

Original Research Article

Safety, complications and predictors of outcomes in extended totally extraperitoneal inguinal hernia repair: a prospective observational study

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ABSTRACT

Background: Inguinal hernia repair is one of the most commonly performed surgical procedures worldwide. The extended totally extraperitoneal (eTEP) approach has gained increasing acceptance because of its improved visualization, enhanced ergonomics, and reduced postoperative morbidity. However, prospective data regarding its safety profile, postoperative complications, recurrence, and factors influencing surgical outcomes remain limited.

Methods: A prospective observational study was conducted among 60 adult patients undergoing eTEP inguinal hernia repair at a tertiary care center. Demographic characteristics, operative details, intraoperative events, postoperative complications, and recurrence were prospectively recorded. Patients were followed at 1, 3, and 6 months after surgery. Data were analyzed using descriptive and inferential statistics, with a p-value <0.05 considered statistically significant.

Results: The mean age of the study population was 52±10 years, and 75% of patients were male. The mean operative time was 75±15 minutes. Intraoperative complications were uncommon, with 95% of patients experiencing no adverse events. Postoperative complications occurred in 15% of patients, with seroma being the most frequent (8.3%), followed by hematoma (3.3%), surgical site infection (1.7%), and foreign body sensation (1.7%). Recurrence was observed in 3.3% of patients at 3 months and 5.0% at 6 months. Patients aged ≥50 years, those with higher body mass index, and those with bilateral hernias had significantly longer operative times, higher postoperative pain scores, and longer hospital stays (p <0.05).

Conclusions: The eTEP technique is a safe and effective minimally invasive approach for inguinal hernia repair, demonstrating low intraoperative and postoperative complication rates with minimal early recurrence. Advanced age, higher body mass index, and bilateral hernia are associated with less favorable perioperative outcomes and should be considered during preoperative assessment and surgical planning.

Keywords: Hernia, Inguinal, Laparoscopy, Herniorrhaphy, Postoperative complications, Recurrence, Risk factors

INTRODUCTION

Inguinal hernia repair is among the most frequently performed surgical procedures worldwide, with millions of operations conducted annually. Despite advances in surgical techniques, the primary goals of hernia repair remain the same: safe defect closure, prevention of recurrence, and minimization of complications.¹

Postoperative complications such as seroma, hematoma, surgical site infection, chronic pain, and recurrence continue to be important determinants of long-term surgical success and patient satisfaction.² Traditionally, open mesh repair techniques such as the Lichtenstein procedure have been considered the gold standard. However, these approaches are associated with certain limitations, including increased postoperative pain,

wound-related complications, and delayed recovery.³ With the advent of minimally invasive surgery, laparoscopic techniques such as Transabdominal Preperitoneal (TAPP) and Totally Extraperitoneal (TEP) repair have gained widespread acceptance due to their advantages of reduced tissue trauma, lower postoperative pain, and quicker return to normal activity.⁴

The extended totally extraperitoneal (eTEP) technique is a relatively recent advancement that builds upon the principles of conventional TEP repair. By providing an expanded working space and improved ergonomics, eTEP facilitates better visualization of anatomical landmarks and allows for more precise mesh placement.⁵ Importantly, the extraperitoneal approach avoids entry into the peritoneal cavity, thereby reducing the risk of intra-abdominal complications such as bowel injury, adhesions, and visceral damage.⁶

While eTEP has shown promising results in terms of feasibility and early recovery, its safety profile and complication rates require further evaluation, particularly in diverse clinical settings. Studies have reported low rates of intraoperative and postoperative complications with laparoscopic hernia repair; however, outcomes may vary depending on patient characteristics, hernia complexity, and surgical expertise.^{7,8} Complications such as seroma formation, hematoma, mesh-related issues, and recurrence remain clinically relevant and may impact long-term outcomes.⁹

In addition to assessing complication rates, identifying predictors of adverse outcomes is essential for optimizing patient selection and improving surgical planning. Factors such as age, body mass index (BMI), hernia type (unilateral vs bilateral), and operative time have been shown to influence surgical outcomes and complication rates in minimally invasive hernia repair.^{10,11} Understanding these associations can help surgeons anticipate potential risks and implement appropriate preventive strategies.

