT

Objective: The aim of this study was to investigate the surgical treatment methods and outcomes of difficult duodenal defects due to perforation.

Material and Methods: Data of patients who had undergone surgery for difficult duodenal defect between January 2012 and November 2022 were collected. Duodenal defect size of 2 cm or more was defined as difficult duodenal defect. Characteristics of the patients, the etiology of perforation, American Society of Anesthesiology (ASA) scores, Mannheim peritonitis index (MPI), surgical treatment, need for re-operation, and morbidity and mortality were evaluated.

Results: Nineteen patients were detected. Etiology was peptic ulcer perforation in 12 (63.1%) patients, aortaduodenal fistula in 2 (10.5%), tumor implant in 2 (10.5%), cholecystoduodenal fistula in 1 (5.2%), endoscopic retrograde cholangio pancreatography (ERCP) in 1 (5.2%), and cholecystectomy related injury in 1 (5.2%) patient. The first surgical procedure was duodenoraphy + omentopexy in 8 (42.1%), Graham repair in 5 (26.3%), duodenal segment 3-4 resection and Roux-en-Y side to side duodenojejunostomy in 4 (21.0%), Roux-en-Y side to side duodenojejunostomy in 1 (0.5%), and 1 (0.5%) subtotal gastrectomy + duodenum 1st part resection + Roux-en-Y gastroenterostomy, cholecystectomy and external biliary drainage via cystic duct. Four patients who had previously undergone Graham repair (3) and duodenoraphy + omentopexy (1) required salvage surgery. As a salvage surgery; 1 end-to-side and 3 side-to-side Roux-en-Y duodenojejunostomies were performed. Overall, mortality occurred in 6 (31.6%) patients. High ASA score and MPI were considered as significant risk factors for mortality ($p=0.015$, $p=0.002$).

Conclusion: Primary repair techniques can be used in the surgical treatment of difficult duodenal defects when peritonitis is not severe and tension-free repair is possible. Otherwise, duodenojejunostomy may be preferred as a fast, easy, and safe technique for both initial and salvage surgeries.

Keywords: Duodenum, peptic ulcer perforation, surgery, peritonitis

INTRODUCTION

Duodenal perforations are rare, but potentially fatal conditions. Mortality rate is reported to vary between 8-25% (1-3). Despite developments in medical treatment, the most common cause of duodenal perforations is complicated peptic ulcer (4). In addition to peptic ulcer, duodenal perforations may occur due to penetrating and blunt injuries, aortaduodenal or cholecystoduodenal fistula or iatrogenic causes (4).

Knutsson was first to define ulcer perforations over 2 centimeters (cm) as "giant duodenal ulcer" (5). In the current literature, defects in the duodenum over 2 cm, especially peptic ulcer perforations, are referred to as "giant duodenal ulcer" or "difficult duodenal defect" (6-9).

In addition to the unique anatomical structure of the duodenum, accompanying severe peritonitis makes surgical treatment of difficult duodenal defects challenging. The incidence of leakage and mortality rate are high (6-8). Despite the variety of recommended techniques, there is no clear consensus in the literature about which method is more appropriate for a specific situation (4,9). In this study, we aimed to share our own clinical experience.

MATERIAL and METHODS

Surgical treatment methods and clinical outcomes of difficult duodenal defects caused by non-blunt and non-penetrating factors were investigated. Duodenal defects of 2 cm or more were defined as "difficult duodenal defects". The study was first approved by the Non-Invasive Research Ethics Committee. We then

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retrospectively analyzed the cases who underwent surgery due to difficult duodenal defects between January 2012 and December 2022. Hospital electronic data processing system and patient files were used. Age, sex, American Society of Anesthesiologists (ASA) score, Mannheim peritonitis index (MPI), etiology of the defect, surgical repair technique, need for re-operation, type of salvage surgery, morbidity and mortality were evaluated (10,11).

The data were analyzed in IBM SPSS Statistics 22® package program. Non-parametric data were statistically evaluated with Chi-square test and parametric data with t-test. For both, $p < 0.05$ was considered significant.

