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Original Article

Learning total extraperitoneal (TEP) herniorrhaphy without supervision: A study on proficiency, efficiency, and safety

Yahya Özel,[1] Yalçın Burak Kara,[2] Sevde Nur Emir[3]

[1]Department of General Surgery, Dogus University, Istanbul, Türkiye
[2]Department of General Surgery, Bahcesehir University, Istanbul, Türkiye
[3]Department of Radiology, Umraniye Training and Research Hospital, Istanbul, Türkiye

ABSTRACT

Introduction: This study investigated the learning curve (LC) of TEP herniorrhaphy performed without supervision and with telescopic dissection.

Materials and Methods: This study was a retrospective data analysis. Patients who underwent inguinal hernia repair via the TEP method between April 2009 and December 2012 were included. Data from patient records, such as demographic information, hernia type, surgical details, intraoperative and postoperative complications, conversion to other surgical techniques, and early hernia recurrence, were collected and analyzed.

Results: A total of 141 patients were included in the study. The mean age was 48.5±14.7 years, and 131 (92.9%) patients were male. The mean surgery duration was 66.7±15.3 minutes. After performing 75 TEP herniorrhaphy surgeries, a significant reduction in operative time was observed ($p<0.001$). The study also reported that 9.2% of surgeries required conversion to other techniques, such as transabdominal preperitoneal (TAPP) or open hernia repair, with the conversion rate decreasing after the 75th surgery. Of the 12 conversions, 9 occurred during the first 75 cases, whereas only 3 were recorded afterward.

Postoperative complication rates remained consistently low throughout the study. Hematoma was observed in only 1.4% of patients, seroma in 4.3%, and mesh infection in 0.7%. There was no significant difference in complication rates before and after the 75-case threshold, suggesting that the safety of the procedure was maintained throughout the learning process. Early recurrence of hernia occurred in one patient (0.79%) within the first month.

Conclusion: This study demonstrated that surgeons with sufficient laparoscopic experience can effectively and safely learn TEP herniorrhaphy without the need for supervision or the use of a balloon dissector, a tool that typically increases procedural costs. However, more complex cases should be approached cautiously until the LC is fully established.

Keywords: Complication rates, hernia repair, laparoscopic surgery, learning curve, operative time. TEP herniorrhaphy, unsupervised surgery

Introduction

The process of inguinal hernia surgery, which began in the 16th century with the Italian anatomist Gabriele Fallopio, advanced with the tissue repair method introduced by Bassini in 1887. To date, more than 100 different techniques described for the repair of inguinal or femoral hernias can be categorized into open (tissue and mesh repair) and laparoscopic mesh repair.[1–4]

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Correspondence: Yalçın Burak Kara, M.D., Department of General Surgery, Bahcesehir University, Istanbul, Türkiye
e-mail: drburakkara@gmail.com

The latest international guidelines from the Hernia Surge Group now recommend the TEP and TAPP techniques (laparoscopic), the Lichtenstein method (open mesh repair), and, with some limitations, the Shouldice technique (mesh-free).[5,6]

In the last guidelines, laparo-endoscopic techniques result in less chronic pain and faster recovery than Lichtenstein repair. If the surgeon is sufficiently experienced with the technique, laparo-endoscopic procedures do not require longer operative times. The high cost can decrease across open techniques, and no significant differences are observed in terms of perioperative complications requiring reoperation between the laparo-endoscopic and Lichtenstein techniques.[6]

Compared with open surgery, laparoscopic surgery is generally considered more challenging because of its unique anatomy and limited workspace, particularly in TEP repair.[6] Additionally, the learning curve for the TEP technique is longer and steeper due to the "inside-out anatomical view" that the surgeon is not accustomed to.

Several studies have been conducted to describe the LC for the TEP and TAPP techniques, and the LC varies between 20 and 250 cases.[7–10] However, there is no consensus in the literature regarding the exact number of cases that a surgeon must perform to determine the LC.[7] LC assessment is generally evaluated through parameters such as operative time, intraoperative and postoperative complications, patient outcomes, and technical difficulty.[11]

This retrospective study was conducted to estimate the number of cases required for the LC in TEP herniorrhaphy without supervision and without using a balloon dissector.

Materials and Methods

Patients who were diagnosed with inguinal hernia and admitted to our clinic between April 2009 and December 2012 were evaluated retrospectively. They underwent elective surgery by a single surgeon, using the TEP herniorrhaphy method for the first time, without a supervisor and without the use of a balloon dissector.

