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Original Article

Comparison of fixed mesh and unfixed plica mesh methods in laparoscopic total extraperitoneal inguinal hernia repair

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Abstract: In this study, we aimed to compare the clinical effectiveness of two mesh methods used in laparoscopic extraperitoneal (TEP) technique for inguinal hernia repair. A total of 190 patients who underwent inguinal hernia repair by laparoscopic TEP technique between January, 2013 and June, 2017 were included in this study. Patients were divided in two groups depending on the mesh placement technique used for repair of inguinal hernia: Patients in Group 1 (TM) had the mesh placed on the cord and mesh fixation was achieved by tacker (n=77). For patients in Group 2 (PM) the mesh was plicated around the cord (around the round ligament in women) without fixation (n=64). All patients underwent inguinal hernia repair by laparoscopic TEP method. The mean operation time was 42.5 minutes for unilateral (right or left) hernias while it was 72.8 minutes for bilateral inguinal hernias, which was significantly longer for the second group. No significant differences were detected between the groups comparing early (TM: 1.3% - PM: 4.7%) and late term postoperative complications (TM: 1.3% - PM: 3.1%). When the TM and PM groups were compared in terms of operation costs, we saved 308 units in total in the PM group (per operation: plica mesh: 1 unit, fixed mesh: 5 units). In conclusion, it is safe and low cost to use plication mesh instead of fixation in inguinal hernia repairs performed with laparoscopic TEP technique.

Keywords: Inguinal hernia, laparoscopy, mesh, tack, totally extraperitoneal hernia repair

Introduction

Inguinal hernia repair is one of the most commonly performed operations by general surgeons [1]. A hernia is defined as a situation in which the intraabdominal structures are displaced and protrude through the abdominal wall. Weak points in the abdominal wall and other conditions increasing the intraabdominal pressure contribute to hernia formation. It can be accompanied by a hernia sac and intraabdominal organs, including the small intestine, colon and bladder or can be empty without tissue. Even though approximately 20 million inguinal hernia repairs are performed worldwide annually, there is a lack of consensus in the literature as to the optimal repair technique and mesh type to be used [2].

Although the diagnosis and treatment of inguinal hernia dates back to the ancient Egyptians, E.Bassini defined the inguinal hernia repair technique for the first time in 1887 which is now referred as Bassini's repair [3]. Since the description of the Bassini's technique, more than 70 methods have been proposed for inguinal hernia repair because of complications and recurrence rates associated with inguinal hernia repair [4]. Considering the chronological order of the methods, the initial methods used sutures to create tension. Over time, these suture-using methods were replaced with new hernia repair methods not employing suture tension. With the introduction of synthetic meshes, Lichtenstein proposed the anterior approach, and Nyhius and Stoppa defined the posterior method. Laparoscopic hernia repair which was first defined in 1982 has been used by many surgeons and became popular as it is minimally invasive in nature and offers multiple advantages. Today, a technique to be used for inguinal hernia repair is expected to be minimally invasive and associated with shorter recovery time, reduced pain in the early and

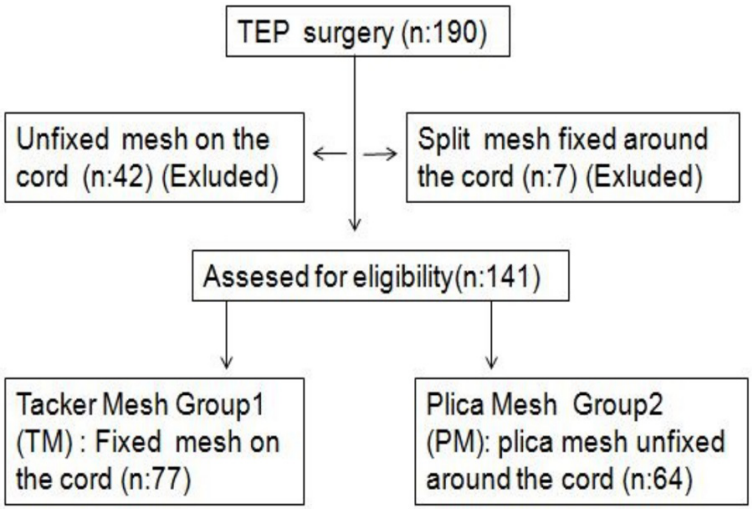

Figure 1. Distribution of Groups.

late postoperative period, with low operation costs and low rate of recurrence [5].

