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Iatrogenic colon perforation during colonoscopy, diagnosis/treatment, and follow-up processes: A single-center experience

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ABSTRACT

Objective: Iatrogenic colon perforation (ICP) is one of the most feared complications of colonoscopy and causes unwanted morbidity and mortality. In this study, we aimed to discuss the characteristics of the cases of ICP we encountered in our endoscopy clinic, its etiology, our treatment approaches, and results in the light of the current literature.

Material and Methods: We retrospectively evaluated the cases of ICP among 9.709 lower gastrointestinal system endoscopy procedures (colonoscopy + rectosigmoidoscopy) performed for diagnostic purposes in our endoscopy clinic during 2002-2020.

Results: A total of seven cases of ICP were detected. The diagnosis was made during the procedure in six patients and after eight hours in one patient, and their treatment was performed urgently. Whereas surgical procedures were performed in all patients, the type of the procedure varied; laparoscopic primary repair was performed in two patients and laparotomy in five patients. In the patients who underwent laparotomy, primary repair was performed in three patients, partial colon resection and end-to-end anastomosis in one patient, and loop colostomy in one patient. The patients were hospitalized for an average of 7.14 days. The patients who did not develop complications in the postoperative follow-up were discharged with full recovery.

Conclusion: Prompt diagnosis and appropriate treatment of ICP is crucial to prevent morbidity and mortality.

Keywords: Colon perforation, colonoscopy, complication

INTRODUCTION

Colonoscopy is the most effective diagnostic/treatment method in the detection and treatment of colon and distal ileum pathologies. During this procedure, bleeding and perforation that occur independently or iatrogenic are the most feared and common complications (1). Perforation frequency is reported to range from 0.03% to 0.8% in diagnostic colonoscopy (2). Mortality due to colon perforation has been reported in the range of 0%-0.05% (3). Major cause of mortality is generalized peritonitis and sepsis as a consequence of late detection of perforation and delayed treatment (4,5). Formation of iatrogenic colon perforation (ICP) is reported to be related with the age of the patient, insufficient bowel cleansing, presence of dolichocolon, previous abdominal surgeries, procedure type, use of analgesics during the procedure, procedure speed and insufficiency of the time allocated, experience of the endoscopist performing the procedure, and quality of the endoscopy system (6-8).

Detection and treatment of colon perforation during the procedure is critical in preventing mortality and morbidity (9). The experience of and attention given to such complications by the endoscopist are crucial. According to the characteristics of the perforation, endoscopic or surgical therapy must be chosen (10-12).

In this study, we aimed to discuss the characteristics of the cases of ICP, the underlying reasons for its occurrence, our treatment approaches, and results in the light of the current literature.

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MATERIAL and METHODS

Cases of ICP in patients who had undergone lower gastrointestinal system endoscopy (rectosigmoidoscopy and colonoscopy) in the endoscopy unit of our hospital between January 2002 and December 2020 were evaluated retrospectively. Demographic characteristics of the patients, features of the colonoscopy procedure (diagnostic or therapeutic), diagnosis of perforation and characteristics of perforation, treatment modalities, and results were assessed. The colonoscopy technique followed by the endoscopists, adequacy of colon cleansing procedure, and how the perforation was detected were recorded.

All procedures were performed with sedoanalgesia (midazolam, propofol -/+ pethidine) under the supervision of an anesthesiologist. The procedures were performed by ten general surgeons and five gastroenterologists. The endoscopy experience of the specialists ranged from 2 to 25 years. Each endoscopist applied his own protocol for colon cleansing of the patients. Pre-anesthetic examinations were performed before the procedure. Fujinon series colonoscopes (EC-250 WL5, 530, 600 EC, 600 WL, 700 series) were used.

Written informed consent for endoscopy procedure and data sharing of the patients was obtained before the procedure. The study was conducted in accordance with the Declaration of Helsinki and approved by the local ethics committee (50-2290).

RESULTS

A total of 9108 colonoscopy and 601 rectosigmoidoscopy procedures were evaluated. Of the patients who underwent colonoscopy, 4325 were males and 4783 were females. Of those who underwent rectosigmoidoscopy, 240 were males, and 361 were females. Perforation occurred in seven patients (0.072%) who underwent colonoscopy due to complaints of iron deficiency anemia, occult blood positivity in stool, change in defecation/constipation, abdominal pain, and rectal bleeding. Among these patients, five were females, and two were males. Mean age of the patients was 72.28 years, and their average body mass index (BMI) was 25.14 kg/m^2.