Inclusion Criteria

- Unilateral and primary hernias.
- Aged between 18 and 75 years.
- Body mass index (BMI) under 35.

Exclusion Criteria

- Patients with bilateral and/or recurrent hernias and large scrotal hernias.
- Patients presenting in emergencies (irreducible, incarcerated).
- Patients with infraumbilical incisions, colostomy, or ileostomy performed or applied.

Out of a total of 195 patients who underwent TEP herniorrhaphy, 24 patients with bilateral and/or recurrent hernias and 30 patients with unilateral recurrent hernias were excluded. One hundred forty-one patients who had unilateral and primary hernias were included in the study.

The diagnosis was made through physical examination and was necessitated with ultrasonography. Patients were discharged with an oral analgesic and maintained without the need for IV analgesics, as indicated by their visual analog scale (VAS) score. When the drainage volume from the drain fell below 20 cc, it was removed either in the hospital or during the follow-up appointment. Patients were called for follow-up after 7 days and 30 days post-discharge.

The hernias were classified as follows: direct (D), indirect (ID), femoral (F), and combined hernia. Patients' demographic characteristics, hernia type, surgery duration, intraoperative complications (vascular and organ injury, bleeding), peritoneal injury, use of a Veress needle, fixation and conversion to different methods, drain use and duration, length of stay, and postoperative complications (bleeding, hematoma, seroma, mesh infection, and early recurrence at the one-month mark) were evaluated.

The surgery duration was defined as the time from the first skin incision until the camera port was removed. Intraoperative complications were defined as vascular injuries (epigastric or testicular artery, etc.), damage to the ductus deferens, and organs. Postoperative complications such as hematoma or seroma were defined as the accumulation of blood or fluid in any subcutaneous tissue area up to the scrotal region. Early recurrence was defined as recurrence occurring within the first 4 weeks.

All patients were operated on by the same surgeon, who was experienced in laparoscopy (more than 300 laparoscopic cholecystectomies) and had performed more than 400 Lichtenstein inguinal hernia repairs but had no experience in laparoscopic TEP herniorrhaphy. All surgeries were performed via the same technique.

The LC evaluation parameters included surgery duration, conversion from TEP to TAPP or open surgery, intraoperative complications, and postoperative complications.

All procedures were conducted in accordance with the 1964 Helsinki Declaration and subsequent guidelines on ethical principles, and informed consent was obtained from all patients included in the study. The Ethics Committee approved this study (Date: 13.06.2024; No: 2024/96).

Surgical Technique

The surgeries were performed under general anesthesia. Three infraumbilical trocars or two infraumbilical trocars and one trocar on the hernia side were placed in the region of the anterior superior iliac spine. A 0° telescope was used to perform blunt dissection up to the pubic bone under CO2 insufflation, while the medial side of the rectus muscle was dissected, and the camera was changed to a 30° telescope. Blunt dissection was initiated without a balloon expander.

If there was any rupture in the peritoneum that hindered work, a Veress needle was sent into the abdomen through the camera port area. If it could not be controlled with Veress, repair was performed. When conversion was needed, the procedure was switched to open surgery or TAPP in favor of the patient. In direct large hernias, the hernia sac on the anterior wall was fixed to the pubic bone.

After controlling for bleeding, a 15x15 cm polypropylene mesh was cut to fit the patient's physical dimensions and was placed in this area, covering indirect and direct femoral hernia areas. Especially for large hernias, the mesh was fixed with absorbable tacks. If deemed necessary, a drain was placed. The surgical technique was performed as previously described.[12]

Statistical Analysis

The descriptive statistics of the data included mean, standard deviation, median, minimum, maximum, frequency, and percentage values. The distribution of variables was measured via the Kolmogorov–Smirnov and Shapiro–Wilk tests. The Mann–Whitney U test was used for the analysis of non-normally distributed quantitative independent data. The chi-square test was used for the analysis of qualitative independent data, and Fisher's test was used when the conditions for the chi-square test were not met. The effect level and cutoff value were investigated with ROC curves. The SPSS 27.0 program was used for the analyses.

Results

A total of 141 patients who underwent laparoscopic TEP repair were included in the study. The patients' mean age was 48.5±14.7 years, with 131 (92.9%) being male and 10 (7.1%) being female. The mean BMI was 24.8±2.2 kg/m². Among the patients, 46 (32.6%) were classified as ASA I, 71 (50.04%) as ASA II, and 24 (17.0%) as ASA III. The mean duration of surgery was 66.7±15.3 minutes.