The first method used for laparoscopic hernia repair was the transabdominal pre-peritoneal (TAPP) approach, which was followed by the totally extraperitoneal (TEP) technique [6]. Now, both endoscopic techniques are used for hernia repair. As compared to open procedures, endoscopic inguinal hernia repair is known to have advantages including improved postoperative pain profile and earlier recovery and quicker return to work [7, 8]. However, chronic pain due to fixation of the mesh in laparoscopic hernia repair procedures has brought the use of biological fixation methods and specific meshes into question which means increased cost in hernia surgery.

Postoperative complications and cost of laparoscopic inguinal hernia repair have been two major questions of debate in the literature. In this study, we aimed to investigate the clinical efficiency by comparing two groups undergoing hernia repair by TEP technique: in one group we used a new mesh placement method created by plication of a polypropylene mesh and in the other group we fixed the mesh on the anterior abdominal wall.

Material and methods

Ethics committee approval

This study was performed between January 2013 and June 2017 at Health Sciences University Istanbul Training and Research Hospital. The Institutional Review Board (IRB) at Health Sciences University Istanbul Training and Research Hospital approved of this retrospective study (approval number: 1385-03/08/2018).

Inclusion criteria

In the present study, we reviewed the files of 190 patients who were diagnosed with inguinal hernia and operated on by an experienced surgeon using the laparoscopic TEP technique. In total, 141 patients were enrolled to the study. For those 141 patients, early postoperative data including 1-3 weeks after operation was taken from polyclinic records and late postoperative data was obtained from telephone interviews with patients along with the patients' medical files.

Group 1 (TM) involved 77 patients for whom a 13 × 15 cm polypropylene mesh was spread on the preperitoneal area as a whole and fixed to the cooper ligament and lateral abdominal wall. Group 2 (PM) involved 64 patients for whom a 13 × 13 cm unfixed plica mesh wrapped around the cord (around the round ligament in women (**Figure 1**). These two groups were compared regarding age, gender, postoperative complications, length of hospital stay, duration of follow-up and operation costs.

Surgical technique

Considering the duration of the operation, we used a urinary catheter for patients who had a bilateral hernia. Just before the administration of general anesthesia, prophylactic intravenous antibiotics were administered to the patients. After sterilization, a mini incision was created under umbilicus through which the anterior rectus sheath was reached. The preperitoneal region was reached by sliding 5 mm towards the hernia from the midline. The rectus muscle was excluded laterally and a 10-mm reusable trocar port was introduced into the preperitoneal space. Carbon Dioxide insufflation was performed into this extraperitoneal area with a pressure of 10-14 mmHg. The extraperitoneal