The perforation area was in the sigmoid colon in five patients, descending colon–sigmoid colon junction in one case, and rectosigmoid corner in one case. Only in one case, the perforation developed on the mesenteric side, in the others (n= 6) the perforation was observed on the antimesenteric side of the colonic lumen. A total of ten perforations were detected in the colon, their diameters were 0.5-6 cm involving 10%-75% of the lumen. The average diameter of the perforations was 2.85 cm. Whereas multiple perforations were detected in the same area during surgery in two patients, serosal tears were observed in one patient. Diagnosis was made during the procedure in six patients and after eight hours in one patient. In the patients in whom ICP was detected during the procedure, surgery was performed under emergency conditions. While three patients underwent laparotomy-primary repair, laparotomy-partial colon resection and end-to-end anastomosis, and laparoscopic primary repair were performed in one and two patients, respectively. Laparotomy and loop colostomy were performed for the patient who was diagnosed late. Laparotomy had to be preferred instead of laparoscopy in these patients. When we looked at the causes of laparotomy in our patients, two patients had advanced chronic heart disease. Laparotomy was performed because an increase in intra-abdominal pressure was not desired. One patient had a large perforation area. One patient was diagnosed late and laparotomy was preferred in the other patient due to peritonitis carcinomatosis. Abdominal drainage was performed in all patients after surgery, and the patients were followed up with broad spectrum antibiotic therapy. The patients were hospitalized for an average of 7.14 (3-13) days. The longest duration of hospitalization (13 days) was required for the patient diagnosed late. All patients were discharged after complete recovery (Table 1).

The colonoscopy technique followed by the endoscopists, adequacy of colon cleansing, and how perforation was detected were questioned. Difficulty reaching the terminal ileum was detected in three patients with perforation, and in two patients, there was difficulty in the passage of the sigmoid colon. In two patients, a sudden abdominal distension was observed when trying to reach the terminal ileum, whereas a suspicion of perforation was noted in one patient, and there was difficulty in passing the rectosigmoid corner in one patient. Perforation was suspected on observing fresh blood on return in two patients, whereas a sudden discharge and relief were observed in the colonoscope in three patients, leading to suspicion of perforation. Perforation was confirmed using standing plain abdominal radiography and abdominal computed tomography (CT) (Figures 1,2). Direct visualization of the perforation sites occurred in three patients, and the diagnosis was made by observing intra-abdominal organs in three patients (Table 2) (Figures 3,4). In one patient, diagnosis could not be made early, and the patient was discharged; however, the patient applied to the emergency clinic with severe abdominal pain eight hours later.

The clinical signs of perforation were defined as pronounced distension in the abdomen, increased and prominent tympanism, fresh blood in unexpected areas, a sudden feeling of relief and emptiness while pushing the colonoscope forward, mucosal tears, appearance of perforation, and appearance of intraperitoneal organs. Despite the lack of statistical analysis, some obvious risk factors for perforation were noted, such as advanced age (mean age 72.3 years), female sex (71.5%), dolichocolon, previous abdominal surgery, peritoneal carcinomatosis, rapidly performed procedure, loop formation, difficulty in accessing the ileocecal valve, and quality of the instrument used.