There was no isolated femoral hernia, and the femoral hernia detected in 5 (3.5%) patients was accompanied by other hernias. Hernia-related information is comprehensively listed in Table 1.

The number of surgeries that required conversion because of technical difficulties with different methods during the operation was 12 (8.5%). In the last three of these cases, TAPP herniorrhaphy was also applied, which is why it was preferred over open surgery. The initial nine procedures were performed via the open method.

In terms of complications, two patients (1.4%) had hematomas that did not require intervention, six patients (4.3%) had seromas, and one patient (0.7%) had a mesh infection that was removed because it could not be controlled with medical treatment.

The average length of hospital stay was 1.21±0.41 days. A total of 111 patients (78.7%) were discharged on the first postoperative day, whereas 30 patients (21.3%) required a two-day stay. No patients needed to stay longer than two days.

When ROC curve analysis was performed, the number of surgeries significantly distinguished between patients with operation times of 60 minutes or more and those with operation times of less than 60 minutes. At a cutoff value of 75 surgeries, the sensitivity for predicting longer operation times was 73.3%, with a specificity of 65.6% (Table 2), (Fig. 1).

The mean surgery duration after the 75th patient was significantly shorter than that before (59.5±11.8 minutes vs. 73.1±15.3 minutes, $p<0.05$). There was no difference in patient age, sex distribution, ASA score, hernia type, length of hospital stay, drain rate and duration, rate of use, complication rates (hematoma, seroma, and mesh infection rates) or fixation rates between the groups with ≤75 and >75 surgeries ($p>0.05$). The BMI value was significantly ($p<0.05$) greater in the surgery duration >75 group than in the surgery duration ≤75 group. In the first group of 75 patients, conversion to a different method was required

Table 1. Demographic and surgical findings of patients

	Min–Max	Median	Mean±SD/n-%
Total number of patients, n			141
Age	18.0-73.0	49	48.5±14.7
Gender			
Female			10-7.1%
Male			131-92.9%
BMI (kg/m^2)	21.2-35.5	24.5	24.8±2.2
ASA score			
I			46-32.6%
II			71-50.4%
III			24-17.0%
Hospitalization day	1	2	1.21±0.41
Hospitalization day			
I day			111-78.7%
II day			30-21.3%
Operation Time (minute)	40.0-115.0	65.0	66.7±15.3
Veres Needle			
(-)			121-85.8%
(+)			20-14.2%
Drain			
(-)			81-57.4%
(+)			60-42.6%
Duration of drain use (number of days)	2.0-7.0	2.0	3.1±1.7
Fixation			
(-)			100-70.9%
(+)			41-29.1%
Type of hernia			
Direct			42-29,78%
Indirect			74-52,48%
D-ID			25-17,73%
D/ID-F			5-3,54%
Side of hernia			
Right			74-52.5%
Left			67-47.5%
Femoral (F)			
(-)			136-96.5%
(+)			5-3.5%
Complications			
(-)			132-93.6%
(+)			9-6.4%
Hematoma			
(-)			139-98.6%
(+)			2-1.4%
Seroma			
(-)			135-95.7%
(+)			6-4.3%

Table 1. Demographic and surgical findings of patients (Cont.)

	Min–Max	Median	Mean±SD/n-%
Mesh Infection			
(-)			140-99.3%
(+)			1-0.7%
Conversion to another method			
(-)			128-90.8%
(+)			13-9.2%
Operation Time			
≥60 minutes			96-68.1%
<60 minutes			45-31.9%

SD: standard deviation; Min–Max: minimum-maximum; BMI: body mass index; ASA score: American Society of Anesthesiologists.

