



Laparoscopic transabdominal preperitoneal and totally extraperitoneal in inguinal hernia surgery: comparison of intraoperative and postoperative early complications of two techniques

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Purpose: Totally extraperitoneal (TEP) and transabdominal preperitoneal (TAPP) are laparoscopic techniques frequently used in inguinal hernia surgeries. There are very few studies directly comparing the outcomes of TEP and TAPP. The present study compared both techniques' technical aspects, intraoperative and postoperative early complications.

Methods: In this study, 108 patients diagnosed with inguinal hernia underwent laparoscopic surgery between May 2016 and December 2020. Seventy six of these patients (70.4%) underwent TEP, and 32 (29.6%) underwent TAPP. This study was retrospective. However, the data were registered prospectively (including video recordings).

Results: No significant difference was found between the groups regarding age, sex, body mass index, American Society of Anesthesiologist physical status classification, and duration of hospitalization. Although the TEP group had a higher overall complication rate than TAPP, the difference between the two groups was not significant (TEP, 9.2% vs. TAPP, 3.1%, $p = 0.979$). Two conversions and two recurrences (2.6% each) were observed in TEP. The hematoma was seen in one case in both techniques (3.1% vs. 1.3%, $p = 0.665$), respectively. A patient in the TEP group developed a pseudoaneurysm and was treated with endovascular embolization.

Conclusion: In our study, conversion and intraoperative early postoperative complications were more prevalent in TEP than TAPP. On the other hand, no significant difference was determined between the results of the two techniques. It has been found that TAPP is as safe as TEP in inguinal hernia surgery; however, the superiority of one method over the other was not observed in this study.

Keywords: Laparoscopic herniorrhaphy, Inguinal hernia, Laparoscopy

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INTRODUCTION

Transabdominal preperitoneal (TAPP) and totally extraperitoneal (TEP) procedures are the most used endolaparoscopic techniques in the surgical treatment of inguinal hernia (IH). Arregui

et al. [1] described TAPP for the first time in 1992. Later, TEP was defined by McKernan and Laws [2] in 1993.

There are many comparisons in studies on open and laparoscopic methods in IH surgery; however, have very few studies directly compared TAPP and TEP techniques [3]. Although some

publications report that the TEP procedure has been performed more frequently in laparoscopic IH surgery, some studies were reported different views. One of these studies is the German hernia registry Herniated study. In this study, 61.9% of the patients who underwent laparoscopic hernia surgery were treated with TAPP, and 38.1% with TEP. However, it was revealed that there was no significant difference between the two techniques regarding perioperative and postoperative complication rates [3].

Contrary to this, in Japan and Switzerland, register-based studies reported that perioperative complications were more common in the TEP group than in the TAPP group [4,5]. There is a consensus in the international hernia guidelines and in the studies of some other working groups that visceral injuries are more prevalent in TAPP, and vascular injuries are more prevalent in TEP.

Technically, the most challenging issue for surgeons is the restriction of the field of vision and work caused by pneumoperitoneum (PP) due to peritoneal tears (PT) in the TEP procedure. It is the most important common cause of conversion, along with bleeding. The technical difficulties in TAPP include the risk of intestinal injury because it is an endoscopic procedure and, in some cases, the necessity of suturing instead of tacker to close the peritoneal flaps. The enhanced view-TEP technique, described by Daes [6] and used in IH surgery, helped overcome some challenges that cause conversion. This technique was later performed by Belyansky et al. [7] in laparoscopic ventral hernia surgery.

In the guidelines developed for IH repair in 2014, the European Hernia Society, The International Endohernia Society, and the European Association for Endoscopic Surgery suggested that both techniques' effectiveness depends on the surgeon's skill and experience since TAPP and TEP have similar surgical outcomes [8].

This study aimed to discuss the intraoperative, postoperative early complications and technical challenges of laparoscopic TEP and TAPP techniques in IH surgery.

MATERIALS AND METHODS

We designed this study for patients admitted to Health Sciences University Ümraniye Training and Research Hospital for hernia repair between May 2016 and December 2020. A total of 108 patients were included in this study. All procedures (TEP and TAPP) were performed and analyzed by a surgeon with advanced laparoscopic surgery experience. TEP was applied to 76 of the patients and TAPP to 32. The present study was retrospective but prospectively recorded the perioperative and postoperative data (including video recordings).