Table 1. Characteristics of the patients with perforation

Patient	Age (years)	Sex	BMI	Colonoscopy Indication	Location of Perforation	Localization of Perforation in the Lumen	Size (cm, its Ratio to Lumen)	Treatment	Duration of Hospitalization (days)	Accompanying Diseases
1	71	F	26.7	Iron deficiency	Descending-sigmoid colon junction	Antimesenteric wall	5 (70%)	EL + primary repair + drainage	6	HT
2	81	F	22.5	Constipation, abdominal pain	Sigmoid colon	Injury on the mesenteric side and serosal injury	2 (25%)	EL + primary repair + drainage	6	CHD
3	87	F	31.2	Anemia	Sigmoid colon	Antimesenteric wall + serosal injury at two points	2.5, 0.5 (30%, 5%)	EL + primary repair + biopsy from metastases + drainage	5	Stomach tumor Carcinomatosis
4	59	F	26	Rectal bleeding	Sigmoid colon	Antimesenteric wall	0.5 (10%)	Laparoscopic primary repair + drainage	3	Hysterectomy
5	63	M	22	Constipation	Sigmoid colon	Antimesenteric and mesenteric wall	6 (75%)	EL + loop colostomy + drainage	10	(–)
6	76	M	17.4	Anemia, OBS (+)	Sigmoid colon	Antimesenteric and mesenteric wall	2, 3, 4 (25%, 35%, 50%)	EL + partial resection + end-to-end anastomosis	13	CHD + COPD + HT
7	69	F	30.2	Anemia	Rectosigmoid corner	Antimesenteric wall	3 (35%)	Laparoscopic primary repair +drainage	3	(–)

BMI: Body mass index, CHD: Chronic heart disease, COPD: Chronic obstructive pulmonary disease, EL: Explorative laparotomy, HT: Hypertension, OBS: Occult blood in the stool.

Figure 1. Diffused free air in standing plain abdominal radiography.

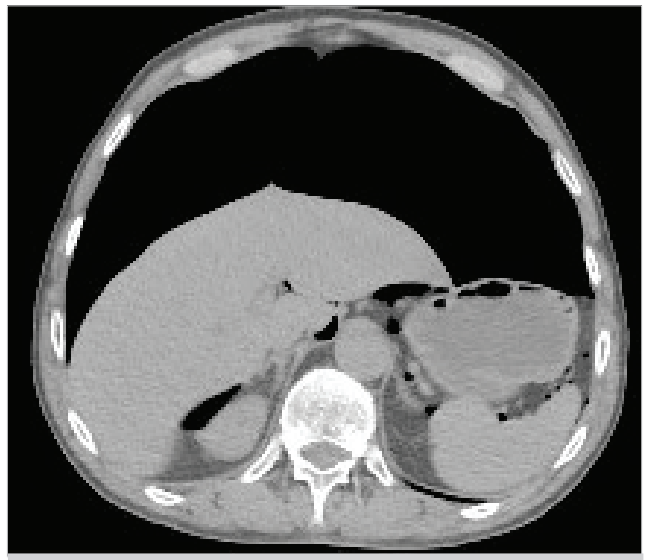

Figure 2. Free air visualized in computed tomography image.

Table 2. Endoscopic diagnostic features in iatrogenic colon perforation (Statements by the endoscopist who performed the procedure)

Cases	Endoscopy Support	Process Features	Indirect Signs of Perforation	Direct Signs of Perforation	Time of Diagnosis
1	Nurse-assisted	Perforation development in the sigmoid colon on the way	Loop formation in the sigmoid colon and sudden relaxation of the colonoscope	Direct visualization of the perforation area	During the process
2	Self	Total colonoscopy	Difficulty crossing the recto-sigmoid field	Direct visualization of the perforation area	During the process
3	Nurse-assisted	Difficulty reaching terminal ileum	Significant distension development in the abdomen and fresh blood at the perforation site	Direct visualization of the perforation area	During the process
4	Self	Perforation development in the sigmoid colon on the way	Sudden relief in the colonoscope	Visualization of intra-peritoneal organs	During the process
5	Self	Total colonoscopy procedure and spastic colon	Not noticed	Not noticed	8 hours after the procedure (with standing abdominal radiography + abdominal computed tomography)
6	Nurse-assisted	Difficulty reaching the terminal ileum	Development of significant distension in the abdomen sudden relief from the colonoscope	Visualization of intraperitoneal organs	During the process
7	Self	A difficult total colonoscopy procedure	Fresh blood at the perforation site and mucosal tears	Visualization of intra-peritoneal organs	During the process

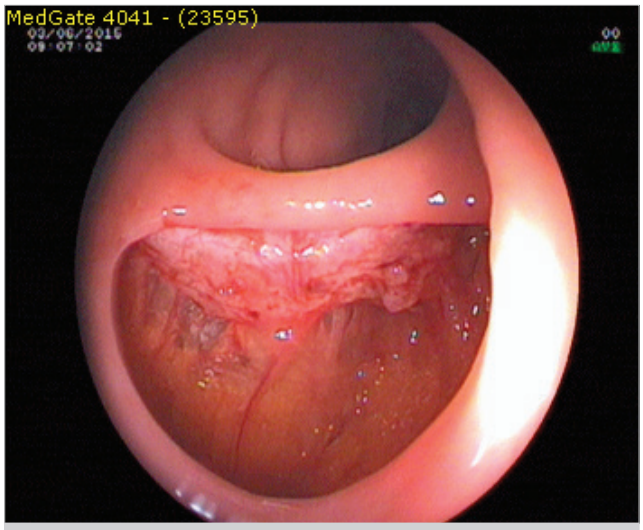

Figure 3. Direct view of colon perforation.