RESULTS

Difficult duodenal defect was detected in 19 patients. Fourteen (73.7%) of these patients were males, and the rest 5 (26.3%) were females. Mean age of the patients was 65.84 ± 2.04 years. Difficult duodenal defect etiology included ulcer perforation in 12 (63.1%) patients, aortoduodenal fistula in 2 (10.5%), tumor implant in 2 (10.5%), cholecystoduodenal fistula in 1 (5.2%), injury during endoscopic retrograde cholangio pancreatography (ERCP) in 1 (5.2%), and cholecystectomy related injury in 1 (5.2%) patient. Intraoperative view of the difficult duodenal defect is seen in Figure 1.

American Society of Anesthesiologists Classification scores were 1 in 6 (31.5%) patients, 2 in 7 (36.8%) patients and 3 in 6 (31.3%) patients. Median MPI score was 26 (5-37). The first surgical intervention was duodenoraphy + omentopexy in 8 (42.1%) patients. Five (26.3%) patients had Graham repair, 4 (21.0%) patients had duodenal segment 3-4 resection and

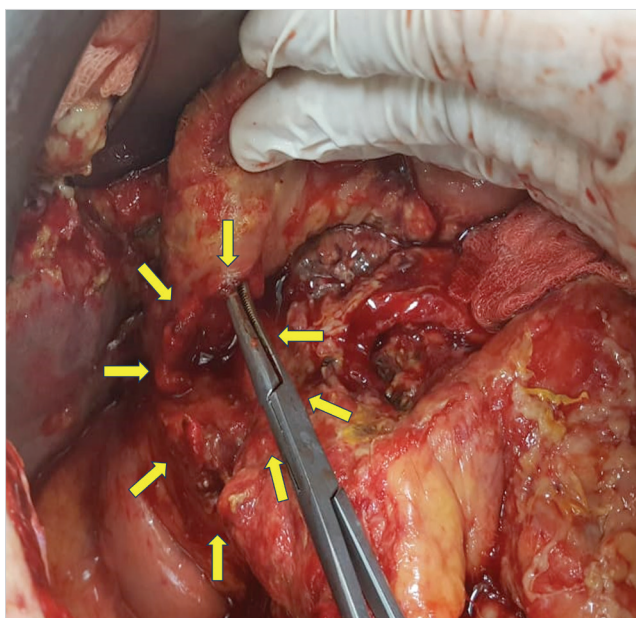


Figure 1. Intra-operative view of difficult duodenal defect. Yellow arrows indicate defect borders.

Roux-en-Y side to side duodenojejunostomy, one patient (0.5%) had Roux-en-Y side to side duodenojejunostomy, one patient (0.5%) had distal subtotal gastrectomy, first part resection of the duodenum, Roux-en-Y gastroenterostomy, cholecystectomy and external biliary drainage via common bile duct catheterization through the cystic duct, and feeding jejunostomy. Four patients died within the first week after surgery secondary to intra-abdominal sepsis.

Leakage developed in 3 (16%) patients who underwent Graham repair and 1 (0.5%) patient who underwent duodenoraphy + omentopexy. Those 4 (22%) patients required second surgical intervention. Second surgical interventions were end-to-side Roux-en-Y duodenojejunostomy in one patient and side-to-side Roux-en-Y duodenojejunostomy in three patients. Additionally, biliary drainage catheter via cystic duct placed one of these three patients to divert the bile. Two of the patients who underwent second intervention died due to sepsis in the early post-operative period. Overall, 6 (31.6%) mortality occurred. Median MPI value was 35 (32-37) in patients with mortality. There was a correlation between the severity of intra-abdominal sepsis and mortality. Morbidity was observed in five patients, including surgical site infection in three and pulmonary infection in two patients. No mortality occurred in these patients. The details of the patients are summarized in Table 1.

In univariate analysis, higher ASA score ($p = 0.015$) was found to be statistically significant in terms of mortality (Table 2). When the relation between MPI elevation and mortality was evaluated statistically significant difference was found between MPI ($p = 0.002$). The cut-off value was determined as "28.5" using the Youden index.

Furthermore, patients were divided into two groups as high and low MPI scores. Although the number of patients in the data set was small, all patients who developed leakage after primary surgery were in the high MPI score group. Statistically, the risk of leak development after primary surgical repair techniques (duodenoraphy + omentopexy and Graham) increased significantly in patients with high MPI scores ($p = 0.002$).

