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A Comparative Study on Effects of Defect Closure versus Non-Closure in Laparoscopic Totally Extraperitoneal Repair of Direct Inguinal Hernia

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ABSTRACT

Background:
Seroma formation is a common postoperative complication following laparoscopic Totally Extraperitoneal (TEP) repair, particularly in moderate-to-large direct inguinal hernias. Defect closure may reduce dead space and thereby decrease seroma formation, but evidence remains inconclusive**.**

Objective:
To compare the outcomes of defect closure versus non-closure in laparoscopic TEP repair of large direct inguinal hernia with respect to seroma formation, pain, intraoperative characteristics, and postoperative recovery.

Methods:
This retrospective cohort study was conducted at Chettinad Hospital and Research Institute from June 2024 to July 2025. A total of 40 adults with uncomplicated direct inguinal hernias (M3 or larger, EHS classification) underwent laparoscopic TEP repair and were divided into defect closure (n=20) and non-closure (n=20) groups. Primary outcomes were seroma formation and postoperative pain (VAS score). Secondary outcomes included operative time, intraoperative complications, hospital stay, return to normal activity, and recurrence. Data were analyzed using SPSS, and $p < 0.05$ was considered statistically significant**.**

Results:
Baseline demographic parameters were comparable between the two groups. Mean operative time was longer in the defect closure group (62.4 ± 8.1 min) compared to the non-closure group (55.6 ± 7.4 min), but the difference was not statistically significant (p=0.070). Intraoperative complications were comparable between groups. Seroma formation at the 10th postoperative day was noted in 25% of patients in the defect closure group and 35% in the non-closure group (p=0.521). At one month follow-up, seroma reduced to 10% and 15% respectively (p=0.633). Univariate analysis showed operative time ≥60 minutes was significantly associated with increased seroma formation (OR = 4.44, 95% CI: 1.07–18.3; p = 0.045).

Conclusion:
Defect closure during laparoscopic TEP repair of large direct inguinal hernia is safe and feasible, with comparable intraoperative and postoperative outcomes to non-closure. Defect closure demonstrated a lower tendency for early seroma formation, while longer operative duration was significantly associated with increased seroma risk. Further large-scale prospective studies with longer follow-up are recommended.

Keywords: Direct inguinal hernia; Laparoscopic TEP repair; Defect closure; Seroma formation; Operative time; Postoperative pain

Introduction:

Inguinal hernia represents one of the most widespread surgical pathologies encountered in global healthcare systems today [1]. It constitutes a significant portion of the general surgery workload, with millions of repairs performed annually to alleviate symptoms and prevent progression [2]. As the most common subtype of abdominal wall hernias, inguinal hernias pose a substantial burden on public health resources and patient quality of life [3]. The sheer magnitude of this condition worldwide underscores the necessity for efficient, reproducible, and effective surgical management strategies [4].

The development of an inguinal hernia is rarely due to a single cause but rather stems from a multifactorial etiology [5]. The pathophysiology involves a complex interplay of congenital predisposition, such as a patent processus vaginalis, and acquired factors that compromise the integrity of the abdominal wall [5]. These acquired factors, including increased intra-abdominal pressure and connective tissue degeneration, lead to the weakening of the musculature in the groin region [5]. Understanding this complex etiology is crucial for surgeons when selecting the most appropriate repair technique for the patient [5].

To ensure consistency in diagnosis, treatment, and research, the European Hernia Society (EHS) established a comprehensive classification system for groin hernias [6]. This system categorizes defects based on their anatomic location—Lateral (L), Medial (M), and Femoral (F)—and the size of the hernia orifice, where size 1 is <1.5 cm, size

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2 is <3 cm, and size 3 is ≥3 cm [6]. This standardized classification is particularly vital for research purposes, allowing surgeons to accurately compare outcomes across different defect sizes, such as the large (M3) defects focused on in this study [6].