Table 2. ROC Curve

	Area Under Curve	95% Confidence Interval	p
Number of Surgeries	0.747	0.663-0.832	0.000
Number of Surgeries (75 Cut-Off)	0.695	0.602-0.788	0.000

	Surgery Time≥60	Surgery Time< 60		%
Number of Surgeries				
≤ 75	63	12	Sensitivity	73.3
> 75	33	33	Positive Predictive Value	50.0
			Specificity	65.6
			Negative Predictive Value	84.0

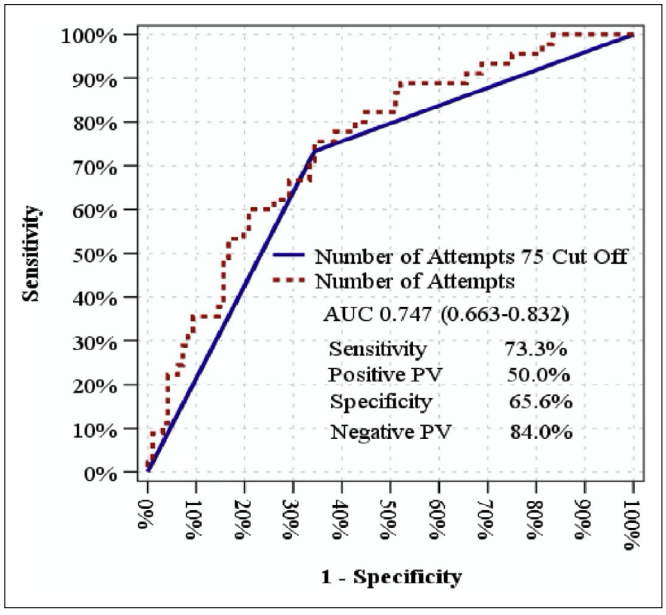

Figure 1. Sensitivity graph for distinguishing patients with ≥60 and <60 surgeries at the cutoff value of 75 surgeries.

in 9 patients, whereas in the group after 75 patients, conversion was required in 3 patients. Despite the higher proportion, the difference was not statistically significant (p>0.05) (as described in Table 3).

When patients were divided into groups of 25, the duration decreased to less than 60 minutes as it approached the upper level of the 25 groups. (Fig. 2).

Discussion

Traditionally, surgical training in surgical disciplines has been conducted based on the master–apprentice relationship according to the fundamental training principles of the specialties. However, when minimally invasive surgery was defined, even instructors with master qualifications were not fully adept in this area. In surgery, the term "learning curve" is used to describe the acquisition of surgical skills necessary to perform a surgical procedure safely, adequately, and effectively.[13]

Table 3. Comparison of patients below and above the cutoff value of 75

	Number of Surgeries ≤75 (Mean±SD/n-%)	Number of Surgeries >75 (Mean±SD/n-%)	p
Total Number of Patients	75	66	
Age	47.7±15.5	49.4±13.9	0.592[m]
Gender			
Female	7 (9.3)	3 (4.5)	0.269[X²]
Male	68 (90.7)	63 (95.5)	
BMI (kg/m^2)	24.4±2.4	25.2±1.9	0.002[m]
ASA Score			
I	28 (37.3)	18 (27.3)	0.301[X²]
II	37 (49.3)	34 (51.5)	
III	10 (13.3)	14 (21.2)	
Side of hernia			
Right	42 (56.0)	32 (48.5)	0.373[X²]
Left	33 (44.0)	34 (51.5)	
Direct hernia (D)	20 (26.7)	22 (33.3)	0.304[X²]
Indircet Hernia (ID)	39 (52.0)	35 (53.0)	0.808[X²]
D-ID	10 (13.3)	15 (22.7)	0.073[X²]
Femoral hernia			
(-)	73 (97.3)	63 (95.5)	0.547[X²]
(+)	2 (2.7)	3 (4.5)	
Fixation			
(-)	58 (77.3)	52 (78.8)	0.054[X²]
(+)	17 (22.7)	14 (21.2)	
Veres needle			
(-)	62 (82.7)	59 (89.4)	0.253[X²]
(+)	13 (17.3)	7 (10.6)	
Hospitalization Day			
I Day	56 (74.7)	55 (83.3)	0.210[X²]
II Day	19 (25.3)	11 (16.7)	
Operation Time (minute)	73.1±15.3	59.5 ±11.8	0.000[m]
> 60 Minute	63 (84)	33 (50)	
≤ 60 Minute	12 (16)	33 (50)	
Drain			
(-)	41 (54.7)	40 (60.6)	0.477[X²]
(+)	34 (45.3)	26 (39.4)	
Duration of drain use (number of days).	3.2±1.8	2.9±1.3	0.978[m]
Conversion to another method			
(-)	66 (88)	63 (95.45)	
(+)	9 (12.0)	3 (4.55)	0.20[X²]
Complications			
(-)	70 (93.3)	63 (93.9)	0.883[X²]
(+)	5 (6.7)	4 (6.1)	
Hematoma			
(-)	74 (98.7)	65 (98.5)	1.000[X²]
(+)	1 (1.3)	1 (1.5)	
Seroma			
(-)	71 (94.7)	64 (97.0)	0.499[X²]
(+)	4 (5.3)	2 (3.0)	
Mesh Infection			
(-)	75 (100.0)	65 (98.5)	0.468[X²]
(+)	0 (0.0)	1 (1.5)	

[X²], Ki-square test (Fischer test); [m]Mann-Whitney U test; SD: standard deviation; BMI: body mass index; ASA: American Society of Anesthesiologists.