DISCUSSION

Difficult duodenal defects are lesions that usually develop as a result of complicated duodenal ulcer perforation. Surgical treatment is problematic. The main reasons for the difficulty in surgical management are as follows: The anatomical location of the duodenum, severe inflammation, and edema due to accompanying peritonitis. Especially in delayed cases, surgical recovery becomes difficult due to generalized peritonitis and abdominal sepsis, and morbidity and mortality increase (4-9). In addition, the large size of the defect and edematous tissues make surgical repair difficult. Furthermore, high intraluminal pressure after defect repair increases the risk of disruption in

Table 1. Features of patients and details of performed surgical interventions

Number of Patients	Age	Sex	Duodenal Defect Etiology	Defect Location	ASA Score	MPI	Initial Surgery	Failure	Salvage Surgery	Mortality
1	82	F	Ulcer perforation	2. part	2	26	Duodenoraphy + Omentopexy			
2	44	M	Ulcer perforation	2. part	1	20	Duodenoraphy + Omentopexy			
3	54	M	Ulcer perforation	2. part	1	21	Duodenoraphy + Omentopexy			
4	72	M	Ulcer perforation	2. part	2	21	Duodenoraphy + Omentopexy			
5	62	F	Ulcer perforation	2. part	3	37	Duodenoraphy + Omentopexy			+
6	61	M	Ulcer perforation	2. part	1	25	Duodenoraphy + Omentopexy			
7	68	M	Ulcer perforation	2. part	2	32	Graham technique	+	Roux-en-Y End to side jejunojejunostomy	
8	58	M	Ulcer perforation	2. part	1	21	Graham technique			
9	62	F	Ulcer perforation	2. part	1	26	Graham technique			
10	74	M	Ulcer perforation	2. part	2	32	Graham technique	+	Roux-en-Y Side to side jejunojejunostomy	+
11	59	M	Ulcer perforation	2. part	2	32	Graham technique	+	Roux-en-Y Side to side jejunojejunostomy	
12	69	M	Ulcer perforation	1-2. part	2	32	Distal subtotal gastrectomy + duodenum 1. part resection + Roux-en-Y gastroenterostomy + cholecystectomy + external biliary drainage via cystic duct cathater + feeding jejunostomy			
13	65	F	ERCP injury	2-3. part	3	37	Roux-en-Y side to side duodenojejunostomy			+
14	75	M	Injury after cholecystectomy	2-3. part	1	32	Duodenoraphy	+	Side to side duodenojejunostomy + external biliary drainage via cystic duct cathater	+
15	76	F	Cholecystoduodenal fistula	2. part	2	10	Duodenoraphy + Omentopexy			
16	63	M	Aortaduodenal fistula	3-4. part	3	5	Duodenum segment 3-4 resection + side to side duodenojejunostomy			
17	68	M	Aortaduodenal fistula	3-4. part	2	5	Duodenum segment 3-4 resection + side to side duodenojejunostomy			
18	65	M	Tumor implant perforation	3-4. part	3	36	Duodenum segment 3-4 resection + side to side duodenojejunostomy			+
19	74	M	Tumor implant perforation	3-4. part	3	36	Duodenum segment 3-4 resection + side to side duodenojejunostomy			+

Table 2. Univariate analysis for mortality ($p < 0.05$, statistical significance)

Parameter	p
Sex	0.637
ASA score	0.015
Age	0.965
Mannheim peritonitis index (MPI)	0.002

the repair line. Advanced age of the patients, comorbidities and sepsis-induced hypoperfusion in delayed cases are other crucial issues that cause healing problems. The fact that some of the recommended surgical techniques are complicated, require experience and take a long time also might lead difficulties. In such cases, Graham repair, duodenoraphy and omentopexy, duodenoraphy and tube duodenostomy, duodenoraphy and triple ostomy, pyloric exclusion, jejunal serosal patch, duodenojejunostomy, duodenal diverticulization, repair with organic or synthetic patch, and in some cases, proximal pancreaticoduodenectomy (Whipple procedure) can be performed (4-9). However, due to the factors mentioned above, there is still no consensus on which type of surgical procedure is more appropriate in difficult duodenal defects.

