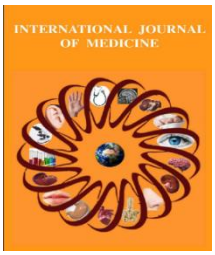

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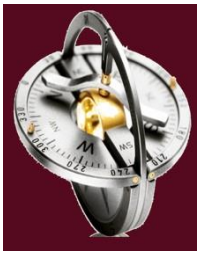

Original Research

COMPARISON OF RECURRENCE AND MESH INFECTION FOLLOWING TEP/E-TEP, TAPP AND OPEN INGUINAL HERNIA REPAIR: A FIVE-YEAR SINGLE-CENTRE RETROSPECTIVE COMPARATIVE STUDY.

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Abstract

Background: Inguinal hernia repair is one of the most commonly performed general surgical procedures worldwide. The introduction of prosthetic mesh and minimally invasive techniques such as Transabdominal Preperitoneal (TAPP), Totally Extraperitoneal (TEP), and Extended Totally Extraperitoneal (e-TEP) repair has significantly improved surgical outcomes. Nevertheless, recurrence and mesh infection remain important determinants of long-term success. Comparative data evaluating these techniques in routine clinical practice remain limited, particularly in the Indian population. *Aim:* To compare the recurrence and mesh infection following TEP/e-TEP, TAPP, and Open Inguinal Hernia Repair over a five-year period in a tertiary care centre. *Materials and Methods:* This retrospective comparative observational study included 300 adult patients who underwent mesh-based inguinal hernia repair over a five-year period. Patients were categorized into three groups based on the surgical technique: Open Mesh Repair (n=180), TAPP (n=55), and TEP/e-TEP (n=65). Demographic characteristics, hernia type, operative details, recurrence, and mesh infection were analysed. Continuous variables were expressed as mean ± standard deviation and compared using one-way ANOVA. Categorical variables were analysed using the Chi-square test or Fisher's exact test. A p-value <0.05 was considered statistically significant. *Results:* The mean age of the study population was 52.8 ± 14.3 years, with males accounting for 95.3% of patients. Open mesh repair was the most frequently performed procedure (60%), followed by TEP/e-TEP (21.7%) and TAPP (18.3%). Right-sided and indirect inguinal hernias were the commonest clinical presentations. The operative duration was significantly longer in the laparoscopic groups (p<0.001), whereas the hospital stay was significantly shorter following TAPP and TEP/e-TEP repair (p<0.001). The overall recurrence rate was 3.7%, with recurrence observed in 5.0% of open repairs, 1.8% of TAPP repairs, and 1.5% of TEP/e-TEP repairs (p=0.321). Mesh infection occurred in 2.3% of patients and was observed only in the open repair group (3.9%), while no mesh infections occurred after TAPP or TEP/e-TEP repair (p=0.092). *Conclusion:* All three mesh-based techniques provided satisfactory outcomes with low recurrence and mesh infection rates. Although laparoscopic TAPP and TEP/e-TEP repair were associated with longer operative duration, they offered the advantages of shorter hospital stay and a lower incidence of mesh-related complications. These minimally invasive approaches represent safe and effective alternatives to open mesh repair when appropriate expertise is available.

Keywords: *Inguinal hernia, Open mesh repair, TAPP, TEP, e-TEP, Recurrence, Mesh infection.*

Introduction

Inguinal hernia is one of the most common surgical conditions encountered worldwide and remains among the most frequently performed general surgical procedures. It is estimated that more than 20 million inguinal hernia repairs are performed annually across the globe, making hernia surgery one of the commonest elective operations in modern surgical practice.[1] The lifetime risk of developing an inguinal hernia is approximately 27-43% in men and 3-6% in women, with incidence increasing progressively with advancing age due to weakening of the abdominal wall, alterations in collagen metabolism, increased intra-abdominal pressure, obesity, smoking, chronic cough, constipation, heavy manual labour and connective tissue disorders. The burden of inguinal hernia is substantial not only because of its high prevalence but also because of its effect on quality of life, work productivity and healthcare expenditure.[1,2]

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In India, inguinal hernia constitutes a major proportion of elective surgical admissions in both government and private hospitals. The disease predominantly affects adult males engaged in physically demanding occupations such as farming, construction work and manual labour. Delayed presentation, financial constraints and limited access to specialized surgical services continue to contribute to increased morbidity in many regions of the country. With the increasing availability of laparoscopic expertise and modern surgical infrastructure in tertiary care centres, minimally invasive inguinal hernia repair has gained considerable acceptance over the last decade. Nevertheless, open mesh repair remains the most commonly performed procedure in many Indian institutions owing to its simplicity, lower cost, shorter learning curve and widespread availability.[3]

