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Comparison of Outcomes of Total Extraperitoneal Repair and Transabdominal Preperitoneal Approach in Inguinal Hernia Surgery

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ABSTRACT

Objective: This study compares the outcomes of transabdominal preperitoneal (TAPP) and totally extraperitoneal (TEP) techniques in inguinal hernia repair, focusing on the relationship between the number of tacks used for mesh fixation and the incidence of chronic postoperative pain. Despite advancements in minimally invasive surgery, chronic pain remains a significant complication.

Methods: This retrospective study analyzes retrospectively collected data from patients who underwent elective laparoscopic inguinal hernia repair (TEP or TAPP) between 2019 and 2023. It compares early and late postoperative complications, examining the relationship between the number of tacks used for mesh fixation and chronic pain or recurrence.

Results: This study includes 164 patients who underwent TEP (n=117) or TAPP (n=47) for inguinal hernia repair. No significant differencec in chronic pain and recurrence rates between the groups were detected. TAPP patients had larger hernias (p=0.024), had more frequent recurrent operations (p=0.042), and higher seroma rates (p=0.003). Operative times and tack numbers were greater in TAPP (p=0.086, p<0.001). American Society of Anesthesiologists class 3, presence of recurrence, and early hematoma were associated with recurrence. Chronic pain correlated with the number of tacks used for mesh fixation (p=0.001) but not with seroma or hematoma (p=0.313, p=0.578). Recurrence rates were similar between groups (p=0.228). The number of tacks used was identified as an independent risk factor for chronic pain in the multivariate analysis (p=0.001, odds ratio: 5,103, %95 confidence intervals: 2,093-12,446).

Conclusion: Comparisons between TEP and TAPP techniques have shown similar outcomes in terms of intraoperative and postoperative complications. Reducing the number of mechanical fixations may help decrease the incidence of chronic pain.

Keywords: Minimal invasive surgery, inguinal hernia, totally extraperitoneal, transabdominal preperitoneal

INTRODUCTION

In recent years, the role of minimally invasive surgery (MIS) in the treatment of inguinal hernia has significantly expanded. Among these, transabdominal preperitoneal (TAPP) and totally extraperitoneal (TEP) techniques are the most employed minimally invasive approaches in inguinal hernia repair. In high-resource countries, the rates of TAPP and TEP procedures have significantly increased. According to the German Herniamed registry, TAPP and TEP account for 64% of inguinal hernia surgeries (1). In the TAPP technique, hernia repair is performed with a wider field of view by accessing the preperitoneal space through entry into the abdominal cavity; however, this approach carries a higher risk of intra-abdominal organ injury. In contrast, the TEP technique reaches the preperitoneal space without entering the abdominal cavity, though with a more restricted field of view (2). The TEP technique requires a longer learning curve compared to TAPP; however, both methods are complex procedures that demand an extended learning curve (3). Advances in surgical techniques, a more comprehensive understanding of the myopectineal orifice anatomy, and the development of superior prosthetic materials have collectively enhanced the success of minimally invasive inguinal hernia surgery (4). It offers advantages such as reduced postoperative pain, earlier return to work, fewer wound site complications, and prevention of new hernia formation by covering the entire myopectineal orifice with mesh (5). With increased surgical experience and a more detailed understanding of the myopectineal orifice anatomy, recurrence rates in MIS for inguinal hernia have shown comparable outcomes to open surgery in recent studies (6). Despite these improvements, chronic postoperative pain remains the primary limitation of minimally invasive inguinal hernia surgery (7). Various studies have been conducted to mitigate this drawback associated with MIS (8,9).

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Postoperative chronic pain remains the most significant complication associated with MIS in hernia repair. While the incidence of chronic postoperative pain ranges from 0.75% to 75%, the incidence of chronic pain that impacts daily life is between 2% and 12%. This wide range is thought to be due to variations in the definition of chronic pain (9). Although its pathophysiology is not yet fully understood, various studies have investigated its risk factors. The aim of this study is to compare the outcomes of patients who underwent TEP or TAPP procedures, and to explore the relationship between the number of tacks used for mesh fixation and the incidence of chronic pain.

METHODS

This research was conducted in accordance with the principles outlined in the Declaration of Helsinki. Written informed consent was obtained from all participants prior to their inclusion in the study. Ethical approval was granted by the University of Health Sciences Türkiye, Gaziosmanpaşa Training and Research Hospital Non-Interventional Ethics Committee (approval no: 67, date: 20.11.2024).