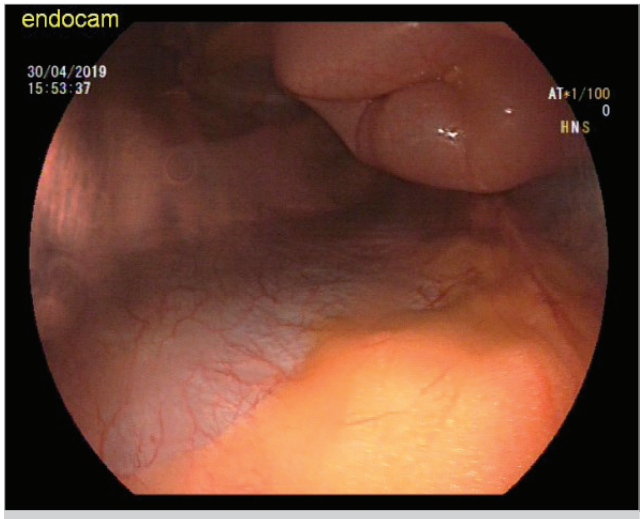

Figure 4. Peritoneal cavity and small intestines.

Table 3. Perforation markers we identified during colonoscopy
Significant distension in the abdomen
Increased pronounced tympanism
Fresh bleeding in unexpected areas
In the situation where the colonoscope is stretched (hardened), the colonoscope suddenly relaxes while trying to move proximally
Tear or perforation in the mucosa
Visualization of intraperitoneal organs

DISCUSSION

Bleeding and perforation due to diagnostic and therapeutic procedures performed during colonoscopy and rectosigmoidoscopy are the most common complications associated with colonoscopy (1,4,13-15). The frequency of perforations in diagnostic colonoscopy is between 0.03% and 0.8% in different studies, whereas it is between 0.15% and 3% in therapeutic procedures (3). Mortality due to colon perforation has been reported in the literature at rates of 0%-0.05% (3). It is reported that 6% of colon perforations are asymptomatic; 75% of the patients with perforations can be diagnosed in ≤24 hours, approximately 98% in ≤96 hours, whereas in some cases, ≥2 weeks are required (4,16). In all of our patients, ICP occurred during diagnostic procedures, and most of them (six out of seven) were diagnosed during the procedure; only one patient was diagnosed eight hours after the procedure. The rate of occurrence of perforations reported in this study was found to be compatible with the literature.

Table 4. Risk factors for iatrogenic colon perforation in the patients
Female sex
Advanced age
History of previous surgery
Peritoneal carcinomatosis
Dolichocolon
Loop formation
Procedure performed in a fast manner

Major reason for the occurrence of mortality and morbidity is generalized peritonitis and sepsis, which occur as a result of the delay in the detection of perforations (4,5). Formation of perforation is affected by the following factors: age> 70 years; female sex; low BMI; insufficient bowel cleansing; structural colon pathologies (dolichocolon, diverticulosis, megacolon); diverticulitis; previous abdominal surgeries (especially in the pelvic area); inflammatory bowel diseases (Crohn's and ulcerative colitis); peritoneal carcinomatosis; abdominal wall hernias with intestinal content; use of steroids; hypoalbuminemia; history of radiotherapy in the pelvic area; pain during the procedure; procedures performed with analgesia; speed of the procedure and insufficient time; procedure followed by and the experience of the endoscopist; and quality of the colonoscope and endoscopy system (6-8,17-22). Among our patients, advanced age, female sex, dolichocolon, previous abdominal surgery, peritoneal carcinomatosis etc. were identified as risk factors for perforation. Contrary to previous reports, the average BMI in the patients with perforations was 25.14 kg/m^2, which was within normal limits.