Despite the increasing adoption of the eTEP technique, there is a relative paucity of prospective data focusing on complications, recurrence rates, and predictors of outcomes, especially in the Indian population. Most available studies emphasize technical feasibility and short-term recovery, with limited emphasis on analytical evaluation of risk factors influencing outcomes.^{7,12}

Therefore, the present study was undertaken to evaluate the safety and complication profile of eTEP inguinal hernia repair, along with assessment of recurrence rates and identification of factors influencing postoperative outcomes. The primary objective was to determine intraoperative and postoperative complications, while secondary objectives included evaluation of recurrence and analysis of predictors affecting surgical outcomes. This study aims to provide clinically relevant insights

into the safety and effectiveness of the eTEP technique in routine surgical practice.

METHODS

This study was conducted as a prospective observational study to evaluate the safety profile, complication rates, and predictors of outcomes in patients undergoing extended totally extraperitoneal (eTEP) repair for inguinal hernia. The observational design allowed systematic assessment of perioperative and follow-up outcomes without intervention in standard surgical practice.

The study was carried out in the Department of General Surgery at GMERS Medical College and Civil Hospital, Valsad, a tertiary care referral center with established expertise in laparoscopic hernia surgery. The study was conducted over a period of 18 months, from March 2023 to August 2024, which included patient recruitment, surgical intervention, and follow-up evaluation.

The study included adult patients diagnosed with inguinal hernia who underwent elective surgical repair using the eTEP technique during the study period. All eligible patients presenting to the surgical department and consenting to participate were included.

Inclusion and exclusion criteria

Patients aged 18 years and above with unilateral or bilateral inguinal hernia, who were willing to provide written informed consent, were included in the study. Patients with BMI less than 30 kg/m² and those presenting with simple obstructed hernias without features of strangulation or gangrene were also considered eligible.

Patients were excluded if they had strangulated or gangrenous hernias, recurrent hernias following previous surgical repair, severe comorbid conditions rendering them unfit for anesthesia, chronic cough or prostatic symptoms predisposing to increased intra-abdominal pressure, or pregnancy.

Sample size and sampling method

A total of 60 patients were included in the study based on the number of eligible cases presenting during the study period. A convenient sampling method was used, wherein all consecutive patients fulfilling the inclusion criteria were recruited until the desired sample size was achieved.

Study procedure

All patients underwent detailed preoperative evaluation, including clinical examination, relevant laboratory investigations, and anesthetic assessment. After obtaining informed consent, patients underwent inguinal hernia

repair using the standardized eTEP technique under appropriate anesthesia.

The surgical procedure involved creation of an extraperitoneal working space, reduction of hernia contents, and placement of a polypropylene mesh in the preperitoneal plane. Mesh fixation was performed using sutures, tacks, or glue based on intraoperative requirements. Patients were monitored intraoperatively for complications such as bleeding and peritoneal breach, and appropriate corrective measures were undertaken when necessary.

Postoperatively, patients were managed according to institutional protocols and were monitored for early complications. Follow-up assessments were conducted at 1 month, 3 months, and 6 months to evaluate complications and recurrence.

Data collection

Data were collected prospectively using a pre-designed structured proforma. Variables recorded included demographic details, clinical characteristics, operative findings, intraoperative complications, and postoperative outcomes. Specific emphasis was placed on documenting intraoperative events, postoperative complications (such as seroma, hematoma, wound complications, and foreign body sensation), and recurrence during follow-up. All data were recorded systematically and maintained in a secure database.

Outcome measures

The primary outcome measures included intraoperative complications and postoperative complications. The secondary outcome measures included recurrence rates at 3 and 6-months follow-up, as well as analysis of factors influencing outcomes such as age, BMI, hernia type (unilateral vs bilateral), and operative time. These variables were evaluated to identify potential predictors of complications and recovery.

Statistical analysis

Data were entered into Microsoft Excel and analyzed using appropriate statistical software. Continuous variables were expressed as mean $\pm$ standard deviation, while categorical variables were presented as frequencies and percentages. Inferential statistical tests, including the chi-square test for categorical variables and Student's t-test for continuous variables, were used to assess associations between variables. Multivariate analysis was performed to identify independent predictors of outcomes. A p-value <0.05 was considered statistically significant.

Ethical considerations

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Approval was obtained from the Institutional Human Ethics Committee (IHEC) and Scientific Research Committee (SRC) prior to initiation of the study. Written informed consent was obtained from all participants. Confidentiality of patient information was maintained throughout the study, and participants retained the right to withdraw at any stage without affecting their treatment.