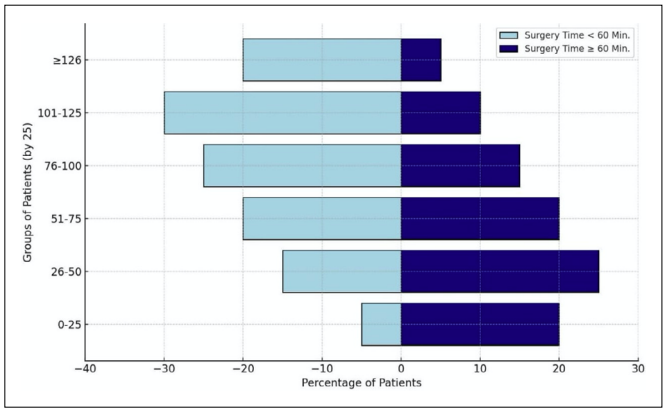

Figure 2. Distribution of surgery times <60 and ≤60 minutes when patients were divided into groups of 25.

The European Hernia Society (EHS) guidelines advocate open Lichtenstein and laparoscopic techniques (TEP and TAPP) as the best evidence-based treatment options for primary unilateral inguinal hernia repair, provided that the surgeon has sufficient experience and that the necessary resources for the specific procedure are available.[6,14]

TEP and TAPP are superior in terms of recovery, postoperative pain, and chronic pain. Additionally, laparoscopic techniques appear to be safe and cost-effective in high-volume centers and skilled hands. However, the guidelines note a well-documented difference in favor of Lichtenstein concerning the LC and initial costs.[5] In our study, we attempted to evaluate a surgeon's TEP performance learning curve using neither supervision control nor a balloon dissector.

According to the EHS guidelines, the LC for laparoscopic-endoscopic repair, especially TEP, appears to be longer than that of the Lichtenstein technique, varying between 50 and 100 procedures, with the first 30–50 being the most critical.[5] Owing to the rarity yet seriousness of complications reported, laparoscopic techniques should be learned under proper supervision if possible.[6] Nevertheless, publications suggest that surgeons with sufficient laparoscopic experience can successfully perform laparoscopic TEP repair unsupervised by observing a supervisor.[15]

Publications indicate that the LC for laparoscopic TEP repair reflects that the operative time decreases to less than one hour or reaches a stable plateau after 65 or more than 100 repairs.[16,17] In different series, the operative time was found to be between 58 and 89 minutes.[4,18,19] Moreover, the average operative time varies from surgeon to surgeon, independent of the timeline for reaching a plateau in the surgeon's learning curve. Indeed, in a study comparing the learning curves of three surgeons in the same clinic, the operative time decreased below the plateau level of 40 minutes after 51, 71, and 81 surgeries, respectively.[20] In our study, 75 surgeries were found to be significant in differentiating patients with operative times of ≥60 and <60 minutes. In the group with more than 75 surgeries, the operative time was significantly ($p<0.05$) lower than that in the group with 75 surgeries or fewer (Table 3).

When evaluated in terms of early recurrence, recurrence was observed in one patient within the first month among the patients in the LC. There was a total of 141 patients, with a recurrence rate of 0.79%. No early recurrences were observed in subsequent patients. When patients with early recurrence were questioned, they reported pain and swelling after lifting heavy weight. In a study comparing TEP and TAPP hernias, only one recurrence was detected among 325 TEP surgeries, which corresponds to 0.28%.[21]

Surgeons who frequently perform the procedure have different LC and complication rates than those who operate sporadically and medical residents.[22] There is evidence that even after 400 cases, the operative time, conversion rate, and short-term complication rates continue to decrease.[23] In a published study, as the surgeon's experience increased, the transition rates to open or TAPP significantly decreased; the rate was 17% in the first 100 cases and decreased to 2.2% in the last 500 cases.[24] In our study, the rate decreased from 12% to 6.1%. In the ≤75 surgeries group, 9 patients transitioned to a different method, whereas in the >75 surgeries group, 3 patients transitioned to a different method ($p>0.05$). Although not statistically significant, a clear decrease was observed in the transition to different methods.