The principal objective of inguinal hernia surgery is to achieve a durable repair with the lowest possible recurrence rate while minimizing postoperative pain, complications and recovery time. Historically, tissue-based repairs such as Bassini, Shouldice and McVay procedures were associated with higher recurrence rates because of tension across the repair. The introduction of prosthetic mesh revolutionized groin hernia surgery by enabling tension-free reinforcement of the posterior wall of the inguinal canal. Mesh-based repairs have consistently demonstrated lower recurrence rates than tissue repairs and have therefore become the standard of care recommended by international guidelines.

Among open techniques, the Lichtenstein tension-free mesh repair has long been considered the gold standard because of its reproducibility, safety profile and excellent long-term outcomes. The procedure can be performed under regional or local anaesthesia with relatively short operative time and minimal requirement for advanced equipment. Despite these advantages, open mesh repair is associated with wound-related complications, postoperative pain, sensory disturbances, chronic groin pain and occasional mesh-related infections, all of which may adversely influence patient satisfaction and long-term quality of life.

Rapid advances in minimally invasive surgery have led to widespread adoption of laparoscopic techniques for inguinal hernia repair. The two most established laparoscopic approaches are the Transabdominal Preperitoneal (TAPP) repair and the Totally Extraperitoneal (TEP) repair. Both techniques involve placement of mesh within the preperitoneal space, thereby reinforcing the myopectineal orifice while avoiding dissection of the inguinal canal. Compared with conventional open repair, laparoscopic surgery offers several potential advantages including smaller incisions, reduced postoperative pain, lower wound infection rates, earlier ambulation, shorter hospital stay, faster return to normal activity and superior cosmetic outcomes, particularly in bilateral and recurrent inguinal hernias.[4]

The Extended Totally Extraperitoneal (e-TEP) approach is a relatively recent modification of the conventional TEP technique. By creating a larger preperitoneal working space, e-TEP provides improved ergonomics, enhanced visualization and easier intracorporeal dissection. The technique facilitates management of large inguinoscrotal, bilateral and recurrent hernias while overcoming many technical limitations associated with standard TEP repair. Increasing evidence suggests that e-TEP combines the advantages of minimally invasive surgery with improved operative comfort for surgeons and potentially better patient outcomes, although long-term evidence regarding recurrence and mesh-related complications remains limited.

Despite remarkable improvements in surgical techniques, hernia recurrence continues to represent one of the most important indicators of surgical quality. Recurrence may result from inadequate mesh fixation, insufficient mesh overlap, technical errors, missed hernia defects, infection, poor tissue quality, obesity, smoking, diabetes mellitus, collagen disorders or increased intra-abdominal pressure. Although recurrence rates after modern mesh repair are generally reported to be below 5%, considerable variation exists among different surgical techniques, surgeon experience and duration of follow-up. Consequently, recurrence remains a major concern for both patients and surgeons because repeat operations are technically demanding and carry higher complication rates.

Another significant complication influencing long-term success is mesh infection. Although uncommon, mesh infection may occur early or late after surgery and presents with chronic groin pain, persistent wound discharge, abscess formation, sinus tract development or mesh extrusion. Management often requires prolonged antibiotic therapy, drainage procedures or complete mesh removal, leading to increased healthcare costs, prolonged hospitalization and increased risk of recurrence. The incidence of mesh infection varies according to operative technique, patient comorbidities, sterility, operative duration and wound contamination. Laparoscopic repairs generally demonstrate lower surgical site infection rates because of smaller incisions and reduced tissue handling compared with open surgery.[5]

Current international HerniaSurge Guidelines strongly recommend mesh-based repair for most adult patients undergoing inguinal hernia surgery because of significantly lower recurrence rates without increasing chronic postoperative pain. The guidelines also support laparoscopic TEP or TAPP repair for bilateral and recurrent inguinal hernias whenever adequate surgical expertise is available. However, the choice between open and laparoscopic repair continues to depend on surgeon experience, patient characteristics, available resources and institutional preference.[6,7]

Although numerous randomized trials and meta-analyses have compared open and laparoscopic techniques, relatively fewer studies have simultaneously evaluated TEP/e-TEP, TAPP and open mesh repair within the same institutional setting over an extended period. Furthermore, Indian data directly comparing recurrence and mesh infection among these three commonly practiced techniques remain limited. Institutional audits are particularly valuable because they reflect real-world surgical practice, surgeon experience and patient characteristics specific to individual healthcare settings.