RESULTS

A total of 60 patients who underwent extended totally extraperitoneal (eTEP) repair for inguinal hernia were included in the study. The baseline demographic and clinical profile is summarized in Table 1. The mean age of the study population was 52 ± 10 years, with a predominance of male patients (75%). The mean body mass index (BMI) was 26 ± 3 kg/m². Comorbid conditions were present in a proportion of patients, with hypertension observed in 30% and diabetes mellitus in 20%. The majority of patients had unilateral hernias (80%), while bilateral hernias were present in 20% of cases. Most hernias were primary (91.7%), with recurrent hernias accounting for 8.3%. In terms of anesthetic risk stratification, the majority of patients were classified as ASA Grade II (66.7%), followed by ASA Grade I and III (16.7% each) (Table 1).

Table 1: Baseline demographic and clinical characteristics of patients undergoing eTEP inguinal hernia repair.

Parameters	Category	Frequency (N)	Percentage (%)	Mean $\pm$ SD
Age (in years)	—	—	—	52 $\pm$ 10
Gender	Male	45	75	—
	Female	15	25	—
BMI (kg/m ²)	—	—	—	26 $\pm$ 3
Hypertension	Present	18	30	—
	Absent	42	70	—
Diabetes Mellitus	Present	12	20	—
	Absent	48	80	—
Hernia Type	Unilateral	48	80	—
	Bilateral	12	20	—
Hernia Status	Primary	55	91.7	—

Continued.

Parameters	Category	Frequency (N)	Percentage (%)	Mean±SD
ASA Grade	Recurrent	5	8.3	—
	I	10	16.7	—
	II	40	66.7	—
	III	10	16.7	—

*BMI = Body Mass Index; ASA = American Society of Anesthesiologists physical status classification.

Operative and intraoperative findings are presented in Table 2. The mean operative time was 75 ± 15 minutes. Mesh fixation was most commonly performed using suturing (50%), followed by tacking (33.3%) and gluing (16.7%). Intraoperative complications were infrequent,

with 95% of patients experiencing no complications. Minor bleeding was noted in 3.3% of patients, while peritoneal tear occurred in 1.7% of cases (Table 2). Postoperative complications and recurrence outcomes are summarized in Table 3. The distribution of postoperative complications is illustrated in Figure 1.

Table 2: Operative and intraoperative complications.

Parameters	Category	Frequency (N)	Percentage (%)	Mean±SD
Operative Time (minutes)	-	-	—	75±15
Mesh Fixation Method	Suturing	30	50	—
	Tacking	20	33.3	—
	Gluing	10	16.7	—
Intraoperative Complications	None	57	95	—
	Minor Bleeding	2	3.3	—
	Peritoneal Tear	1	1.7	—

*Data are presented as frequency (n), percentage (%), or mean $\pm$ standard deviation (SD)

Table 3: Postoperative complications and recurrence following eTEP repair.

Parameters	Category	Frequency (N)	Percentage (%)
Recurrence at 3 months	Present	2	3.3
	Absent	58	96.7
Recurrence at 6 months	Present	3	5
	Absent	57	95

*SSI = Surgical site infection.