Patient inclusion criteria included several parameters: (1) IH (unilateral, bilateral, chronic irreducible cases, femoral, scrotal, and recurrence hernia cases), (2) between 18 and 80 years of age,

and (3) suitability for general anesthesia. Patient exclusion criteria for this study were as follows: (1) having a greater risk of postoperative complications due to uncontrolled comorbidities, uncontrolled diabetes (hemoglobin A1c of >10%), and concurrent malignancy; (2) American Society of Anesthesiologist (ASA) physical status (PS) classifications III and IV; and (3) pregnancy, coagulation disorder, and ascites.

Totally extraperitoneal technique

A 12-mm infraumbilical incision was made and carried sharply to the fascia level. The anterior rectus sheath was incised transversely to expose the rectus abdominis muscle, and the muscle fibers retracted laterally for exposing the posterior rectus sheath. Two additional 5-mm trocars were placed between the umbilicus and pubic symphysis. In some cases, we used a balloon dissector. Insufflated the preperitoneal area with CO₂ and pressure set to 12 mmHg. A 10-mm, 30° laparoscope was inserted and used for blunt dissection to create a preperitoneal space. The pubic symphysis is the first anatomical landmark recognized. Other landmarks are Cooper's ligament inferior epigastric vessels. All myopectineal orifices were completely controlled for hernia(s) and identified all potential sites of hernia formation were. We used energy devices for dissection. After hernia reduction and parietalization, a propylene mesh was placed (about 12 × 13 cm) and reinforced the whole myopectineal orifices.

Transabdominal preperitoneal technique

Inserted a Veress needle from the left subcostal (Palmer's point) in patients with previous surgical history, and the abdomen was insufflated. However, in some cases, Hasson's technique was used. A 10- to 12-mm trocar was placed just below the umbilicus. Two more 5-mm trocars were placed on the lateral side of the rectus abdominis muscle. After abdominal exploration, the table was moved to the 30° reverse Trendelenburg position. A peritoneal incision was made just above 2 cm to the internal ring by the energy devices from the medial of spina iliaca anterior superior to the medial umbilical ligament. The other steps were explained in the TEP section. After that, the peritoneum was sutured with either tacker, v-lock, or absorbable continued sutures. The abdomen was checked for intestinal injury, and the operation was completed.

Data collection

Demographic profiles, preoperative and intraoperative variables, surgery duration, complications, and hospital stays were recorded. Our primary outcomes were considered complications, such as perioperative vascular and visceral injuries, conversion,

Table 1. The distribution of demographic and clinical characteristics of the patients

Characteristic	TAPP group	TEP group	<i>p</i> value
No. of patients	32	76	
Age (yr)	48.6 ± 12.2	42.4 ± 10.3	0.012
Male sex	25 (78.1)	69 (90.8)	0.113
Operation time (min)	51.6 ± 21.4	45.4 ± 22.3	0.010
Hospital stay (day)	1.1 ± 0.4	1.1 ± 0.3	0.600
Body mass index (kg/m ²)	23.3 ± 4.5	22.4 ± 2.3	0.179
ASA PS classification			0.729
I	28 (87.5)	69 (90.8)	
II	4 (12.5)	7 (9.2)	
Chronic irreducible cases	4 (12.5)	1 (1.3)	0.086
History of abdominal surgery	2 (6.3)	5 (6.6)	0.571
Recurrent case (preoperatively diagnosed)	10 (31.3)	3 (3.9)	<0.001

Data are expressed as number only, mean ± standard deviation, or number (%).

TAPP, transabdominal preperitoneal; TEP, totally extraperitoneal; ASA, American Society of Anesthesiologists; PS, classification.

postoperative hematoma, seroma, and recurrence. All patients were monitored and evaluated at regular intervals. Postoperative bleeding and seroma were classified as symptomatic and asymptomatic. PT requiring or not requiring repair (up to 10 mm) was also described. Chronic pain was defined as pain that lasts more than 6 months after surgery.