There are three major mechanisms for the development of perforation, which are difficulty in passing through the bends in the colon mechanically with the loop or endoscope tip, barotrauma due to excessive air insufflation and electrocautery in therapeutic procedures, and ischemia occurring as a result of laser and argon plasma coagulation procedures (3,9,23-25). Further, serosal tears are known to occur without mucosal damage

due to mechanical stress (26). In our study, when the causes of perforation were investigated by consulting with the specialists who performed the procedure, it was understood that there was a loop formation in four patients, difficulty in turning the rectosigmoid corner in one patient, whereas no such difficulties were observed in one patient. In an interrogation about perforation, endoscopists stated that the colonoscope suddenly relaxed in two patients due to the occurrence of strain, significant distension occurred in the abdomen in two patients, fresh blood in the perforation area was observed in two patients, and mucosal tears were observed in one patient.

Perforations caused by direct mechanical effects are the most common type in the sigmoid colon and rectosigmoid region, whereas those occurring due to barotrauma are the most common in the cecum. The most important causes of perforation are the loop formation in the sigmoid colon and angulation at the rectosigmoid junction and excessive insufflation (3,4). In a study by Iqbal et al., the frequency of ICP has been reported as 52% in the sigmoid colon, 17% in the cecum, 14% in the ascending colon, 8% in the descending colon, 7% in the transverse colon, and 1% in the rectum. In addition, they have reported perforation sizes of 0.1-6 cm (average 1.7 cm) and found that the defects in perforations developed with electrocautery are smaller than those developed due to mechanical injuries (27). In our study, all of the perforations occurred in the sigmoid colon or its proximity, and all of the perforations were caused by mechanical effects.

The factors that increase postperforation morbidity and mortality are diagnosis time, degree of peritoneal contamination, accompanying diseases, and perforation size (28). Detecting and treating colon perforation during the procedure is of critical importance in avoiding mortality and morbidity. Early diagnosis and treatment and surgical intervention when necessary are the best strategic approaches to prevent mortality and morbidity (29-31). The experience of the endoscopist and attention paid to these factors are important. In patients who are suspected of perforation but cannot be diagnosed directly, direct radiographs should be taken first. If direct radiographs are normal and suspicion of perforations remains, abdominal CT with oral contrast should be performed (27,32). In this study, the diagnosis was made on the basis of directly observing perforation site in three patients and by visualizing the intraperitoneal organs in three patients. In one patient whose diagnosis was delayed, significant distension, defense, and rebound were observed in the abdomen on standing direct abdominal radiography and abdominal CT. The diagnosis was made by visualizing widespread free air.

There are three basic treatment modalities for ICP: conservative, endoscopic, and surgical therapies. When choosing the modality, it is necessary to consider the location and characteristics of the perforation, time of occurrence, colonic pathologies, level of peritoneal contamination, and the peritonitis status of the patient (9). Conservative treatment requires broad-spectrum antibiotherapy, adequate hydration and parenteral nutrition, cessation of oral intake, and nasogastric decompression. Conservative treatments are reported by some authors to be selectively applied to some patients; however, this is not a risk-free choice (33-35). In cases where conservative treatment is unsuccessful, surgical procedures have to be applied, and severe peritonitis, peritoneal contamination, and sepsis may be encountered. In these cases, major surgical procedures and developing septic scenarios cause significant increases in mortality (33,36,37).

In recent years, endoscopic treatments have played a key role in the treatment of perforations, and consequently, the need for surgery for small perforations has considerably decreased (38). With through-the-scope and over-the-scope clips developed in recent years, 93% and 89% success rates were reported in ICP closures of <2 cm, respectively. Endoscopic treatment is recommended for ICPs of <2 cm in treatment-follow-up algorithms (11,39). Perforation can be closed with band ligation technique, end-loop clip, and self-expendable metal stent as alternative techniques other than clip closure (40-44). These patients should additionally receive conservative treatments and their clinical and laboratory and radiological findings should be closely monitored. It is very important that patients who do not improve in the follow-up undergo surgical treatment without delay (11).