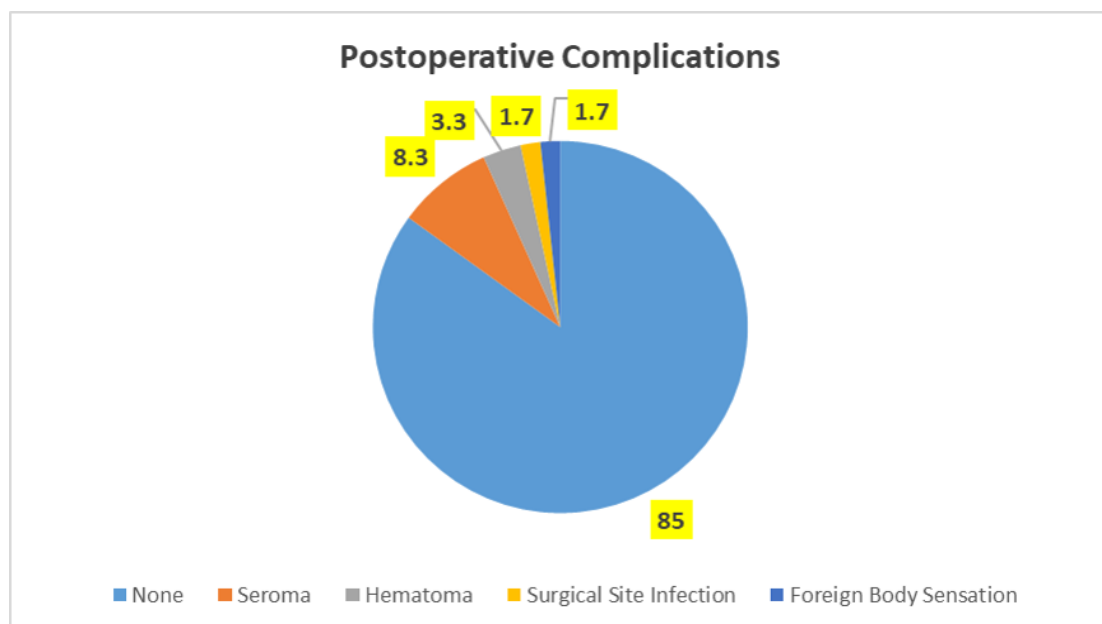


Figure 1: Distribution of postoperative complications among patients.

The majority of patients (85%) had no postoperative complications. Among those who developed complications, seroma was the most common (8.3%), followed by hematoma (3.3%), surgical site infection (1.7%), and foreign body sensation (1.7%). Recurrence was observed in 2 patients (3.3%) at 3 months and in 3 patients (5.0%) at 6 months follow-up. Overall, recurrence rates remained low during the follow-up period (Table 3). The distribution of postoperative complications is illustrated in Figure 1, which demonstrates that seroma constituted the most frequent complication.

Table 4: Factors affecting outcomes (predictor analysis)

Parameters	Group	Outcome	Mean±SD / N (%)	P value
Age in years	≤50	Operative time	70 ± 10	0.04*
	≥50	Operative time	78 ± 15	
BMI	<25	Pain score (Day 1)	3.8 ± 1.2	0.03*
	25–30	Pain score (Day 1)	4.5 ± 1.6	
Hernia type	Unilateral	Hospital stays (days)	1.2 ± 0.4	0.01*
	Bilateral	Hospital stays (days)	1.8 ± 0.6	

*BMI = Body Mass Index. Statistically significant at $p < 0.05$.

Overall, the eTEP technique demonstrated a low complication rate, minimal intraoperative adverse events, and low recurrence rates, supporting its safety and effectiveness in inguinal hernia repair.

DISCUSSION

The present study evaluated the safety profile, complication rates, recurrence, and predictors of outcomes following extended totally extraperitoneal (eTEP) repair for inguinal hernia. The findings of this study demonstrate that the eTEP technique is associated with low intraoperative and postoperative complication rates, minimal recurrence, and identifiable patient-related predictors influencing outcomes, thereby supporting its role as a safe and effective minimally invasive approach.

The demographic profile of the study population revealed a predominance of middle-aged males, with a mean age of 52 ± 10 years and 75% male patients. This distribution is consistent with the known epidemiology of inguinal hernia, which shows higher prevalence in males due to anatomical and occupational factors.¹³ Similar demographic patterns have been reported in previous studies evaluating laparoscopic hernia repair, including those by Bittner and Schwarz, who highlighted male predominance and comparable age distribution in their cohort.¹⁴

The mean operative time in the present study was 75 ± 15 minutes, which is in line with reported operative durations for eTEP and TEP techniques. Studies by Claus et al. and Belyansky et al. have reported operative times ranging between 60 and 90 minutes, depending on surgeon experience and complexity of hernia.^{15,16} In

Subgroup analysis evaluating predictors of outcomes is shown in Table 4. Patients aged ≥ 50 years had a significantly longer operative time compared to younger patients (78 ± 15 minutes vs 70 ± 10 minutes; $p = 0.04$). Higher BMI ($25\text{--}30 \text{ kg/m}^2$) was associated with significantly higher postoperative pain scores on Day 1 (4.5 ± 1.6 vs 3.8 ± 1.2 ; $p = 0.03$). Additionally, patients with bilateral hernias had a significantly longer hospital stay compared to those with unilateral hernias (1.8 ± 0.6 days vs 1.2 ± 0.4 days; $p = 0.01$). These findings indicate that patient-related and disease-related factors significantly influence surgical outcomes and recovery following eTEP repair (Table 4).