Statistical analysis

Statistical analyses of the data obtained in this study were performed using IBM SPSS version 25.0 (IBM Corp., Armonk, NY, USA). The relationship between categorical features and groups was examined using the chi-square and Fisher exact tests. Descriptive statistics used mean ± standard deviation and number and percentage values for categorical variables. An accepted *p* value of <0.05 was considered significant.

RESULTS

This study included 108 adult patients with IH (TEP, 76; TAPP, 32). The average follow-up period of patients was 21.6 months (range, 16–30 months). The mean duration of operation for the TAPP and TEP was 51.62 and 45.43 minutes, respectively.

No significant differences were in age, sex, ASA PS classifica-

Table 2. Distribution of the patients according to laterality, types of inguinal hernia, and scrotal descent

Variable	TAPP group (n = 32)	TEP group (n = 76)	<i>p</i> value
Laterality			0.008
Right	17 (53.1)	28 (36.8)	
Left	13 (40.6)	21 (27.6)	
Bilateral	2 (6.3)	27 (35.5)	
Type			0.966
Medial	11 (34.4)	24 (31.6)	
Lateral	23 (71.9)	52 (68.4)	
Femoral	1 (3.1)	3 (3.9)	
Scrotal descent	4 (12.5)	3 (3.9)	0.192

Data are expressed as number (%).

TAPP, transabdominal preperitoneal; TEP, totally extraperitoneal.

tion, body mass index (BMI), chronic pain, and hospital stays (Table 1).

The total complication rate was higher in the TEP group, although the difference was not statistically significant (TEP, 9.2%; TAPP, 3.1%; *p* = 0.979). More chronic irreducible cases were found in the TAPP group (12.5% vs. 1.3%, *p* = 0.086). TEP was applied more commonly to patients with bilateral IH (*p* = 0.002). Contrariwise, patients with recurrent IH who underwent TAPP were significantly higher than the TEP group (*p* = 0.001), as shown in Table 2.

Two cases had a recurrent IH (2.6%), and one patient had pseudoaneurysm (1.3%) in the TEP study group. The pseudoaneurysm was treated by endovascular coil embolization. In two patients, hematomas occurred in the TEP and TAPP groups (80 × 60 mm and 40 × 40 mm), respectively. Seromas occurred in six patients in the TEP study group, but only one was treated by aspiration (Table 3).

On the other hand, one patient had a seroma in the TAPP study group; however, it resolved spontaneously. PT was observed in six patients in the TEP group (7.9%). Conversion to the open procedure was observed in one of the TEP patients because of limitations of view due to PT (>2 cm). Another reason for conversion was the sigmoid colon injury in a patient who underwent TEP with the diagnosis of recurrent IH. In this case, about a 2-cm perforation occurred in the sigmoid colon during hernia sac dissection. The repair was done by converting it to the open procedure. After the primary repair, the peritoneal defect was closed by releasing the sigmoid colon loop with the TAPP technique. The present study did not find a hernia from the trocar site, surgical site infection, mesh rejection, testicular complications, or mortality.

Table 3. Distribution of perioperative complication, open conversion, and recurrence

Variable	TAPP group (n = 32)	TEP group (n = 76)
Total perioperative complication except for asymptomatic seroma	1 (3.1)	7 (9.2)
Intraoperative complications		
Vascular injury	0 (0)	1 (1.3)
Visceral injury	0 (0)	1 (1.3)
Postoperative complications		
Hematoma	1 (3.1)	1 (1.3)
Pseudoaneurysm	0 (0)	1 (1.3)
Symptomatic seroma requiring intervention	0 (0)	1 (1.3)
Asymptomatic seroma	1 (3.1)	5 (6.6)
Chronic pain	0 (0)	2 (2.6)
Open conversion	0 (0)	2 (2.6)
Recurrence	0 (0)	2 (2.6)

Data are expressed as number (%).

TAPP, transabdominal preperitoneal; TEP, totally extraperitoneal.