Over the last few decades, the management of inguinal hernias has undergone a paradigm shift from open tissue repairs to minimally invasive tension-free techniques [7]. Current evidence-based guidelines strongly advocate for laparoscopic approaches, such as Totally Extraperitoneal (TEP) repair, particularly for bilateral and recurrent hernias, and increasingly for primary unilateral cases [7]. Systematic reviews and meta-analyses of randomized controlled trials have consistently demonstrated that laparoscopic repair offers distinct advantages, including reduced postoperative pain, lower rates of chronic pain, and an earlier return to normal work and activities [8].

Despite the clear benefits of laparoscopic TEP repair, postoperative complications—often categorized under the umbrella of Surgical Site Occurrences (SSO)—remain a pertinent challenge [9]. Seroma formation, or the collection of fluid in the dead space following hernia reduction, is one of the most frequently reported outcomes in TEP repair, especially in patients with moderate-to-large direct defects [10]. While often self-limiting, these fluid collections can cause patient anxiety and discomfort, prompting an ongoing surgical debate regarding the utility of closing the defect to obliterate the dead space versus standard non-closure [10].

Current evidence remains controversial regarding the superiority of defect closure versus non-closure during TEP repair for large direct inguinal hernias, as closure may reduce seroma formation by obliterating dead space but carries the risk of increased operative time and postoperative pain. Consequently, this study was designed to evaluate the feasibility and effects of defect closure in moderate-to-large hernias during laparoscopic TEP repair by specifically comparing seroma formation, postoperative pain, operative metrics (operative time, hospital stay, and return to normal activity), recurrence, and intraoperative complications between the two techniques.

Methodology:

Study Design, Setting and Period

This hospital-based, retrospective cohort study was conducted in the Department of General Surgery at Chettinad Hospital and Research Institute, a tertiary care centre located at Kelambakkam, near Chennai. The study was conducted over a period of one year from June 2024 to July 2025.

Study Population (Inclusion and exclusion criteria)

The study included patients aged more than 18 years, who were diagnosed with uncomplicated direct inguinal hernias (M3 or larger, as per the European Hernia Society classification) and underwent laparoscopic TEP repair. Patients with Hernia defect size ≤ M2, complicated (obstructed/strangulated) or recurrent hernias, and patients unfit for general anaesthesia were excluded from the study.

Sampling Technique and Sample Size

A consecutive sampling strategy was employed where all eligible participants admitted to the surgery ward during the study period were screened and recruited until the desired sample size was achieved.

The sample size was calculated based on effect sizes reported in prior studies evaluating the effects of defect closure versus non-closure in laparoscopic totally extraperitoneal repair of direct inguinal hernia. Using data from a randomized controlled trial by Sah et al. [11], the maximum standard deviation of operative time was 4.3 minutes, and a minimum difference of 4.2 minutes between the means of operative time was considered clinically meaningful. The formula used for calculating sample size was:

$$n = [2(Z_{\alpha/2} + Z_{\beta})^2 \sigma^2] / d^2$$

where:

n = sample size per group

$Z_{\alpha/2}$ = standard normal variate for a 5% significance level (1.96)

Z_{β} = standard normal variate for 90% power (1.28)

σ = estimated standard deviation (based on previous literature) = 4.3

d = minimum clinically meaningful difference between the two group means = 4.3

Thus, a sample size of **20 per group** was finalized (total n = 40), which was divided into two groups:

- Group A (Defect Closure): 20 patients
- Group B (Non-Closure): 20 patients

Procedure

Patients who met the inclusion criteria at the study setting were explained about the study procedure, and written informed consent was obtained. Participants were asked to fill out a pre-validated, structured case record form (CRF). All patients underwent Laparoscopic Totally Extraperitoneal (TEP) repair using a standard 3-port technique performed by the same surgeon.

- **Defect Closure Group:** The direct defect was closed using a polypropylene barbed suture.
- **Non-Closure Group:** The mesh was placed without closing the defect.

Outcome Measures

- **Primary Outcomes:** Seroma formation and postoperative pain assessed using the Visual Analogue Scale (VAS).
- **Secondary Outcomes:** Operative time, length of hospital stay, time to resume normal activities, recurrence, and intraoperative complications (vas deferens injury, vessel injury, visceral injury, or peritoneal tear).