Primary repair and omentopexy of the defect in duodenal perforations were defined by Cellan Jones in 1929, and repair of the defect by filling with a free omental flap was described by Graham in 1937 (12,13). These two methods are the most commonly applied primary surgical repair techniques in the treatment of duodenal perforations. However, the use of these primary repair techniques in the repair of difficult duodenal defects is often not ideal, mainly due to the following reasons: Large size of the perforation, the inflamed, edematous, and necrotic tissue edges, the risk of high intraluminal pressure to disrupt the repair line, and the inability to provide optimal omental grafts (4,9). Therefore, surgical treatments which are technically more complicated are recommended in such cases. However, complicated surgical procedures require experience; additionally, they have significant disadvantages such as prolonging the operation time in septic and hemodynamically unstable patients. In cases of difficult duodenal defect secondary to delayed perforation, leak rates of 10% and mortality rates between 10% and 65% are reported after complicated surgical procedures (7,14,15). Among the complicated surgical procedures, the pyloric exclusion method is relatively easier and faster to apply. Repair of the duodenum is done by gastrotomy, closure of the pylorus and gastrojejunostomy, and it is one of the most frequently used methods in the repair of difficult duodenal defects (4). Nevertheless, there are publications reporting that frequent complications develop after pyloric exclusion and that the length of hospital stay is prolonged (16-18).

Muhammed Ali et al. have reported the "triple ostomy" technique, which is relatively easier and faster to perform, as an alternative for patients who are not suitable for primary surgical repair. The authors have reported that complication rates were lower and successful results were obtained after this technique (9). For patients who are hemodynamically unstable and those complicated surgical procedures cannot be performed on, it is recommended to rapidly remove intra-abdominal contamination, place a large tube into the defect, suture and close the defect, and perform tube duodenostomy (4,19). The goal is to create a controlled duodenal fistula. Some centers recommend distal gastrectomy, gastrojejunostomy and feeding jejunostomy to maintain nutrition in addition to tube duodenostomy in hemodynamically stable patients (20).

Another method recommended for the repair of difficult duodenal defects is end-to-side or side-to-side duodenojejunostomy. We prefer duodenojejunostomy in cases for whom primary repair techniques are not possible as it is technically easy and rapidly applicable. Even though edematous and inflamed perforation line seems to be a disadvantage for anastomosis in duodenojejunostomy, we think that a healthy jejunal edge with good perfusion eliminates this handicap and has a positive effect on anastomotic healing. Furthermore, circumferential debriding of the perforation line provides duodenal tissue with good perfusion and optimizes anastomotic healing. In their recent publication, Gan et al. have reported successful results with retrocolic loop side-to-side duodenojejunostomy repair in four patients with giant duodenal defects caused by ulcer perforation (21). In support of our view, the authors have reported that well-blooded jejunal edge and debrided ulcer edges on duodenal side optimizes anastomotic healing. In our technique, unlike that of Gan et al, we prefer to perform duodenojejunostomy in the Roux-en-Y fashion. The primary reason for this preference is because, unlike in loop anastomosis, the nutrient contents do not return to the anastomotic line in Roux-en-Y fashion. It is thought that the return of the nutrient contents back to the anastomosis line forces the anastomosis line and may cause complications such as passage problems, gastric reflux and risk for anastomotic dehiscence.

However, it should be kept in mind that a second anastomosis is required in Roux-en-Y reconstruction, and there may be additional complications related to this. Also, according to the surgeon's preference, cholecystectomy, cystic stump cannulation, and external drainage of the bile can be added to Roux-en-Y duodenojejunostomy in order to reduce intraluminal pressure (Figure 2). In such cases, the application of post-operative percutaneous transhepatic biliary drainage can be considered as an alternative option.