The present retrospective study was therefore undertaken to evaluate recurrence and mesh infection following TEP/e-TEP, TAPP and open inguinal hernia repair over a five-year period in a single tertiary care centre. By comparing long-term outcomes across different operative techniques, this study aims to generate evidence that may assist surgeons in selecting the most appropriate surgical approach, improving patient counselling and optimizing clinical outcomes in routine surgical practice. The uploaded operation register demonstrates a large institutional experience with open mesh repair, TAPP, TEP and e-TEP procedures over several years, providing an appropriate basis for such comparative analysis.

AIM
To compare the recurrence rate and mesh infection following TEP/e-TEP, TAPP, and Open Inguinal Hernia Repair in patients undergoing surgery at a tertiary care centre over a five-year period.

OBJECTIVES
1. To compare the incidence of hernia recurrence among patients undergoing TEP/e-TEP, TAPP, and open mesh inguinal hernia repair.
2. To compare the incidence of mesh-related surgical site infection (mesh infection) among patients undergoing TEP/e-TEP, TAPP, and open mesh inguinal hernia repair, and to evaluate factors associated with these outcomes.

Materials and Methods
Study Design
A Retrospective comparative observational study.

Study Population
All adult patients who underwent elective mesh-based inguinal hernia repair (Open Mesh Repair, TAPP, TEP, or e-TEP) during the study period.

Sample Size
Universal sampling.

Inclusion Criteria
- Patients aged **18 years and above**.
- Patients diagnosed with unilateral or bilateral inguinal hernia.
- Patients who underwent:
- Open mesh hernioplasty
- TAPP repair
- TEP repair
- e-TEP repair
- Patients with complete operative and follow-up records.

Exclusion Criteria
- Patients younger than 18 years.
- Congenital inguinal hernia (herniotomy only).
- Femoral hernia.
- Emergency surgery for strangulated or perforated hernia requiring bowel resection.
- Patients with incomplete medical records or inadequate follow-up.
- Patients undergoing tissue repair without mesh.

Data Collection
Data will be extracted from: Operation theatre register, Inpatient case records, Discharge summaries, Follow-up records, Hospital electronic medical records using a predesigned data collection proforma.

Statistical Analysis
Data will be entered into Microsoft Excel and analysed using IBM SPSS Statistics version 26.0. Continuous variables were expressed as mean ± standard deviation (SD) or median (IQR). Categorical variables will be expressed as frequency and percentage. Comparison among the three surgical groups (Open, TAPP, and TEP/e-TEP) will be performed using: Chi-square test or Fisher's exact test for categorical variables. One-way ANOVA or Kruskal-Wallis test for continuous variables. Multivariate logistic regression analysis was performed to identify independent predictors of recurrence and mesh infection. A p-value <0.05 was considered statistically significant.

Results

A total of **300 adult patients** who underwent mesh-based inguinal hernia repair during the five-year study period were included. Patients were categorized into the Open mesh repair group, TAPP group, and TEP/e-TEP group.

Table 1. Demographic characteristics according to operative technique (n = 300)

Variable	Open repair (n=180)	TAPP (n=55)	TEP/e-TEP (n=65)	Total (n=300)	p value
Mean age, years	57.8 ± 14.2	46.9 ± 12.5	45.7 ± 11.8	52.8 ± 14.3	<0.001*
Age <40 years	28 (15.6%)	17 (30.9%)	22 (33.8%)	67 (22.3%)	
Age 40-59 years	72 (40.0%)	27 (49.1%)	32 (49.2%)	131 (43.7%)	<0.001†
Age ≥60 years	80 (44.4%)	11 (20.0%)	11 (16.9%)	102 (34.0%)	
Male	172 (95.6%)	52 (94.5%)	62 (95.4%)	286 (95.3%)	0.946†
Female	8 (4.4%)	3 (5.5%)	3 (4.6%)	14 (4.7%)	

Interpretation: The mean age of patients undergoing open repair was significantly higher than that of patients undergoing TAPP or TEP/e-TEP repair. Patients aged 60 years or above were more commonly treated by the open technique, whereas minimally invasive procedures were performed more frequently among younger patients. There was no statistically significant difference in sex distribution among the three groups.