Data from patients who underwent laparoscopic inguinal hernia repair between 2019 and 2023 were retrospectively analyzed. The study included patients aged 18 to 80 years who underwent elective TEP or TAPP procedures for primary or recurrent groin hernias. Exclusion criteria included patients with incomplete preoperative data (e.g., missing demographic information, comorbid conditions, or hernia characteristics), those without at least one year of postoperative follow-up data, and those who underwent emergency surgery due to strangulation or bowel obstruction. Additionally, patients with previous pelvic surgery or pelvic radiation therapy that would affect the feasibility of laparoscopic repair were excluded. Furthermore, cases for which the surgical report did not specify the number and type of tacks used during the procedure were excluded from the analysis (Figure 1).

Patient characteristics, including hernia size, hernia side, history of recurrence, body mass index (BMI), and history of heavy sports or labor, were documented. Preoperative clinical and demographic characteristics, intraoperative complications, characteristics of the mesh and tacks used, and early (within the first 90 days) and late (after 90 days) postoperative complications were recorded through a review of hospital records. The HerniaSurge group defines postoperative chronic pain as moderate pain lasting longer than 3 months and impacting daily life. In our study, we also set 90 days as the threshold period to identify chronic complications and diagnosed chronic pain according to this definition (10). The patients were categorized into two groups according to the surgical technique performed: TEP and TAPP. Postoperative complications, both early and late, were evaluated and compared between these groups. For subgroup analysis, patients were categorized based on the development of chronic pain and recurrence to identify risk factors associated with these outcomes. Variables with a p-value <0.1 in univariate analysis were further assessed separately through multivariate analysis, for chronic pain and recurrence. The diagnosis of inguinal hernia was established through ultrasound and physical examination. The diagnoses of hematoma, seroma, recurrent, and ischemic orchitis were confirmed using ultrasound and Doppler imaging. All TAPP and TEP procedures were performed by surgeons experienced in MIS. General anesthesia was administered for all patients. A minimum 10 cm x 15 cm polypropylene mesh was used in each case. In cases where mesh fixation was performed, a variable number of absorbable tacks were used, ensuring that tacks were anchored at least 2 cm superior to the iliopubic tract. For TAPP procedures, the peritoneum was closed with absorbable barbed sutures. All patients underwent surgery using one 10 mm trocar and two 5 mm trocars, without routine use of a bladder catheter.

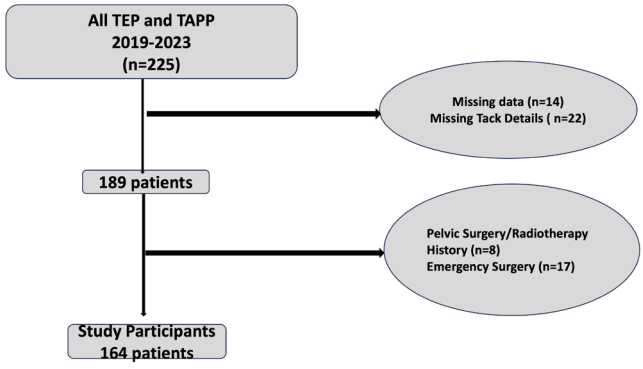

Figure 1. Flowchart for patient selection
TEP: Total extraperitoneal, TAPP: Transabdominal preperitonea

Statistical Analysis

Statistical analyses were performed using SPSS version 27.0. The assessment of data distribution normality was conducted via the Kolmogorov-Smirnov test. For normally distributed data, results were expressed as mean±standard deviation, while non-normally distributed data were reported as median and interquartile range. Independent group comparisons were carried out using the Student's t-test for normal distributions and the Mann-Whitney U test for non-normal distributions. Categorical variables were analyzed using the chi-square test or Fisher's exact test. Variables with a p-value <0.1 in univariate analysis were pre-selected for inclusion in the multivariate logistic regression model. Logistic regression was utilized to determine independent risk factors, and the odds ratio (OR) and 95% confidence intervals (CI) were calculated. Statistical significance was defined as a p-value <0.05. The goodness-of-fit of both logistic regression models was assessed using the Hosmer-Lemeshow test, which evaluates whether the observed event rates match expected event rates.