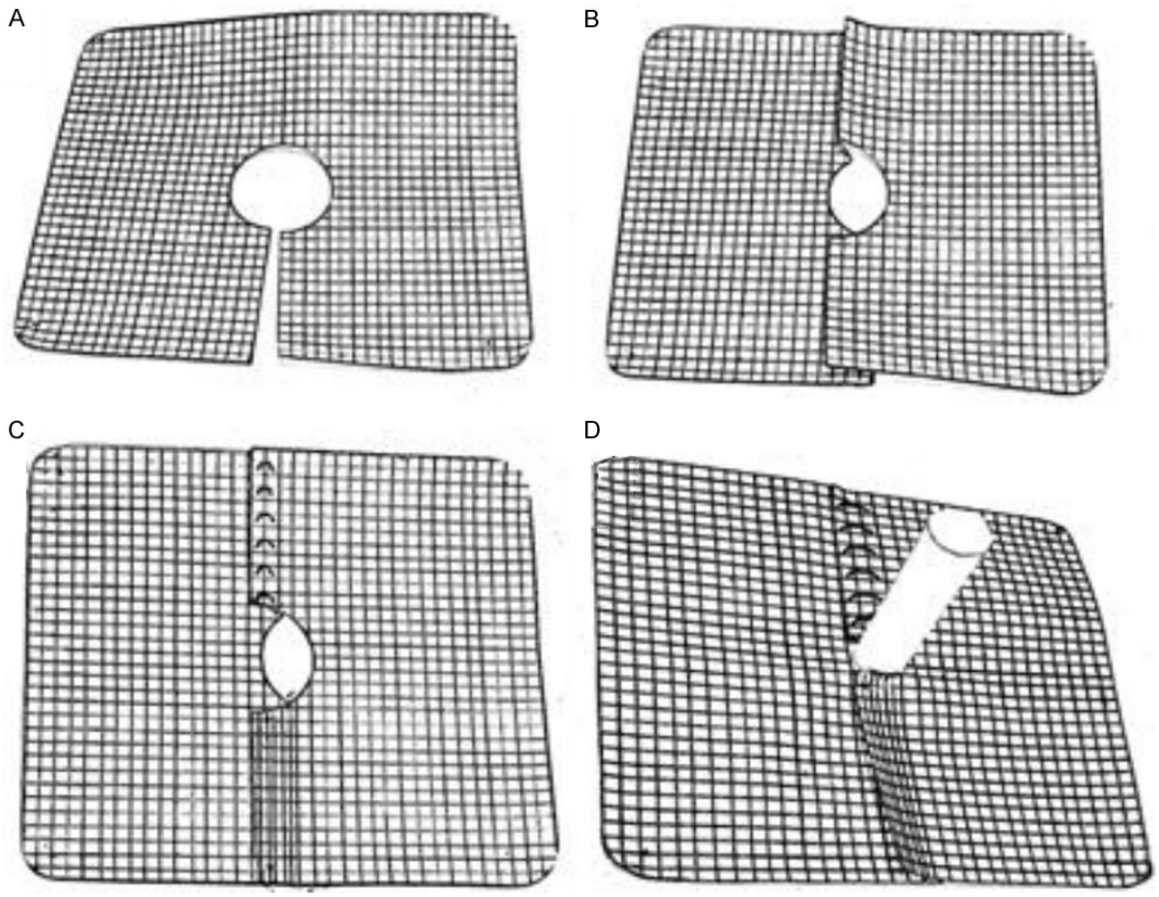

Figure 2. Plica mesh method.

space was dissected in the midline under direct optical vision and two 5 mm trocar ports were placed in approximately 5 cm and 10 cm proximal to the symphysis pubis. The copper ligament was revealed and then, dissection of the extraperitoneal space was completed starting from the superior towards inferior under the guidance of epigastric vessels. The hernia sac was found and separated from the peripheral tissues and the spermatic cord (from the round ligament in women).

For patients in Group 1 (TM), a 15 × 13 cm polypropylene mesh® (Paha polypropylene mesh, Altaylar Medikal, Ankara, Turkey) was spread on the preperitoneal area and fixed to the copper ligament and lateral wall of the abdomen using Absorbable Tacks® (Covidien, Absorbable Tacks™, 5 mm-15 Tacks).