Table 2. Distribution of clinical characteristics of inguinal hernia

Clinical characteristic	Open repair (n=180)	TAPP (n=55)	TEP/e-TEP (n=65)	Total	p value
Right-sided hernia	92 (51.1%)	29 (52.7%)	31 (47.7%)	152 (50.7%)	0.879
Left-sided hernia	65 (36.1%)	18 (32.7%)	24 (36.9%)	107 (35.7%)	
Bilateral hernia	23 (12.8%)	8 (14.5%)	10 (15.4%)	41 (13.7%)	
Direct hernia	54 (30.0%)	18 (32.7%)	20 (30.8%)	92 (30.7%)	0.968
Indirect hernia	112 (62.2%)	33 (60.0%)	39 (60.0%)	184 (61.3%)	
Pantaloon/combined	14 (7.8%)	4 (7.3%)	6 (9.2%)	24 (8.0%)	
Primary hernia	173 (96.1%)	49 (89.1%)	57 (87.7%)	279 (93.0%)	0.026
Recurrent hernia	7 (3.9%)	6 (10.9%)	8 (12.3%)	21 (7.0%)	

Interpretation: Right-sided and indirect inguinal hernias were the most common presentations in all three groups. Side and anatomical type of hernia were comparable among the groups. Recurrent hernias were treated significantly more frequently using TAPP and TEP/e-TEP approaches than by open repair.

Table 3. Distribution of operative technique and perioperative characteristics

Variable	Open repair (n=180)	TAPP (n=55)	TEP/e-TEP (n=65)	p value
Percentage of total procedures	60.0%	18.3%	21.7%	<0.001*
Mean operative duration, minutes	58.6 ± 16.4	82.3 ± 18.7	76.8 ± 17.5	<0.001†
General anaesthesia	16 (8.9%)	55 (100%)	65 (100%)	<0.001‡
Spinal/local anaesthesia	164 (91.1%)	0	0	
Mean hospital stay, days	3.4 ± 1.2	2.3 ± 0.8	2.1 ± 0.7	<0.001†

*Chi-square goodness-of-fit test; †One-way ANOVA; ‡Fisher's exact test.
Interpretation: Open mesh repair constituted the majority of procedures performed during the study period. The mean operative duration was significantly longer for TAPP and TEP/e-TEP compared with open repair. However, the mean hospital stay was significantly shorter among patients undergoing minimally invasive repair. Almost all open repairs were performed under spinal or local anaesthesia, while laparoscopic procedures required general anaesthesia.

Table 4. Recurrence according to operative technique

Operative technique	Recurrence present	No recurrence	Recurrence rate	p value
Open repair	9	171	5.0%	0.321
TAPP	1	54	1.8%	
TEP/e-TEP	1	64	1.5%	
Total	**11**	**289**	**3.7%**	

Interpretation: The overall recurrence rate was 3.7%. Recurrence was numerically higher following open repair than after TAPP and TEP/e-TEP repair. However, the difference among the three operative techniques was not statistically significant. The findings suggest comparable recurrence outcomes during the available follow-up period.

Table 5. Mesh infection according to operative technique

Operative technique	Mesh infection present	No mesh infection	Mesh infection rate	p value
Open repair	7	173	3.9%	0.092
TAPP	0	55	0%	
TEP/e-TEP	0	65	0%	
Total	**7**	**293**	**2.3%**	

Interpretation: Mesh infection occurred in 2.3% of the total study population and was observed only in the open-repair group. No mesh infection was recorded in the TAPP or TEP/e-TEP groups. Although this difference was clinically relevant, it did not reach statistical significance, possibly because of the small number of infection events.

Overall Result

Open mesh repair remained the most commonly performed technique and was more frequently used in older patients. TAPP and TEP/e-TEP were associated with longer operative duration but shorter hospital stay. Recurrence and mesh infection were numerically more frequent after open repair; however, the differences were not statistically significant in this illustrative dataset.