RESULTS

In this study, 164 consecutive patients who underwent TEP (n=117) and TAPP (n=47) for inguinal hernia were included. Of these, 18 (10.98%) were female, and 146 (89.02%) were male. A statistically significant higher number of patients in the TAPP group had hernias larger than 3 cm (p=0.024). Additionally, the TAPP group

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Table 1. Demographic and preoperative characteristics of patients

Variables		Group 1: TEP (n=117)	Group 2: TAPP (n=47)	p-value
Age (mean±SD)		49.91±13.10	49.34±13.11	0.803
BMI (median-IQR)		26.30-2.99	25.95-3.38	0.481
Height in cm (median-IQR)		78.00-11.00	77.00-7.00	0.861
Weight in kg (median-IQR)		170,00-6.00	170-8.00	0.282
Type of hernia	Indirect n,%	89 (76.10%)	33 (70.20%)	0.142
	Direct n,%	24 (20.50%)	11 (23.40%)	
	Femoral n,%	0 (0.00%)	2 (4.30%)	
	Combined n,%	4 (3.40%)	1 (2.10%)	
Hernia side	Right n,%	39 (33.30%)	23 (48.90%)	0.842
	Left n,%	29 (24.80%)	9 (19.10%)	
	Bilateral n,%	49 (41.90%)	15 (31.90%)	
Hernia size	<1.5 cm n,%	56 (47.90%)	17 (36.20%)	0.024
	1.5-3 cm n,%	53 (45.30%)	20 (42.60%)	
	>3 cm n,%	8 (6.80%)	10 (21.30%)	
Follow-up duration (in months) (median-IQR)		17.00-22.00	16.00-17.00	0.504
History of heavy labor or sports, yes n,%		66 (56.40%)	25 (53.20%)	0.708
Presence of recurrence, yes n,%		16 (13.70%)	13 (27.70%)	0.042
Smoking	Yes (n,%)	52 (44.40%)	24 (51.10%)	0.491
	No (n,%)	23 (48.90%)		
Sex	Female n, %	9 (7.70%)	9 (19.10%)	0.051
	Male n, %	38 (80.90%)		
ASA class	1,2 (n, %)	114 (97.40%)	46 (97.90%)	1.000
	3, (n, %)	1 (2.10%)		

IQR: Interquartile range, BMI: Body mass index, ASA: American Society of Anesthesiologists, TAPP: Transabdominal pre-peritoneal, TEP: Totally extraperitoneal repair, SD: Standard deviation

Table 2. Comparison of intraoperative characteristics and early and late postoperative complications

Variables		Group 1: TEP (n=117)	Group 2: TAPP (n=47)	p-value
90-day complications	None n, %	77 (65.8%)	21 (44.7%)	
	Hematoma n, %	8 (6.8%)	3 (6.4%)	1.000
	Seroma n, %	22 (18.8%)	20 (42.6%)	0.003
	Pain n, %	2 (1.7%)	1 (2.1%)	0.198
	Ischemic orchitis n, %	4 (%3.4)	0 (0.0%)	0.579
	Recurrence n, %	4 (3.4%)	2 (4.3%)	1.000
Intraoperative complications	None n, %	103 (88.0%)	43 (91.5%)	
	Hemorrhage n, %	5 (4.3%)	2 (4.3%)	1.000
	Conversion to open surgery n, %	4 (3.4%)	1 (2.1%)	1.000
	Anesthesia complication n,%	0 (0.0%)	1 (2.1%)	0.287
Late-term complications	None n, %	105 (89.7%)	39 (83.0%)	
	Chronic pain n, %	8 (6.8%)	4 (8.5%)	0.744
	Recurrence n, %	4 (3.4%)	4 (8.5%)	0.228
Operation time (in min) (median-IQR)		60.00-25.00	70.00-15.00	0.086
Number of tacks used for mesh fixation (median-IQR)		4.00-2.00	4.00-1.00	**<0.001**

IQR: Interquartile range, TAPP: Transabdominal pre-peritoneal, TEP: Totally extraperitoneal repair