For patient in Group 2 (PM), the inguinal cord was released in 360-degrees. A 13 × 13 cm polypropylene mesh® (Paha polypropylene mesh, Altaylar Medikal, Ankara, Turkey) was four-folded and a 0.5 × 2 cm piece was elliptically removed from the middle. With an incision from the middle of the longer edge, the edge was united with the elliptic hole in the middle. Mesh wings were created to wrap around the cord by plication of the intact edge in the opposite of the incision on the longer edge with polypropylene suture. After the cord was placed in the middle of the hole between the mesh wings in a way that the mesh part with plication cover the postero-inferior of the cord (the round ligament in women), the procedure was completed by spreading the mesh on the preperitoneal area with its wings' facing surfaces overlapping in the superior (**Figure 2**).

Statistical analysis

Average, standard deviation, median lowest, highest, frequency and ratio values were used in the descriptive statistics of the data. The distribution of variables was measured with

Table 1. Distribution of length of surgery, hospital stay and postoperative follow-up, postoperative complications, inguinal hernia types, and demographic data among

		Min-Max	Median	Avg.±s.d./n-%
Age		17.0-78.0	50.5	50.7±13.3
Gender	Female			8-%5.7
	Male			133-%94.3
Side	Right			67-%47.5
	Left			48-%34.0
	Bilateral			26-%18.4
Follow-up Period (Month)		4.0-71.0	36.0	37.7±16.6
Operation Duration (Minute)		20.0-120.0	45.0	48.1±17.6
Hospitalization (day)		1.0-3.0	1.0	1.0±0.3
Type	Direct			26-%18.4
	Indirect			65-%46.1
	Pantaloon			11-%7.8
	Femoral			2-%1.4
	Recurrent			4-%2.8
	Scrotal			10-%7.1
	Mixed			23-%16.3
Complication	(-)			134-%95.0
	(+)			7-%5.0
Postop. Early Complication	(-)			137-%97.2
	(+)			4-%2.8
Postop. Late Complication	(-)			138-%97.9
	(+)			3-%2.1

Kolmogorov Simirnov test. Independent sample t test, Kruskal-Wallis, Mann-Whitney u test were used in the analysis of quantitative independent data. In the analysis of qualitative independent data, Fischer test was used when chi-square test conditions were not met. SPSS 22.0 program was used in the analysis.

Results

Distribution of groups, hospitalization and operation times

Of 141 patients included in the study group undergoing laparoscopic total extraperitoneal repair, 8 (5.67%) patients were female and 133 (94.3%) were male and the mean age was 50.7±13.3 (range, 17-78 years) years. For those patients, the mean operation time was 48.1± 17.6 (range, 20-120 minutes) minutes; the mean length of postoperative hospitalization was 1±0.3 (range, 1-3 days) days and the mean follow-up period was 37.7±16.6 (range, 4-71 months) months. Although the operation time in group 2 was longer (Group 1: 46.9±17.6/ Group 2: 49.6±17.7), no significant difference (P>0.05) was found. Hospitalization in group 1 was shorter (Group 1: 1.0±0.0/Group 2: 1.1± 0.4), but no significant difference was found (P>0.05) (**Tables 1**, **2**).

Complications

In the early postoperative period, 1 patient from Group 1 (TM) developed scrotal edema and 3 patients from Group 2 (PM) developed seroma in the operation field, but it was resorbed within the next 3 months. In the late postoperative period, on the other hand, 1 patient from Group 1 (TM) suffered from bride ileus 8 months after the operation and the disease recurred in 2 patients from Group 2 (PM). In total, we encountered postoperative complications in 7 (5%) patients. There was no significant difference between patients complications in Group 1 and Group 2, for both early and late term complications (P>0.05) (**Tables 1**, **2** and **5**).