DISCUSSION

Laparoendoscopic TAPP and TEP techniques are commonly used in IH surgery. Although these two techniques have similarities, they have different and significant consequences. Intestinal complications, postoperative pain, and long operation duration are disadvantages of TAPP, whereas bleeding and conversion to open technique are cited as disadvantages of TEP [7,8].

The effectiveness of an operating technique should be evaluated both by the total number of complications and their severity. In a Swiss registry study, intraoperative and postoperative complications were higher in the TEP group [4]. Our results were similar to the Swiss research regarding intra- and postoperative complications.

Despite being not statistically significant, visceral injuries were more common during the TAPP than the TEP procedure [8]. Since TAPP is a laparoscopic procedure, visceral injuries may occur due to the uncontrolled use of trocar and other surgical instruments in the abdomen.

Postoperative hematoma is an important cause of infection, mesh dislocation, and recurrence. The bleeding due to inferior epigastric vessels may cause conversion and postoperative hematomas. However, most bleeding can be laparoscopically controlled in these cases [9]. In this study, bleeding (about 100–150 mL) occurred in one patient treated with TEP due to inferior

epigastric vascular injury during dissection (1.3%) and controlled the bleeding with hem-o-lok clips. In one study, vascular complications reported in TEP and TAPP were 1.39% and 1.13% ($p = 0.03$), respectively [8]. Two hematomas were observed in the TEP and TAPP. The stable patients were clinically and radiologically followed up. These hematomas were resolved without any complication in the 1st and 3rd months. The HerniaSurge Group suggests that only symptomatic hematomas should be accepted as a postoperative complication [8].

Most abdominal and pelvic pseudoaneurysms result from trauma, inflammation, or infection. Isolated internal iliac artery aneurysms are rare, and only a few cases have been reported in the literature [10]. However, a postoperative pseudoaneurysm developed (1.3%) in a patient in the TEP group. This patient underwent a left varicocelectomy 20 years ago and underwent a TEP with a diagnosis of bilateral IH. The patient developed postoperative bleeding/hematoma and underwent angiography because of continued bleeding. Computed tomography demonstrated that an aneurysm originated from one of the terminal ends of the internal iliac artery. The patient was treated with endovascular coil embolization. However, this patient underwent surgery again 6 months later after the diagnosis of right recurrent IH. The cause of recurrence was evaluated as mesh rejection or displacement due to hematoma.

Seroma incidence after IH repair was reported to be between 0.5% and 12.2% [11]. Postoperative seromas usually resolve spontaneously. IH communities strongly suggest that intervention is needed only for symptomatic seromas [8,11]. In our study, symptomatic seroma (necessary aspiration) was observed only in one case in the TEP group. To prevent seroma formation, suggesting the total reduction of the sac in scrotal hernia or fixation of the direct sac to the Cooper [11,12].

PP is the most frequent cause of laparoscopic failure-related conversion in the TEP [13]. In our study, conversion to the open procedure was reported in two TEP cases. One was due to the PP caused by a PT. The other case was a patient who underwent TEP with the diagnosis of recurrence hernia. The sigmoid colon (sliding hernia) injury occurred during hernia sac dissection. In this case, the perforation area was repaired with the open technique (conversion). However, the operation was completed with the TAPP procedure (hybrid method).

In most of the compared studies, the conversion from TEP to open or the TAPP technique was significantly higher (mean of three studies, 5.3%) [14]. However, in another study, the conversion between the TEP and TAPP was reported to be similar [15]. In the present study, PT was seen in the TEP group and was reported in 7.8% of cases in the TEP study group; however, only one of these cases underwent conversion to open technique. In a 123-case series of TEP, a PT was reported in 47% of the patients [7]. Thirteen percent of these PTs were large defects, so conversion

was preferred. When the PP occurs, we first lower the abdominal pressure. If this decrease is not sufficient, a Veress needle is inserted from Palmer's point, attempting to balance the pressure. In some cases, suture, endoloop, endostapler, hem-o-lok clips, and electro-surgical devices were used for peritoneal closure.

In our study, four irreducible cases were operated with TAPP and one case with TEP. In a single-center study of 275 patients who underwent TEP and TAPP, irreducible cases were reported at 2.5% and 0.6% in TAPP and TEP, respectively [16].