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had a higher proportion of patients who underwent surgery due to recurrent inguinal hernia (27.70% vs. 13.70%, p=0.042) (Table 1). Among early complications, only seroma occurred at a significantly higher rate statistically in the TAPP group (p=0.003). While early recurrence rates were similar, ischemic orchitis was observed in 4 (3.4%) patients in the TEP group. No significant difference was observed between the groups concerning chronic pain and recurrence rates (p=0.744, p=0.228). Although not statistically significant, the median operative times were longer in the TAPP group (70.00-1.00 minutes vs. 60.00-25.00 minutes, p=0.086). Patients in the TAPP group underwent mesh fixation with a higher number of tacks (p<0.001) (Table 2). Conversion to TAPP was required in 5 (4.3%) patients initially planned for TEP, and their data were analyzed in the TAPP group. The presence of ASA class 3 comorbidities, recurrence, and the development of early postoperative hematoma was found to be associated with recurrence (Table 3). In multivariate analysis, the ASA classification was not found to be significant for recurrence. However, recurrence and early postoperative hematoma were identified as independent risk factors for recurrence (OR: 6,537, p=0.029, 95% CI: 1,210-35,330; OR: 8,109, p=0,039, 95% CI: 1,111-59,185, respectively) Table 4. The occurrence of early hematoma and seroma was not found to be associated with chronic pain, with p=0.578 for hematoma and p=0.313 for seroma, respectively (Table 3). The number of tacks used for mesh fixation was an independent risk factor for chronic pain (p=0.001, OR: 5,103, 95% CI: 2,093-12,446) but was not associated with recurrence (p=0.557) (Table 4). The Hosmer-Lemeshow test results demonstrated a good fit for the models, with p=0.741 for the chronic pain model and p=0.719 for the recurrence model, indicating no significant difference between observed and predicted outcomes.

Table 3. Subgroup analysis based on chronic pain and recurrence status

Variables		Chronic pain group (n=12)	Non-chronic pain group (n=152)	p-value	Recurrent group (n=8)	Non-recurrent group (n=156)	p-value
Number of tacks used for mesh fixation median (IQR)		5.00 (1.00)	4.00 (1.00)	**<0.001**	4.00 (0.00)	4.00 (1.00)	0.557
BMI median (IQR)		25.73 (3.23)	26.28 (3.16)	0.716	27.68 (2.09)	26.15 (3.19)	0.158
Height median (IQR)		170.00 (9.00)	170.00 (6.00)	0.995	170.00 (6.00)	170.00 (6.00)	0.265
Weight median (IQR)		77.50 (6.00)	78.00 (9.00)	0.929	80.00 (12.00)	78.00 (8.00)	0.693
Age median (IQR)		54.50 (20.00)	51.00 (16.00)	0.394	51.00 (18.00)	51.00 (18.00)	0.593
Sex, male n, %		11 (91.7%)	135 (89.4%)	1.000	6 (75.0%)	140 (89.7%)	0.214
Operation duration median (IQR)		72.50 (18.00)	64.50 (20.00)	0.103	70.00 (4.00)	64.50 (20.00)	0.385
ASA classification, ASA 3/4 n, %		0 (0.00%)	4 (2.6%)	1.000	2 (25.0%)	2 (1.3%)	**0.012**
Hernia size	<1.5 cm n, %	6 (50.0%)	67 (44.4%)	0.659	1 (12.5%)	72 (46.2%)	0.600
	1.5-3 cm n, %	4 (33.3%)	69 (45.4%)		7 (87.5%9	66 (42.3%)	
	>3 cm n, %	2 (16.7%)	16 (10.5%)		0 (0.0%)	18 (11.5%)	
Smoking, yes n, %		7 (58.3%)	69 (45.4%)	0.387	4 (50.0%)	72 (46.2%)	1.000
History of heavy labor or sports, yes n, %		9 (75.0%)	82 (53.9%)	0.158	5 (62.5%)	86 (55.1%)	0.733
Presence of recurrence		4 (33.3%)	25 (16.4%)	0.228	4 (50.0%)	25 (16.0%)	**0.034**
Early hematoma		1 (8.3%)	10 (6.6%)	0.578	3 (37.5%)	8 (5.1%)	**0.011**
Seroma		5 (41.7%)	40 (26.3%)	0.313	3 (37.5%)	42 (26.9%)	0.685

IQR: Interquartile range, BMI: Body mass index, ASA: American Society of Anesthesiologists

Table 4. Logistic Regression Analysis of Variables Associated with chronic pain and recurrence

Logistic regression models		Odds ratio	%95 CI	p-value
Variables associated with chronic pain	Number of tacks used for mesh fixation	5.103	2.093-12.446	**<0.001**
Variables associated with recurrent	ASA classification, ASA 3	15.311	0.971-241.363	0.052
	Presence of recurrence	6.537	1.210-35.330	**0.029**
	Early hematoma	8.109	1.111-59.185	**0.039**