Patients in the LC period were noted to have a BMI below 25 and to be in line with the recommendations for patient selection. Literature reviews indicate that having a BMI >25 not only increases the likelihood of complications but also introduces technical difficulties.[25,26] In one study, it was suggested that younger patients be selected during the LC stage, whereas females were shown to have a high risk of recurrence.[25] Surgical procedures for direct hernias are easier and shorter in duration.[18] In our study, there was no difference in patient age, sex distribution, ASA score, or hernia type between the groups with ≤75 and >75 surgeries, and both groups were homogeneous. Only the BMI value was significantly ($p<0.05$) greater in the group with a surgery duration >75 than in the group with a surgery duration ≤75 (Table 3). However, the com-

pletion of the LC and the fact that the threshold of 25 in the literature has not been significantly exceeded may have reduced its negative effects on the outcomes. No significant (p>0.05) differences were observed in the complication rates (hematoma, seroma, and mesh infection rates) between the ≤75 and >75 surgeries groups.

The LC stage can be evaluated significantly in terms of risk. The total complication rate was lower for those under 60 years of age, whereas when evaluated separately for hematoma, seroma, and mesh infection, no statistically significant difference was found. The need for drains and the number of drain days were found to be greater in relation to the duration of surgery.

TEP herniorrhaphy, performed without a supervisor and without a balloon dissector, resulted in a decrease in the average operative time after the 75th repetition and then stabilized, with no additional difference in terms of complications detected.

Limitations

The study is retrospective and was conducted by a single surgeon; thus, it is worthwhile to note that technical capabilities may vary among surgeons. Multicenter studies comparing a diverse range of surgeons and socioeconomically heterogeneous populations are necessary to provide a more comprehensive and precise analysis of the development of the LC.

Conclusion

Surgeons with sufficient laparoscopic experience can safely learn TEP hernia repair without a supervisor and without the use of a balloon dissector, which contributes to increased costs. In our study, a stable plateau was reached at or below the 60th minute in 75 patients.

Disclosures

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Ethichs Committee Approval: Prior to the study, ethical approval was obtained from the Dogus University Ethics Committee (Date: 13.06.2024 No: 2024/96).

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Authorship Contributions: Conception - Y.Ö., Y.B.K.; Design - Y.Ö., Y.B.K., S.E.; Supervision – S.E.; Data Collection and/or Processing - Y.Ö., Y.B.K., S.E.; Analysis and/or Interpretation – Y.Ö., Y.B.K.; Literature Review – Y.Ö., S.E.; Writer – Y.Ö.; Critical Review – Y.B.K., S.E.

References

1. Komorowski AL. History of the inguinal hernia repair. In: Komorowski AL (ed). Inguinal Hernia. London: InTech Open; 2014.
2. Köckerling F, Simons MP. current concepts of inguinal hernia repair. Visc Med 2018;34(2):145–50.
3. Ergenç M, Uprak TK. A comparative study of abdominal wall hernia surgery before and after the COVID-19 pandemic: Results from a 2-year observational period. Int J Abdom Wall Hernia Surg 2023;6(3):171–5.
4. Ergenç M, Gülşen T. Laparoscopic inguinal hernia repair: A comparison of transabdominal preperitoneal and total extraperitoneal techniques - Results of initial experiences. Int J Abdom Wall Hernia Surg 2023;6(3):166–70.
5. Tran H. Endorsement of the HerniaSurge guidelines by the Australasian Hernia Society. Hernia.2018;22(1):177.
6. Stabilini C, van Veenendaal N, Aasvang E, Agresta F, Aufenacker T, Berrevoet F, et al. Update of the international HerniaSurge guidelines for groin hernia management. BJS Open 2023;7(5):zrad080.
7. Bansal VK, Krishna A, Misra MC, Kumar S. Learning curve in laparoscopic inguinal hernia repair: Experience at a tertiary care centre. Indian J Surg 2016;78(3):197–202.
8. Köckerling F, Sheen AJ, Berrevoet F, Campanelli G, Cuccurullo D, Fortelny R, et al. The reality of general surgery training and increased complexity of abdominal wall hernia surgery. Hernia 2019;23(6):1081–1091.
9. Haidenberg J, Kendrick ML, Meile T, Farley DR. Totally extraperitoneal (TEP) approach for inguinal hernia: the favorable learning curve for trainees. Curr Surg 2003;60(1):65–8.
10. Tazaki T, Sasaki M, Kohyama M, Sugiyama Y, Yamaguchi T, Takahashi S, et al. A single surgeon's experience of 1000 consecutive transabdominal preperitoneal repair cases and measures to prevent recurrence. Int J Abdom Wall Hernia Surg 2022;5(2):69–76.
11. Lim JW, Lee JY, Lee SE, Moon JI, Ra YM, Choi IS, et al. The learning curve for laparoscopic totally extraperitoneal herniorrhaphy by moving average. J Korean Surg Soc 2012;83(2):92–96.
12. Ozel Y, Kara YB. Comparison of clinical outcomes of laparoscopic totally extraperitoneal (TEP) and transabdominal preperitoneal (TAPP) techniques in bilateral inguinal hernia repair: A retrospective study. Cureus 2024;16(9):e69134.
13. Köckerling F. What is the influence of simulation-based training courses, the learning curve, supervision, and surgeon volume on the outcome in hernia repair?-A systematic review. Front Surg 2018;5:57.