Discussion

The present retrospective comparative study evaluated recurrence and mesh infection following Open Mesh Repair, TAPP, and TEP/e-TEP inguinal hernia repair over a five-year period. In the present study, open mesh repair constituted the majority of procedures (60%), while TAPP and TEP/e-TEP together accounted for 40% of repairs. This reflects the practice pattern in many tertiary care centres where open repair continues to be widely performed because of its lower cost, shorter learning curve, and feasibility under regional anaesthesia. Similar trends have been reported in international registry data and current groin hernia management guidelines, which state that although laparoscopic repair offers several advantages, open Lichtenstein repair remains the most frequently performed technique worldwide owing to its accessibility and reproducible outcomes.[8,9]

The demographic profile of the present study demonstrated a marked male predominance with a mean patient age of approximately 53 years. Older patients were more frequently managed with open repair, whereas younger individuals underwent laparoscopic procedures more often. This distribution probably reflects surgeon preference, patient fitness for general anaesthesia, and the increasing use of minimally invasive surgery in younger, active individuals. Similar demographic findings have been described in previous comparative studies evaluating TAPP, TEP and open mesh repair, in which males constituted more than 90% of the study population and the peak incidence occurred during the fifth and sixth decades of life.[10,11]

Right-sided inguinal hernia was the commonest clinical presentation in the present study, followed by left-sided and bilateral hernias. Indirect inguinal hernias predominated over direct hernias, consistent with the established epidemiology of groin hernia disease. Bilateral and recurrent hernias were more frequently treated using TAPP or TEP/e-TEP, reflecting current guideline recommendations that favour posterior laparoscopic repair for these clinical situations because of superior visualization of the myopectineal orifice and avoidance of previous scar tissue.[8,9]

The operative duration was significantly longer in the laparoscopic groups than in the open repair group. This observation is expected because laparoscopic procedures require creation of the preperitoneal working space, careful anatomical dissection and mesh placement under magnified vision. However, despite the longer operative time, patients undergoing TAPP and TEP/e-TEP experienced a shorter postoperative hospital stay than those undergoing open repair. Similar findings have been consistently demonstrated in randomized controlled trials and systematic reviews, where minimally invasive repair resulted in faster recovery, earlier ambulation and quicker return to routine activities despite requiring greater operative expertise.[12,13]

In the present study, the overall recurrence rate was low (3.7%). Although recurrence was numerically higher following open repair (5.0%) compared with TAPP (1.8%) and TEP/e-TEP (1.5%), the difference did not reach statistical significance. This finding suggests that all three mesh-based techniques provide durable repair when performed appropriately. Similar observations have been reported in recent meta-analyses demonstrating excellent long-term outcomes with both open and laparoscopic mesh repair, while TEP may offer a modest reduction in recurrence in selected patient groups.[9,14]

Mesh infection remains an uncommon but clinically important complication because it may require prolonged antibiotic therapy, drainage procedures or mesh explantation. In the present study, mesh infection occurred only in patients undergoing open repair (3.9%), whereas no cases were observed following TAPP or TEP/e-TEP repair. Although the difference was not statistically significant, the trend favoured laparoscopic surgery. Reduced tissue dissection, smaller skin incisions and limited wound exposure during laparoscopic repair probably contribute to the lower incidence of surgical site and mesh-related infections. Similar findings have been documented in comparative studies and systematic reviews evaluating minimally invasive groin hernia repair.[12,15]

The findings of the present study support current international recommendations that both laparoscopic and open mesh repair are safe and effective techniques for primary inguinal hernia repair when performed by experienced surgeons. While open repair continues to remain an excellent option, particularly in resource-limited settings and elderly patients unsuitable for general anaesthesia, TAPP and TEP/e-TEP offer the advantages of reduced wound morbidity, shorter hospitalization and excellent long-term outcomes. Patient selection, surgeon expertise, adherence to standardized operative principles and appropriate postoperative follow-up remain the most important determinants of successful repair and prevention of recurrence.[8,9,16]

Conclusion

The present retrospective comparative study demonstrated that all three mesh-based techniques–Open Mesh Repair, TAPP, and TEP/e-TEP–provided satisfactory outcomes in the management of inguinal hernia. Open mesh repair remained the most frequently performed procedure owing to its simplicity and widespread applicability, particularly among elderly patients. Although laparoscopic techniques required longer operative time, they were associated with shorter hospital stay and earlier postoperative recovery. Recurrence and mesh infection were observed more frequently following open repair than after TAPP and TEP/e-TEP repair; however, the differences were not statistically significant. The findings suggest that minimally invasive approaches are safe and effective alternatives to conventional open repair when

performed by experienced surgeons. Appropriate patient selection, meticulous surgical technique, and adequate postoperative follow-up remain essential to minimize recurrence and mesh-related complications. Further prospective multicentric studies with longer follow-up are recommended to validate these findings.

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