Cost

Due to the exchange rate differences among countries, 1 unit of mesh (1 unt) corresponded

Table 2. Comparison of groups regarding the length of surgery, hospital stay and postoperative follow-up, postoperative complications, and inguinal hernia types

		Tacker Mesh Group 1 (TM-Fixed) Avg±s.d./n-% Median		Plica Mesh Group 2 (PM-Unfixed) Avg±s.d./n-% Median		P
Age		52.5±11.9	54.0	48.5±14.5	48.0	0.075[t]
Gender	Female	6-%7.8		2-%3.1		0.233[x2]
	Male	71-%92.2		62-%96.9		
Side	Right	40-%51.9		27-%42.2		0.175[x2]
	Left	27-%35.1		21-%32.8		
	Bilateral	10-%13.0		16-%25.0		
Follow-up Period (Month)		35.2±17.2	33.0	40.8±15.4	39,5	0.030[m]
Operation Duration (Minute)		46.9±17.6	45.0	49.6±17.7	45.0	0.322[m]
Duration of Hospital Stay (day)		1.0±0.0	1.0	1.1±0.4	1.0	0.056[m]
Type	Direct	11-%14.3		15-%23.4		0.239[x2]
	Indirect	35-%45.5		30-%46.9		0.999[x2]
	Pantaloon	6-%7.8		5-%7.8		0.755[x2]
	Femoral	1-%1.3		1-%1.6		1.000[x2]
	Recurrent	2-%2.6		2-%3.1		0.747[x2]
	Skrotal	7-%9.1		3-%4.7		0.493[x2]
	Mixed	15-%19.5		8-%12.5		0.374[x2]
Complication	(-)	75-%97.4		59-%92.2		0.156[x2]
	(+)	2-%2.6		5-%7.8		
Post op. Early Complication	(-)	76-%98.7		61-%95.3		0.329[x2]
	(+)	1-%1.3		3-%4.7		
Post op. Late Complication	(-)	76-%98.7		62-%96.9		0.591[x2]
	(+)	1-%1.3		2-%3.1		

[t]T test/[m]Mann-whitney u test/[x2]Chi-square test (Fischer test).

Table 3. Duration of operation by unilateral and bilateral hernia types

		Duration of Operation (minutes)			P
		Min-Max	Median	Avg±s.d.	
Side	Right	20.0-70.0	42.5	42.5±11.4	0.000[K]
	Left	30.0-90.0	40.0	42.5±13.0	
	Bilateral	50.0-120.0	70.0	72.8±16.9	

[K]Kruskal-wallis (Mann-whitney u test).

to a cost of 4 units for the tacker in the cost comparison. While we saved (PM: prolene mesh:1 unt/TM: prolene + Tacker:5 unt) PM/TM 1/5 per patient and the total saving was 308 units in the study (**Table 6**).

Subgroup operation times

Of all of the patients included in this study, 67 (47.5) had right-sided hernia, 48 (34%) had left-sided hernia, and 26 (18.4%) had bilateral hernias. Patients had indirect (n=65, 46.1%), direct (n=26 (18.4%), mixed type (n=23, 16.3%), pantaloon (n=11, 7.8%), scrotal (n=10, 7.1%), recurrent (n=4, 2.8%), and femoral (n=2, 1.4%) hernias (**Table 1**). Operations for a bilateral hernia were significantly longer (P<0.05) as compared to those for unilateral hernias. However, the duration of the operation did not significantly differ between left-sided and right-sided hernias (P>0.05) (**Table 3**). Duration of the operation did not significantly change according to hernia types (P>0.05) (**Table 4**).

Discussion

Although the Lichtenstein technique is recommended for an anterior approach and the laparoscopic technique is suggested for a posterior approach, one standard hernia repair technique for all inguinal hernias does not exist [9]. The Lichtenstein hernioplasty technique is recommended for primary inguinal hernias. However, in the case of recurrent and bilateral hernias laparoscopic TEP is the suggested technique [10].