14. Ertekin SC, Ergenç M. Mini transabdominal preperitoneal repair (mTAPP) of inguinal hernia: Better to use three 5 mm trocars. Curr Probl Surg 2024;61(11):101609.
15. Peterman NJ, Li RL, Kaptur BD, Yeo EG, Yang D, Keita P, Carpenter K. Evaluation of Regional Geospatial Clusters in Inguinal Hernia Repair. Cureus 2022;14(6):e26381.
16. Lau H, Patil NG, Yuen WK, Lee F. Learning curve for unilateral endoscopic totally extraperitoneal (TEP) inguinal hernioplasty. Surg Endosc 2002;16(12):1724–8.
17. Suguita FY, Essu FF, Oliveira LT, Iuamoto LR, Kato JM, Torsani MB, et al. Learning curve takes 65 repetitions of totally extraperitoneal laparoscopy on inguinal hernias for reduction of operating time and complications. Surg Endosc 2017;31(10):3939–45.
18. Toma H, Eguchi T, Toyoda S, Okabe Y, Kobarai T, Naritomi G, et al. A 10-year experience of totally extraperitoneal endoscopic repair for adult inguinal hernia. Surg Today 2015;45(11):1417–20.
19. Odabaşı M, Özkan E, Eriş C, Kamil Yıldız M, Kaya B, Aktekin A, et al. Comparision of the usage of slit and non-slit meshes in laparoscopic total extraperitoneal hernia repair. J Surg Arts [in Turkish] 2014;7(1):11–4.
20. Goksoy B, Azamat IF, Yilmaz G, Sert OZ, Onur E. The learning curve of laparoscopic inguinal hernia repair: a comparison of three inexperienced surgeons. Wideochir Inne Tech Maloinwazyjne 2021;16(2):336–46.
21. Cao C, Shi X, Jin W, Luan F. Clinical data analysis for treatment of adult inguinal hernia by TAPP or TEP. Front Surg 2022;9:900843.
22. Meyer A, Bonnet L, Bourbon M, Blanc P. Totally extraperitoneal (TEP) endoscopic inguinal hernia repair with TAP (transversus abdominis plane) block as a day-case: A prospective cohort study. J Visc Surg 20151;152(3):155–9.
23. Schouten N, Simmermacher RK, van Dalen T, Smakman N, Clevers GJ, Davids PH, et al. Is there an end of the "learning curve" of endoscopic totally extraperitoneal (TEP) hernia repair? Surg Endosc 2013;27(3):789–94.
24. Feliu-Palà X, Martín-Gómez M, Morales-Conde S, Fernández-Sallent E. The impact of the surgeon's experience on the results of laparoscopic hernia repair. Surg Endosc 2001;15(12):1467–70.
25. Schouten N, Elshof JWM, Simmermacher RKJ, Van Dalen T, De Meer SGA, Clevers GJ, et al. Selecting patients during the "learning curve" of endoscopic Totally Extraperitoneal (TEP) hernia repair. Hernia 2013;17(6):737–43.
26. Kara YB, Ozel Y, Yardimci S. Efficacy of omentopexy on complications of laparoscopic sleeve gastrectomy. Obes Surg 2024;34(9):3298–305.