The role of laparoscopic TAPP and TEP in chronic incarcerated or irreducible cases is controversial. The leading cause of controversy is technical difficulties in dissection and reducing the hernia sac. In addition, advanced laparoscopic surgical experience is required for these procedures. TAPP would be more effective than TEP in these cases due to the limited working space in TEP and the difficulty of controlling the contents of the sac. In addition, no extradissection is required in TAPP as in TEP to control the other side. One advantage of TAPP over TEP is that it is possible to control the intestine's vitality and, if necessary, perform intracorporeal intestinal resection and anastomosis with TAPP.

Choosing the right technique is an important issue for people who are overweight and have undergone previous surgery. Because of the high probability of PP and some complications in TEP, open or TAPP technique was generally used in these cases. In our study, TAPP was applied to three patients who had previously undergone appendectomy and umbilical hernia surgery, and TEP was applied to one patient. High BMI scores were observed in TAPP cases; however, there was no significant difference between the two techniques in overweight patients in present study.

In one study, patients with a BMI <20 and >25 kg/m² had a significantly increased risk compared with patients with a BMI between 20 and 25 kg/m² [3]. As a result, we can associate the choice of technique with the experience and skill of the surgeon. Randomized controlled trials on this topic need more study.

Recurrence after laparoscopic IH can be seen in 10% to 15% of the cases in the long-term follow-up period [8]. Surgical inexperience, insufficient dissection of the myopectineal orifice, insufficient hernia sac, and mesh space dissection is the main reasons for recurrence after primary IH repair. Postoperative hematomas, seromas, and surgical site infections are considered reasons for unsuccessful surgery [8]. One of our cases in the TEP group had recurrence due to postoperative hematoma and mesh dislocation. This patient underwent a second surgery with an open technique after 6 months.

At the follow-up of 21.6 months, the recurrence rate of the TEP group was 2.6%. However, there was no recurrence detected in patients with TAPP. In one study, the researchers reported that some recurrence cases were related to the size of the mesh and

that recurrence was more commonly seen in cases in which the mesh was small (6 × 9 cm) [16]. In our patients, although mesh size differed according to the hernia type and defect size, the smallest mesh size was 12 × 13 cm.

We observed that the TAPP technique in laparoscopic IH surgery provides a better visual angle than TEP, especially in chronic irreducible or incarcerated hernias. In these cases, intestinal resection and anastomosis can be applied with TAPP. One of the superiorities of TAPP is that conversion from TAPP to TEP is quite rare. However, closure of the peritoneal flaps is one of the difficulties of the TAPP technique because, in some cases, closure of the peritoneum might not be possible using tackers. For this reason, if one does not have sufficient intracorporeal suture experience, the surgeon could experience technical difficulties.

The present study has several limitations. The main restriction includes the possible presence of biases because the investigation was retrospective in design. The sample size was small, and the study groups were not uniform (including unilateral, bilateral, recurrences, and chronic irreducible) IH cases. The follow-up periods were not long (the average follow-up period of patients was 21.6 months, ranging from 16 to 30 months). The strengths of the present study are the outcomes data, including perioperative bleeding, PT, conversion, visceral injury, postoperative bleeding or hematoma, seroma, and recurrence. The results were prospectively recorded for objective analysis (including video recording).

In conclusion, total complications were higher in the TEP than in TAPP in this study. However, there was no statistical difference between the two techniques. TAPP is as safe as TEP in IH surgery. TAPP can be safely applied mainly in patients with recurrence after anterior approach and complicated cases, such as scrotal, chronic incarcerated, or irreducible IH. These are additional advantages for TAPP.

The present study could not show the superiority of one method over the other. We will need a large scale of register-based observational studies to evaluate the efficiency and safety of the two techniques.

NOTES

Ethical statements

Ethics committee approval was obtained for the Clinical Research study (No. 14.04.2020/82). We conducted this study by the principles of the Declaration of Helsinki. Before the operation, informed the patients about the operation and possible complications. Written informed consent was waived because this study was retrospective.

Conflict of interest

The author has no conflicts of interest to declare.

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