When mesh is placed in the preperitoneal region without fixation and extraperitoneal pneumoperitoneum is deflated, the peritoneum tends to return completely to its original position, fixing the mesh against the pelvic wall as a

Table 4. Duration of operation by inguinal hernia types

		Duration of Operation (minutes)			P
		Min-Max	Median	Avg±s.d.	
Type	Direct	30.0-120.0	45.0	48.5±21.9	0.052[K]
	Indirect	30.0-90.0	40.0	43.9±13.3	
	Pantaloon	30.0-74.0	45.0	48.1±12.3	
	Femoral	20.0-44.0	32.0	32.0±17.0	
	Recurrent	30.0-60.0	40.0	42.5±12.6	
	Scrotal	30.0-90.0	60.0	56.0±20.4	
	Mixed	30.0-120.0	60.0	59.1±20.4	

[K]Kruskal-wallis (Mann-whitney u test).

"sandwich" [11]. Within the following two months, foreign body reactions and fibrosis result in tissue incorporation with mesh [12]. Whereas the Sandwich effect may be held responsible for early stabilization, mesh and tissue incorporation are responsible for late term stabilization. Beattie et al., the source of inspiration for our study, divided the mesh in half vertically, and spread the mesh on cord [13]. However, they took no measure for any potential gap between the mesh legs. In this study, we split the mesh in half and created two wings which wrapped 360 degrees around the inguinal cord. As we created a holding point on the cord preventing the migration of the cord, and thus, supported early mesh stabilization in addition to the sandwich effect.

Perioperative injuries are rare in laparoscopic inguinal hernia surgery, and the major injury rate is reported to be 0.12% [14]. In the literature, it is recommended to perform at least 20 operations under supervision for a successful learning curve [15]. In our study, all operations were carried out by an experienced surgeon and postoperative complications were not readily observed in our patients.

In the literature, postoperative complication rates vary between 10.67% and 16.8% following laparoscopic TEP repair [16, 17]. In a prospective study conducted by Gass et al. patients who underwent unilateral or bilateral TEP procedure reported that the complication rate varies around 3.2% and 2.3% for bilateral and unilateral hernias, respectively [18]. Jang et al. made a comparison between primary and recurrent hernias repaired with the TEP technique and reported 30% postoperative complication rate in total (3% peritoneal rupture, 4.5% seroma, 22.5% urinary retention) for the primary hernia group; however, they reported 21.1% postoperative complication rate (21.1% urinary retention) for the recurrent hernia group. None of their patients stated chronic pain, recurrence or hematoma [19]. Maghrebi et al. investigated 92 patients undergoing TAPP or TEP procedure and associate their 5% postoperative complication rate with surgical experience [20]. In our study, on the other hand, there was no significant difference between the groups regarding postoperative complications. Postoperative complication rates of the plica mesh and tacker groups (Total complications: 5%, complication of Tacker Mesh: 2, 6%, Complication of Plica Mesh: 78%) were similar to the results reported in the literature. In Lau et al.'s prospective study, the overall postoperative seroma incidence was 7.2%. The risk factors that lead to seroma which was resorbed in average by 2.4 moths, included advanced age, large hernia defects, residual sac, and scrotal hernia [21]. In this study, 3 (4.7%) patients from the plica mesh group developed seroma and 1 (1.3%) patient from the tacker group developed scrotal edema in the early postoperative period, but these complications resolved within the following 3 months. It is reported that the recurrence rate ranges from 1.5% to 5.9% after laparoscopic TEP procedures in the short and mid-term follow-up in literature [22, 23]. It is reported that long-term follow-up, the overall recurrence rate is 8.9%, while it is 8.5% in primary hernias and 10.5% in recurrent hernias in the literature [10]. It is mentioned that insufficient mesh fixation and foreign body reactions are the causes of hernia recurrence in literature. These conditions lead to a reduction in the polypropylene mesh surface area by approximately 60% which is secondary to scar tissue contraction and results in potential weaknesses in mesh edges and increase in Type III/Type I collagen ratio. However, mechanical fixation devices which are used to increase the strength of the mesh and to reduce the risk of migration and recurrence are responsible for neuralgia secondary to bleeding, pain and nerve compression. The most important disadvantage of biological fixation materials which are used to prevent complications associated with the use of mechanical fixation is the increased cost [24, 25, 28]. In a meta-analysis, Tam et al. indicated that using the mesh without fixation in TEP technique significantly decreased the duration of the opera-