Early diagnosis and emergency surgical intervention make it possible to avoid peritoneal contamination and primary colon repair (9). The treatment to be applied in surgery should be selected according to the degree of peritoneal contamination, severity of peritonitis, and size and number of injuries. Open surgery should be preferred in cases where laparoscopy is difficult. Laparoscopic approach in ICPs is a strategically safer treatment option with minimal morbidity and mortality compared to the open surgical method and conservative methods (33,34). The most important thing determining the prognosis after diagnosis is the treatment method to be chosen. However, the treatment to be chosen is mostly limited by the hospital facilities and practical experience of the specialists (10).

Although there was no mortality in our patients, the patient who was diagnosed late had to undergo a staged surgical procedure that involved a loop colostomy due to the common peritonitis scenario. The duration of hospitalization of this patient was long. Primary repair was performed by open surgical method or laparoscopically in all of our patients diagnosed during the procedure. Only one patient required resection anastomosis. Duration of hospitalization and morbidity of these patients were significantly less.

Limitations

The limitation of the study is that our patients were treated only with surgical method. However, we would like to point out that the main goal of the study was not treatment comparison. It was to determine the frequency of perforation and perforation risk factors. Therefore, we believe that this limitation does not have a major impact on the value of our study.

CONCLUSION

In our case series, main indications for surgical treatment in all patients can be listed as inadequate experience of the endoscopy team in closing perforations, large perforation areas (6, 5, and 4 cm, respectively in three cases), and the endoscopy team's predisposition to surgery. In conclusion, ICPs are a rare complication of colonoscopy; however, they have high mortality and morbidity, which may be avoided by early diagnosis and endoscopic treatment in appropriate cases.

Main Points:

ICPs are a rare complication of colonoscopy, our frequency was 0.072%.

Early diagnosis and treatment of ICP is the most important point.

Inadequate experience of the endoscopy team in closing perforations is the main indication for surgical treatment.

Ethics Committee Approval: This study was approved by S.B.Ü. İstanbul Training and Research Hospital Clinical Research Ethics Committee (Decision number: 2896 Date: 30.07.2021).

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – N.G.; Design – N.G.; Supervision – N.G., R.İ.; Data Collection and/ or Processing – N.G., A.H.G., H.Ü.; Analysis and/or Interpretation – N.G., R.İ., A.Ö.; Literature Search – N.G., B.Ö.; Writing Manuscript – N.G.; Critical Reviews – R.İ., A.A.

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Kolonoskopi sırasında iyatrojenik kolon perforasyonu vakalarımız, tanı/tedavi ve takip süreçleri

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ÖZET

Giriş ve Amaç: İyatrojenik kolon perforasyonu (İKP) kolonoskopi işleminin en korkulan komplikasyonu olup, morbidite ve mortaliteye sebep olmaktadır. Bu çalışmada endoskopi ünitemizde İKP sıklığını, vakaların özelliklerini, oluşumunun altında yatan sebepleri, tedavi yaklaşımlarını ve sonuçları güncel literatür ışığında tartışmayı amaçladık.

Gereç ve Yöntem: 2002-2020 yıllarında endoskopi ünitesinde diagnostik amaçlı gerçekleştirilen 9,709 alt GİS endoskopisi (kolonoskopi + rektosigmoidoskopi) sırasında iyatrojenik olarak gelişen kolon perforasyonu vakalarını retrospektif olarak değerlendirdik.

Bulgular: Toplam yedi vaka tespit edildi. İCP sıklığı %0,072 olarak saptandı. Tanı, hastaların altısında işlem sırasında, birinde sekiz saat sonra kondu ve tedavileri gerçekleştirildi. Tüm hastalara cerrahi uygulandı. İki hastaya laparoskopik primer tamir işlemi, beş hastaya laparotomi yapıldı. Laparotomi yapılanlarda üç hastaya primer tamir, bir hastaya parsiyel kolon rezeksiyonu ve uç uca anastomoz, bir hastaya lup kolostomi yapıldı. Ortalama 7,14 gün hastane yatışı oldu. Postop takiplerinde komplikasyon gelişmeyen hastalar şifa ile taburcu edildi.

Sonuç: İKP'nin erken teşhisi ve uygun tedavisi, morbidite ve mortalitenin önlenmesinde en önemli faktörlerdir.

Anahtar Kelimeler: Kolon perforasyonu, kolonoskopi, komplikasyon

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