CI: Confidence interval, ASA: American Society of Anesthesiologists

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DISCUSSION

Minimally invasive techniques, particularly laparoscopic approaches, have revolutionized inguinal hernia repair, offering advantages such as reduced postoperative pain and faster recovery. While open repair remains a commonly performed technique, laparoscopic methods, including TAPP and TEP approaches, have gained widespread acceptance due to their potential benefits. A comprehensive meta-analysis comparing open and laparoscopic inguinal hernia repairs demonstrated that laparoscopic techniques are associated with reduced postoperative pain and a shorter recovery period, while recurrence rates remain comparable between the two approaches (11). Furthermore, among laparoscopic techniques, it is still unclear whether TEP or TAPP provides better outcomes, as both methods have shown similar efficacy in previous studies (12). Given this ongoing uncertainty, our study aimed to directly compare TEP and TAPP to further clarify their respective advantages and potential drawbacks. Consistent with prior research, our findings revealed no statistically significant differences between the two techniques in terms of recurrence or chronic pain. However, we observed that the number of tacks used during the procedure was associated with an increased incidence of chronic pain, suggesting that fixation strategies may play a critical role in postoperative outcomes.

A population-based study conducted between 1995 and 2006, comparing the short-term outcomes of over 4,500 patients who underwent either TEP or TAPP, reported a significantly higher rate of intraoperative and postoperative complications with the TEP technique. The same study also found a longer operative time for TEP (66.6 minutes vs. 59.0 minutes, p<0.001). Conversely, the length of hospital stay was significantly longer in patients who underwent TAPP (2.9 vs. 2.3 days, p=0.002) (2). Two recent meta-analyses of randomized controlled trials have shown no significant difference between TEP and TAPP regarding postoperative pain, hematoma, seroma, and recurrence rates (5,13). Although earlier studies with large cohorts conducted during the initial years of laparoscopic hernia surgery, suggested that TEP might be at a disadvantage, recent research indicates no significant differences in postoperative complications between TAPP and TEP. This shift may be attributed to a better understanding of the procedure, improved knowledge of myopectineal orifice anatomy, and advances in laparoscopic equipment with enhanced image quality. Krishna et al. (14) reported no significant difference in operative time between TEP and TAPP in a cohort of 100 MIS patients (p=0.343); and, unlike our study, they observed a higher incidence of seroma in TEP cases (37.8% vs. 17.0%, p=0.021). In the same study, a cost comparison between TEP and TAPP showed no statistically significant difference (14). Although we did not conduct a formal cost analysis for each case, the relatively higher cost of TAPP at our center may be attributed to the greater number of tacks used and the application of absorbable barbed sutures for peritoneal closure. In our study, seroma was found to be significantly more prevalent in the TAPP group (18.8% vs. 42.6%, p=0.003), while hematoma, postoperative pain, and early recurrence rates were comparable. The higher seroma rate observed in the TAPP group could be related to the larger proportion of patients with hernias exceeding 3 cm and/or recurrent hernias in this group (15).

In a study on bilateral inguinal hernias, Hidalgo et al. (16) reported a significant increase in laparoscopic surgery, rising from 22% in 2016 to 94% in 2020. At our center, as the rates of laparoscopic hernia surgery have increased over the years, approximately 30% of all inguinal hernias in 2023 were treated laparoscopically. In the same study, 46% of cases utilized the TEP approach, while 54% employed TAPP. Although TAPP had a significantly longer operation time (107.2±31.29 vs. 82.99±30.84 minutes, p<0.001), there were no statistically significant differences in postoperative complications (any complication, p=0.672) (16). Some studies have also documented longer operative times for TEP compared to TAPP. In our cohort, there were 65 patients with bilateral inguinal hernia, with 49 (75%) undergoing TEP and 15 (25%) undergoing TAPP. All TAPP cases demonstrated a trend toward longer operation times (25.00-60.00 vs. 15.00-70.00 minutes, p=0.086). Despite reports in the literature indicating longer times for TEP, we find the longer operative times required for TAPP to be reasonable, given the additional peritoneal suturing required and the tendency to prefer TAPP for larger hernias.