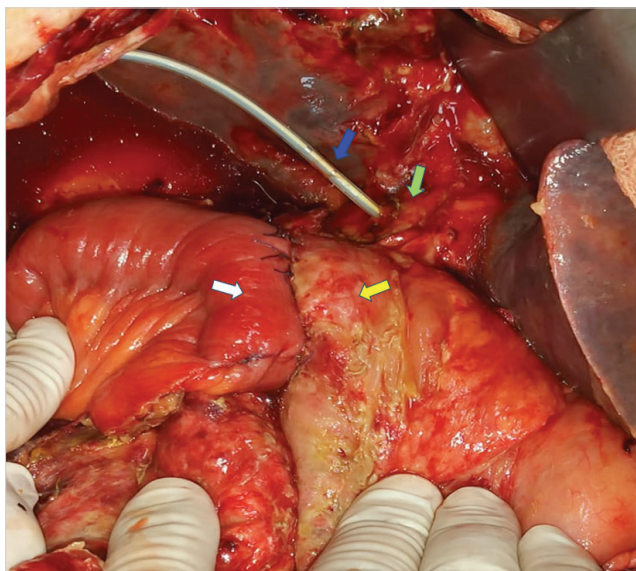


Figure 2. Salvage surgery due to leakage after initial primary repair. Side-to-side Roux-en-Y duodenojejunostomy and biliary drainage catheter via cystic duct was performed.

Yellow arrow: Duodenum, White arrow: Jejunum, Green arrow: Common bile duct, Blue arrow: Biliary drainage catheter via cystic duct.

In our clinic, primary repair techniques of duodenorrhaphy and Graham repair were performed on 13 patients with difficult duodenal defects. One of these patients died due to post-operative sepsis. In 4 (30%) of the other 12 patients, leakage developed after primary repair, and a second surgical intervention was required. Statistical analysis showed that the risk of post-repair leakage increased in patients with high MPI score. The second surgical interventions were duodenojejunostomies, 1 end-to-side and 3 side-to-side. In two of these four cases, early mortality developed owing to septic complications after the second surgical intervention. In other cases where severe peritonitis or tension-free primary repair techniques were not possible, direct side-to-side duodenojejunostomy was preferred. Since most of these cases had aortaduodenal fistula and perforation on the basis of tumor implant, resections of the 3rd and 4th parts of the duodenum were also performed. In one case, the first part of the duodenum and the distal part of the stomach were necrotic on the basis of a large ulcer. Therefore, surgical treatment was provided by distal subtotal gastrectomy and duodenal 1st part resection. As can be seen in Table 1, primary repair techniques can be applied with acceptable success rates in cases with difficult duodenal defects, if peritonitis is not severe, and there is a possibility of tension-free repair with primary repair techniques. Otherwise, duodenojejunostomy is more appropriate. Consistent with the literature, higher MPI and ASA scores were statistically associated with mortality

($p= 0.002$, $p= 0.015$). The MPI cut-off value for mortality was determined as 28.5. Additionally, the risk of leakage was found to increase in patients with high MPI score. Moreover, according to the data of our study, we concluded that linear duodenal defects can be safely repaired with primary repair techniques in cases which are not accompanied by severe peritonitis, regardless of size. We believe that duodenal defects should be considered as two-dimensional rather than one-dimensional, unlike how it is often portrayed in many publications; the suitability of tension-free repair should be evaluated by considering both dimensions of the defect.

While it is crucial to ensure the safety of the ampulla of Vater, the application of segmental duodenal resection is feasible for treating defects affecting the 3rd or 4th segments of duodenum. Duodenojejunostomy provides gastrointestinal continuity after resection. On the contrary, segmental resection cannot be used to treat defects in or affecting the 2nd segment of the duodenum; the only applicable resectional procedure is proximal pancreaticoduodenectomy. Thus, particularly for treating defects affecting segment 2nd, duodenojejunostomy is very important as an alternative technique. Because in these cases, duodenojejunostomy provides duodenal defect repair beside enabling gastrointestinal continuity.

There are certain classifications for duodenal defects, but they mostly describe trauma-related injuries or are used by endoscopists to classify injuries in ERCP procedure, and these classifications are not suitable for the optimal identification of difficult duodenal defects on the basis of perforation and for the determination of the surgical approach (20,22). Therefore, considering the above-mentioned criteria, it is necessary to establish a new scoring system for standard definition of difficult duodenal defects.

The small number of cases and retrospective design can be considered as weaknesses of our study. These cases are not common; thus, multicenter studies are needed for effective research with a larger number of cases. Such studies will help to develop scoring and surgical treatment algorithms for difficult duodenal defects secondary to perforation.

CONCLUSION

In conclusion, we point out that primary repair techniques can be successful in difficult duodenal defects that have low risk factors and have a chance of tension-free repair. Otherwise, duodenojejunostomy may be preferred as a fast, easy and safe technique for both initial and salvage surgeries.