Statistical Analysis

All data were entered into Microsoft Excel and analyzed using IBM SPSS Version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as means ± standard deviations (SD). Categorical variables were reported as frequencies and percentages.

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Associations were tested using the Chi-square test or Fisher's exact test, as appropriate. Continuous variables were compared using an independent t-test or Mann–Whitney U test. A p-value of <0.05 was considered statistically significant.

Ethical Considerations

Ethical Committee approval was obtained from the Institutional Human Ethics Committee (IHEC) of Chettinad Hospital and Research Institute before the commencement of the study. Written informed consent was obtained from all patients regarding the procedure and the use of their data for research. The study adhered to ethical standards, maintaining patient confidentiality.

Results

Table 1. Baseline Demographic and Clinical Characteristics

Variable	Defect Closure (n = 20)	Non-Closure (n = 20)	p-value
Age (years), mean ± SD	40.1 ± 12.4	45.3 ± 13.1	0.211
Sex,	**n (%)**	**n (%)**	
Male	19 (95.0)	19 (95.0)	1.000
Female	1 (5.0)	1 (5.0)	
BMI (kg/m²), mean ± SD	24.8 ± 2.9	25.2 ± 3.1	0.633
Hernia laterality,	**n (%)**	**n (%)**	
Right-sided	9 (45.0)	10 (50.0)	0.886
Left-sided	5 (25.0)	4 (20.0)	
Bilateral	6 (30.0)	6 (30.0)	

A total of 40 patients were included in the study, with 20 patients each in the defect closure and non-closure groups. The mean age of patients in the defect closure group was 40.1 ± 12.4 years, compared to 45.3 ± 13.1 years in the non-closure group, with no statistically significant difference between the groups (p = 0.211). The sex distribution was comparable between the two groups, with males constituting 95% of patients in both the defect closure and non-closure groups (p = 1.000). Female patients accounted for 5% in each group.The mean body mass index (BMI) was similar between the groups (24.8 ± 2.9 kg/m² in the defect closure group versus 25.2 ± 3.1 kg/m² in the non-closure group), and this difference was not statistically significant (p = 0.633). Regarding hernia laterality, right-sided hernias were the most common in both groups, followed by bilateral and left-sided hernias. The distribution of hernia laterality did not differ significantly between the defect closure and non-closure groups (p = 0.886).

Overall, the baseline demographic and clinical characteristics were well balanced between the two groups, indicating comparability prior to surgical intervention.

Table 2. Distribution of Intraoperative Characteristics

Variable	Defect Closure (n = 20)	Non-Closure (n = 20)	p-value
Operative time (in min), mean ± SD	62.4 ± 8.1	55.6 ± 7.4	0.070
Peritoneal tear	**n (%)**	**n (%)**	
Yes	3 (15.0)	2 (10.0)	0.635
No	17 (85.0)	18 (90.0)	
Vascular injury			
Yes	1 (5.0)	1 (5.0)	1.000
No	19 (95.0)	19 (95.0)	

The mean operative time was slightly longer in the defect closure group (62.4 ± 8.1 minutes) compared to the non-closure group (55.6 ± 7.4 minutes); however, this difference was not statistically significant (p = 0.070). Peritoneal tears were observed in 15.0% of patients in the defect closure group and 10.0% of patients in the non-closure group, with no significant difference between the groups (p = 0.635). Vascular injury occurred in one patient (5.0%) in each group, and the incidence was comparable between the two groups (p = 1.000).Overall, intraoperative characteristics, including operative time and intraoperative complications, were similar between the defect closure and non-closure groups, indicating that defect closure did not significantly increase intraoperative risk.