Recent randomized controlled trials have demonstrated that laparoscopic hernia surgery reduces the incidence of chronic pain compared to open surgery (5,6,17,18). In a meta-analysis by Scheuermann et al. (19), comparing Lichtenstein repair with TAPP, patients who underwent TAPP experienced significantly lower rates of chronic pain than those in the open surgery group (OR: 0.42, 95% CI: 0.23-0.78, p=0.006). Additionally, studies comparing laparoscopic and open surgery, particularly those conducted in the early years of laparoscopic inguinal hernia repair, have reported mixed results regarding chronic pain, with some indicating no significant difference and others suggesting a higher incidence of chronic pain associated with laparoscopic surgery (20,21).

In a meta-analysis comparing the outcomes of TEP and TAPP, Aiolfi et al. (5) found no significant difference in terms of chronic pain. In a prospective randomized controlled study, pain scores at 1 month and 3 months were significantly higher in the TAPP group compared to the TEP group, but by 6 months, no significant difference was observed between the groups, (respectively, p=0.001, p=0.002, p=0.231) (14). An international study analyzing 782 TEP and 1464 TAPP cases also showed no difference between the techniques in terms of chronic pain. Chronic pain requiring treatment was observed in 4.48% of the TEP patients and 3.41% of the TAPP patients (p=0.206) (22). Similarly, in our study, no significant difference was found between TEP and TAPP in terms of chronic pain (p=0.744).

Female sex, younger age, high preoperative pain sensitivity, surgery for recurrent hernia, open surgery, inadequate mesh fixation, low-weight mesh, early severe pain, postoperative hematoma, and wound infection have been identified as

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independent risk factors for chronic pain following inguinal hernia surgery (23-26). In this study, only the number of tacks used in mesh fixation was found to be a significant risk factor for chronic pain. Kim et al. (26) reported that benign prostatic hyperplasia (BPH) and low BMI were statistically significant risk factors for chronic pain following TEP and TAPP (p=0.035 and p=0.043, respectively). In the multivariate analysis of the same study, BPH was found to be the only significant independent risk factor (OR: 5,363; CI: 1,028-27,962, p=0.046) (26). In this study, no notable correlation was identified between BMI and the development of chronic pain (p=0.716). In their meta-analysis, Shi et al. (24) reported no significant difference in recurrence rates or chronic pain between mesh fixation using fibrin glue and tack fixation methods. Another study found a higher incidence of pain among patients who underwent mesh fixation with non-absorbable staples or self-adhesive mesh. Conversely, in the group where no fixation was applied, a lower incidence of chronic pain was reported (25). Buyukasik et al. (27) conducted a study comparing the outcomes of patients who underwent TEP repair with and without fixation and reported that fixation did not reduce the recurrence rate but increased the risk of complications. A recent randomized controlled trial compared permanent tacks and absorbable tacks in 333 patients who underwent laparoscopic inguinal hernia repair, focusing on their association with chronic pain. The number of tacks used was also identified as a risk factor for chronic pain development. However, in multivariate analysis, neither the type of tack (permanent vs. absorbable) nor the number of tacks was found to be statistically significant in predicting chronic pain outcomes (23). Another randomized controlled trial reported that using more than six tacks significantly increased pain incidence (p=0.008) (28). In the present study, an increase in the number of attacks was also identified as an independent risk factor for chronic pain.

Study Limitations

The primary limitation of the study is its retrospective design. The small number of patients, particulary the limited number of cases undergoing TAPP, represents another important limitation.

CONCLUSION

In conclusion, recent studies have demonstrated that minimally invasive inguinal hernia surgery offers comparable recurrence rates to open surgery, with the added benefit of reduced postoperative pain. Comparisons between TEP and TAPP techniques have shown similar outcomes in terms of intraoperative and postoperative complications. Reducing the number of mechanical fixations may help decrease the incidence of chronic pain.

Ethics

Ethics Committee Approval: Ethical approval was granted by the University of Health Sciences Türkiye, Gaziosmanpaşa Training and Research Hospital Non-Interventional Ethics Committee (approval no: 67, date: 20.11.2024).

Informed Consent: Written informed consent was obtained from all participants prior to their inclusion in the study.

Footnotes

Author Contributions:

Surgical and Medical Practices - M.G., D.G.; Concept - M.G., D.G.; Design - M.G., D.G.; Data Collection and/or Processing - M.G., D.G.; Analysis and/or Interpretation - M.G., D.G.; Literature Search - M.G., D.G.; Writing – M.G., D.G.

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

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