Table 5. Early and late postoperative complications

Complication Category		Tacker Mesh Group 1 (TM/n:77)	Plica Mesh Group 2 (PM/n:64)
Intraoperative Complication		0	0
Postoperative Early Complication	Seroma	0	3
	Scrotal edema	1	0
Postoperative Late Complication	*Small Bowel Adhesion*	1	0
	Recurrence	0	2
Total		2	5

Table 6. Comparison of groups by unit cost

Product	Unit price per patient (unt)	Tacker Mesh Group 1 (TM/n:77)	Plica Mesh Group 2 (PM/n:64)
Prolene Mesh	1 unt	77 unt	64 unt
Tacker	4 unt	308 unt	0 unt
Total	5 unt	385 unt	64 unt

tion, hospitalization and the operation costs, but did not cause a significant difference in postoperative complications [26]. Beattie et al. conducted a comparison study on 89 patients: in one group, they spread a mesh over the cord while in the other group, they placed a split mesh over the preperitoneal region and hernia defect by wrapping the split mesh around the cord. As a result of their comparison, Beattie et al. revealed that there is no increase in morbidity and hernia recurrence. In their conclusion, Beattie et al. stated that it is not necessary to fix the mesh to the preperitoneal area [13]. In the present study, the mean follow-up period was 35.2 months and there was no evidence of recurrence in the tacker group. Whereas, the rate of recurrence was 3.1% in the plica mesh group with a mean follow-up period of 40.8 months. Our results are similar to the medium-term recurrence rates in the literature. Although the difference between the mesh surface areas used in our groups (taker group: 13 × 15 cm/ plica mesh group: 13 × 13 cm) may seem to be responsible for scar tissue contraction secondary to foreign body reaction, fibrosis intensity, recurrence and adhesion and the fixation of mesh with tacker be seems to be responsible for the negative impact in recurrence, there was no statistically significant difference between the groups in terms of late postoperative complications. Considering the cost, when we accepted the cost of a mesh as 1 unit price and compared with the fixed mesh group, we provided a saving of 4 units. The total saving was 308 units in the study.

In recent studies, the incidence of chronic pain after inguinal hernia repair with TEP method varies between 0.2% and 25%. Mesh fixation to the preperitoneal area and foreign body reaction against the mesh are the factors blamed for chronic pain and hypersensitivity in those studies [27, 28]. Unlike to the literature, we did not observe postoperative chronic pain in any of the patients undergoing surgery.

In laparoscopic TEP repair technique, the mean operation time is reported to range 33-100 minutes depending on the factors affecting the duration of operation including surgical experience, mesh fixation, nature of inguinal hernia (primary, recurrent), side of inguinal hernia (unilateral, bilateral) and type of inguinal hernia (simple, mixed) operation duration due to factors affecting the average duration of operation [15, 29]. In this study, the mean operation duration was 48.1 minutes for all groups, with 72.8 minutes for bilateral hernias and 42.5 minutes for unilateral hernias. In other words, the mean duration of operation was significantly longer in bilateral hernias as compared to unilateral hernias, which is consistent with the literature.

Our study has some limitations. As the data was collected retrospectively, their accuracy and completeness is dependent on the medical records and the 10 years long term follow up was not observed.

Considering the studies in the literature, spreading the mesh on the preperitoneal region with plication does not cause an increase in

postoperative complication rate. Not fixing the mesh saves in operation costs. Using mesh plication without fixation can be safely used for laparoscopic hernia repair by TEP in direct, indirect, pantaloon, and femoral, recurrent and mixed type hernias regardless of the fact that they are unilateral or bilateral. However, we need further prospective randomized controlled trials and long-term results for more information.

Acknowledgements

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Disclosure of conflict of interest

None.

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