Ethics Committee Approval: This study was obtained from Dokuz Eylül University Faculty of Medicine Non-Interventional Research Ethics Committee (Decision no: 2020/23-09, Date: 28.09.2020).

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Author Contributions: Concept - TE, ÖÇ, CA, SD; Design - TE, ÖÇ, CA, SD, SA; Supervision - TE, TÜ, MÖ; Data Collection and/or Processing - ADÇ, İY, ÖÇ, TE; Analysis and/or Interpretation - TE, ÖÇ, SD, TÜ, MÖ; Literature Search - TE, ADÇ, İY, TB, BM; Writing Manuscript - TE, ÖÇ, CA; Critical Reviews - TE, TÜ, MÖ.

Conflict of Interest: The authors have no conflicts of interest to declare.

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**ORİJİNAL ÇALIŞMA-ÖZET**

Türk J Surg 2024; 40 (2): 161-167

Zor duodenal defektler nasıl yönetilmeli? Tek merkez deneyimi

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ÖZET**Giriş ve Amaç:** Perforasyon nedeniyle meydana gelen zor duodenal defektlerde uygulanan cerrahi tedavi yöntemleri ve sonuçlarının araştırılmasıdır.**Gereç ve Yöntem:** Kliniğimizde Ocak 2012 ve Kasım 2022 tarihleri arasında perforasyona bağlı zor duodenal defekt nedeniyle cerrahi tedavi uygulanan hastaların verileri toplandı. Duodenal defekt boyutu 2 cm ve üzeri olgular zor duodenal defekt olarak tanımlandı. Hastaların karakteristik özellikleri, perforasyon etiyojisi, Amerikan Anesteziyoloji Birliği (AAB) skorları, Mannheim peritonit indeksleri (MPI), uygulanan cerrahi tedavi, tekrar cerrahi girişim gereksinimi, morbidite ve mortalite bilgileri değerlendirildi.**Bulgular:** Zor duodenal defekt nedeniyle cerrahi uygulanan 19 hasta saptandı. Zor duodenal defekt etiyojisi hastaların; 12 (%63,1)'inde peptik ülser perforasyonu, 2 (%10,5)'inde aortaduodenal fistül, 2 (%10,5)'inde tümör implantı, 1 (%5,2)'inde kolesistoduodenal fistül, 1 (%5,2)'inde endoskopik retrograd kolanjiyo pankreatografi (ERCP) ve 1 (%5,2)'inde kolesistektomi kaynaklı yaralanmaydı. İlk cerrahi işlem hastaların; 8 (%42,1)'inde duodenorafi + omentopeksi, 5 (%26,3)'inde Graham onarım, 4 (%21,0)'ünde duodenum segment 3-4 rezeksiyonu ve Roux-en-Y yan yana duodenojejunostomi, 1 (%0,5)'inde Roux-en-Y yan yana duodenojejunostomi, 1 (%0,5)'inde subtotal gastrektomi, duodenum birinci kıta rezeksiyonu, Roux-en-Y gastroenterostomi, kolesistektomi ve ana safra kanalına sistik kanal üzerinden eksternal biliyer drenajdı. Öncesinde Graham onarım (3) ve duodenorafi + omentopeksi (1) uygulanan dört hastaya ikinci cerrahi gerekti. İkinci cerrahi birinci hastada uç-yan, üç hastada yan yana Roux-en-Y duodenojejunostomiydi. Toplamda 6 (%31,6) hasta kaybedildi. Yüksek AAB skoru ve MPI mortalite gelişimi açısından anlamlı risk faktörü olarak belirlendi (p= 0,015, p= 0,002).**Sonuç:** Zor duodenal defektlerin cerrahi tedavisinde, peritonit şiddeti yüksek olmayan ve gerginliksiz onarımın mümkün olduğu olgularda primer onarım teknikleri uygulanabilir. Aksi durumlarda duodenojejunostomi gerek ilk gerekse kurtarma cerrahisinde hızlı, kolay ve güvenli bir teknik olarak tercih edilebilir.**Anahtar Kelimeler:** Duodenum, peptik ülser perforasyonu, cerrahi, peritonit**DOI:** 10.47717/turkjsurg.2024.6476