our study, operative time was significantly longer in patients aged ≥ 50 years, which may be attributed to increased tissue fragility, comorbidities, and altered anatomical planes. This observation is consistent with previous reports indicating that age and patient factors may influence operative difficulty.¹⁷

Intraoperative complications were minimal in this study, with 95% of patients experiencing no adverse events. Minor bleeding (3.3%) and peritoneal tear (1.7%) were the only complications observed, and both were managed effectively intraoperatively. These findings are comparable to those reported in the literature, where intraoperative complication rates for laparoscopic inguinal hernia repair typically range from 2% to 10%.¹⁸ The low complication rate observed in this study highlights the safety of the eTEP technique when performed by experienced surgeons.

Postoperative complications were observed in 15% of patients, with seroma being the most common complication (8.3%), followed by hematoma (3.3%), surgical site infection (1.7%), and foreign body sensation (1.7%). These findings are consistent with previous studies, which have identified seroma as the most frequent complication following laparoscopic hernia repair due to dead space formation in the preperitoneal plane.¹⁹ Simons et al reported similar complication patterns in their guidelines, emphasizing that most postoperative complications following minimally invasive hernia repair are minor and self-limiting.²⁰ The low incidence of surgical site infection in the present study further supports the advantage of laparoscopic approaches in reducing wound-related complications.

Recurrence is a critical parameter for evaluating the long-term success of hernia repair. In the present study, recurrence rates were low, with 3.3% at 3 months and 5% at 6 months follow-up. These findings are comparable to previously reported recurrence rates for laparoscopic techniques, which generally range between 1% and 5%.²¹ Studies such as those by Neumayer et al have demonstrated that recurrence rates in laparoscopic hernia repair are comparable to open repair when performed by experienced surgeons.²² The slightly higher recurrence observed at 6 months compared to 3 months may reflect early technical failures or patient-related factors.

An important aspect of this study was the identification of predictors influencing outcomes. Subgroup analysis revealed that age, BMI, and hernia type were significantly associated with variations in operative time, pain, and hospital stay. Patients with higher BMI had significantly increased postoperative pain scores, which may be attributed to technical challenges, increased intra-abdominal pressure, and difficulty in dissection. Similarly, patients with bilateral hernias had longer hospital stays, reflecting increased operative complexity and surgical duration. These findings are consistent with those reported by Köckerling and Simons, who identified obesity and hernia complexity as important predictors of outcomes in inguinal hernia repair.

The identification of these predictors is clinically relevant, as it allows for better patient selection, preoperative counseling, and perioperative planning. Surgeons can anticipate potential challenges in patients with higher BMI or bilateral hernias and adopt strategies to minimize complications and improve outcomes.

Overall, the findings of this study reinforce that the eTEP technique is associated with a favorable safety profile, low complication rates, and acceptable recurrence rates, comparable to or better than other laparoscopic techniques. The enhanced visualization and ergonomics offered by eTEP contribute to reduced intraoperative complications and improved surgical precision. However, the technique requires adequate training and experience to achieve optimal outcomes.

Despite these strengths, certain limitations should be acknowledged. The study was conducted at a single center with a relatively small sample size, and follow-up duration was limited to 6 months. Longer follow-up and multicentric studies are required to assess long-term recurrence and validate the predictors identified.

CONCLUSION

The present study demonstrates that the extended totally extraperitoneal (eTEP) technique for inguinal hernia repair is a safe and effective minimally invasive approach, characterized by low intraoperative and postoperative complication rates and minimal early recurrence. The majority of patients experienced

uneventful intraoperative and postoperative courses, with only a small proportion developing minor complications such as seroma and hematoma, which were managed conservatively.

The observed recurrence rates at 3 and 6 months were low, indicating satisfactory short-term surgical outcomes. Importantly, this study identified key factors influencing surgical outcomes, including advanced age, higher body mass index, and bilateral hernia, which were associated with increased operative time, higher postoperative pain scores, and longer hospital stay. These findings highlight the importance of patient selection, preoperative risk stratification, and individualized surgical planning.

Overall, the eTEP technique offers a favorable safety profile with acceptable recurrence rates and predictable outcomes. With appropriate surgical expertise and careful consideration of patient-related factors, eTEP can be considered a reliable and effective technique for inguinal hernia repair. Further large-scale, multicentric studies with long-term follow-up are recommended to validate these findings and assess long-term recurrence and complication rates.

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