Table 3. Univariate Analysis for Seroma Formation at 10th POD

Variable	Seroma Present (n = 12)n %)	Seroma Absent (n = 28)n (%)	OR (95% CI)	p-value
Defect closure				
Yes	5 (41.7)	15 (53.6)	**0.55 (0.14–2.11)**	0.388
No	7 (58.3)	13 (46.4)	Reference	
Age group				
≥ 45 years	6 (50.0)	10 (35.7)	**2.40 (0.62–9.21)**	0.200
< 45 years	6 (50.0)	18 (64.3)	Reference	
BMI category				
≥ 25 kg/m²	7 (58.3)	11 (39.3)	**2.27 (0.59–8.69)**	0.236
< 25 kg/m²	5 (41.7)	17 (60.7)	Reference	
Hernia laterality				
Bilateral	5 (41.7)	7 (25.0)	**3.21 (0.79–13.0)**	0.091
Unilateral	7 (58.3)	21 (75.0)	Reference	
Operative time				
≥ 60 minutes	8 (66.7)	9 (32.1)	**4.44 (1.07–18.3)**	**0.045**
< 60 minutes	4 (33.3)	19 (67.9)	Reference	

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On univariate analysis, defect closure was associated with a lower odd of seroma formation at the 10th postoperative day; however, this association was not statistically significant (OR = 0.55, 95% CI: 0.14–2.11; p = 0.388).
Patients aged ≥45 years showed higher odds of developing seroma compared to those aged <45 years (OR = 2.40, 95% CI: 0.62–9.21), though this association did not reach statistical significance (p = 0.200). Similarly, patients with a BMI ≥25 kg/m² had increased odds of seroma formation when compared to those with BMI <25 kg/m² (OR = 2.27, 95% CI: 0.59–8.69), but the difference was not statistically significant (p = 0.236).
Bilateral hernia was associated with higher odds of seroma formation compared to unilateral hernia (OR = 3.21, 95% CI: 0.79–13.0); however, this association did not achieve statistical significance (p = 0.091).
A statistically significant association was observed between longer operative time (≥60 minutes) and seroma formation. Patients with operative duration ≥60 minutes had significantly higher odds of developing seroma compared to those with operative time <60 minutes (OR = 4.44, 95% CI: 1.07–18.3; p = 0.045).
Variables with a p-value <0.20 on univariate analysis were considered for inclusion in multivariate logistic regression.

Table 4. Distribution of Postoperative Outcomes

Outcome	Defect Closure (n = 20) n (%)	Non-Closure (n = 20) n (%)	p-value
Seroma at 10th POD, n (%)			
Present	5 (25.0)	7 (35.0)	0.521
Absent	15 (75.0)	13 (65.0)	
Seroma at 1 month, n (%)			
Present	2 (10.0)	3 (15.0)	0.633
Absent	18 (90.0)	17 (85.0)	
VAS pain score (10th POD), mean ± SD	2.3 ± 0.7	1.9 ± 0.6	0.085
Hospital stay (days), mean ± SD	1.2 ± 0.4	1.1 ± 0.3	0.441
Return to normal activity (days), mean ± SD	7.3 ± 1.2	7.1 ± 1.3	0.677

At the 10th postoperative day, seroma formation was observed in 25.0% of patients in the defect closure group and 35.0% of patients in the non-closure group; however, the difference between the two groups was not statistically significant (p = 0.521).At one month of follow-up, the incidence of seroma further decreased in both groups, with 10.0% of patients in the defect closure group and 15.0% of patients in the non-closure group exhibiting seroma, and this difference also did not reach statistical significance (p = 0.633).The mean visual analogue scale (VAS) pain score at the 10th postoperative day was slightly higher in the defect closure group (2.3 ± 0.7) compared to the non-closure group (1.9 ± 0.6); however, this difference was not statistically significant (p = 0.085).Postoperative hospital stay was comparable between the two groups, with a mean duration of 1.2 ± 0.4 days in the defect closure group and 1.1 ± 0.3 days in the non-closure group (p = 0.441).The time taken to return to normal activity was similar in both groups, with patients resuming normal activities in 7.3 ± 1.2 days in the defect closure group and 7.1 ± 1.3 days in the non-closure group; the difference was not statistically significant (p = 0.677).

Discussion

The present study focused on Effects of Defect Closure versus Non-Closure in Laparoscopic Totally Extraperitoneal Repair of Direct Inguinal Hernia, this study observed 15.0% of patients in the defect closure group and 10.0% of patients in the non-closure group had intraoperative complications which is similar to study done by William W Hope et al,[11] intraoperative complications among the group among Laparoscopic Hernia Repair group. Overall, intraoperative outcomes appear to depend more on surgical technique and operative handling than on whether the defect is closed or left open. This study showed intraoperative characteristics, including operative time and intraoperative complications, were similar between the defect closure and non-closure groups similarly study done by Giovanni E et al,[12] showed similar findings to our study. The similarity in intraoperative characteristics such as operative time and intraoperative complications between the defect closure and non-closure groups suggests that defect closure does not add significant operative burden or increase intraoperative risk during laparoscopic TEP repair. The agreement with Giovanni E et al. further supports that both techniques are intraoperatively comparable and safe, and the choice of closure may be guided more by surgeon preference and expected postoperative benefits rather than intraoperative concerns.
This study showed defect closure was associated with a lower odd of seroma formation at the 10th postoperative day similarly study done by Singh Sachin S et al, [13] showed there was no seroma formation among the defect closure type strengthening the evidence that defect closure may provide a protective effect against early postoperative seroma following laparoscopic TEP repair
This study observed the risk of seroma formation is high in patients above the age group of 45 which is similar to study done by Shunsuke Hayakawa et al,[14] which showed higher risk of seroma formation on patients above the age of 66 years suggesting that age-related tissue changes and reduced lymphatic drainage may contribute to increased seroma formation in older individuals.
This study showed patients with a BMI ≥25 kg/m² had increased odds of seroma formation when compared to those with BMI <25 kg/m² (OR = 2.27, 95% CI: 0.59–8.69) which correlates with the study done by Hong-yang Xie et al,[15] in which the patients with BMI above 25 are at higher risk of developing seroma when compared to patients with low BMI supporting the view that greater preperitoneal fat and larger dead space/dissection area in higher BMI patients may predispose to seroma formation.

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This study showed Bilateral hernia was associated with higher odds of seroma formation compared to unilateral hernia (OR = 3.21, 95% CI: 0.79–13.0) which is similar to study done by T. Suresh B P et al,[16] whose study showed similar outcome to our study supporting bilateral hernia as a potential risk factor for postoperative seroma following laparoscopic repair. Our study observed longer operative time (≥60 minutes) and seroma formation. Patients with operative duration ≥60 minutes had significantly higher odds of developing seroma compared to those with operative time <60 minutes (OR = 4.44, 95% CI: 1.07–18.3; p = 0.045) which is similar to study done by Mukesh Kumar et al,[17] which showed longer surgical times were correlated with a higher incidence of seroma, particularly in operations lasting more than 3 hours indicating that reducing tissue handling and limiting extensive dissection time may help lower postoperative seroma risk

Limitations

This study was retrospective in nature, and therefore carries the risk of selection bias and incomplete documentation. The sample size was relatively small, which limits the statistical power and generalizability of the findings. The follow-up period was short (up to one month), hence long-term outcomes such as hernia recurrence and chronic postoperative pain could not be evaluated. Additionally, the number of seroma events was low, restricting robust multivariate analysis and adjustment for confounding factors. Since the study included only large direct inguinal hernias, the results may not be applicable to other hernia types. Seroma detection was mainly based on clinical assessment, which may introduce observer variability, and pain scoring using VAS is subjective and may differ among individuals. Lastly, the study being conducted in a single centre may limit external validity.

Conclusion

The present study concludes that defect closure during laparoscopic totally extraperitoneal repair of direct inguinal hernia is a feasible and safe technique. Intraoperative characteristics such as operative time and intraoperative complications were comparable between the defect closure and non-closure groups, indicating that closure does not add significant operative risk. Defect closure was associated with a lower tendency for early postoperative seroma formation, supporting its role in reducing dead space, though the difference was not statistically significant. Postoperative outcomes such as pain scores, duration of hospital stay, and return to normal activity were similar in both groups. A significant association was noted between longer operative duration (≥60 minutes) and increased seroma formation, suggesting that minimizing operative time may help reduce this complication. Larger prospective randomized studies with longer follow-up are recommended to confirm the benefits of defect closure on seroma reduction and long-term outcomes such as recurrence.

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