RESEARCH PAPER

Comparative Analysis of Mesh Fixation Techniques in Laparoscopic Inguinal Hernioplasty: Multiple Tacks versus Single Tack Plus Glue

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ABSTRACT

Mesh fixation technique influences postoperative pain and recovery after laparoscopic inguinal hernia repair. Multiple tack fixation provides secure mesh placement but may increase pain due to tissue penetration. Hybrid fixation using a single tack with biological glue may reduce tissue trauma; however, comparative evidence is limited. To compare postoperative pain and recovery outcomes between multiple tack fixation and single tack plus glue fixation in laparoscopic inguinal hernia repair. This retrospective comparative study was conducted from January to December 2025 at a tertiary care center and included 60 adult male patients undergoing elective transabdominal preperitoneal (TAPP) repair. Patients were allocated to multiple tack fixation (n=30) or single tack plus glue fixation (n=30). Pain was assessed using the Visual Analog Scale (VAS) at 24 hours, 1 week, and 1 month. Secondary outcomes included operative time, hospital stay, and complications. Independent t-test, Mann–Whitney U test, and Fisher's exact test were used for analysis. Baseline characteristics were comparable. Median VAS scores were lower in the hybrid group at 24 hours (2 vs 3; $p<0.001$) and 1 week (1 vs 2; $p<0.001$), with no difference at 1 month ($p=0.078$). Operative time was similar (115.90±24.13 vs 117.30±26.96 min; $p=0.833$). Hospital stay was shorter with hybrid fixation (5.00±0.95 vs 5.93±0.94 days; $p<0.001$). Complications occurred only in the multiple tack group (16.7% vs 0%; $p=0.052$). Hybrid fixation reduces early postoperative pain and hospital stay without increasing operative risk, supporting its use over conventional multiple tack fixation.

Keywords: Inguinal Hernia, Hernioplasty; Mesh fixation techniques; Tack-glue hybrid; Treatment outcome.
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1. INTRODUCTION

Laparoscopic inguinal hernia repair (LIHR) has emerged as the established standard of care in contemporary surgical practice, primarily attributable to its well-documented advantages over traditional open techniques, including reduced severity of postoperative pain, accelerated recovery timelines, and a more rapid return to preoperative levels of normal daily activities [1,2]. Within the spectrum of laparoscopic methodologies, transabdominal preperitoneal (TAPP) repair and totally extraperitoneal (TEP) repair represent the predominant approaches, each substantiated by extensive clinical evidence demonstrating equivalent efficacy, safety profiles, and long-term durability in terms of recurrence prevention and complication rates [3,4]. Notwithstanding these substantial advancements in minimally invasive hernia management, postoperative pain intensity and early

recovery trajectories remain significantly modulated by intraoperative technical variables, with the method of prosthetic mesh fixation emerging as a critical determinant of these patient-centered outcomes [5,6].

Conventional mesh fixation using multiple tacks has been associated with effective mesh stabilization; however, it has also been implicated as a potential contributor to postoperative pain due to tissue penetration and possible nerve irritation [3,5]. Several studies have highlighted that fixation-related trauma may play a role in both acute postoperative pain and the development of chronic pain following laparoscopic inguinal hernia repair [6,7]. Consequently, there has been growing interest in alternative fixation strategies aimed at minimizing tissue injury while maintaining adequate mesh stability [5,8].

Tissue adhesives, particularly fibrin and synthetic glues, have emerged as promising adjuncts or alternatives to tack fixation [5,7]. Glue-assisted mesh fixation has been proposed to reduce postoperative pain by limiting mechanical trauma and nerve involvement, while still providing sufficient mesh adherence [5,9]. Previous studies have reported favorable short-term pain outcomes with glue fixation, with some suggesting comparable recurrence rates to tack-based fixation [9,10]. However, concerns remain regarding optimal fixation techniques, cost considerations, and the consistency of clinical benefits across different patient populations and surgical settings [10,11].

More recently, hybrid fixation strategies such as the use of a single tack combined with glue have been introduced as a potential compromise between mechanical security and reduced tissue trauma [5,8]. While this approach theoretically offers the advantages of both methods, evidence directly comparing single tack plus glue fixation with conventional multiple tack fixation remains limited [5,10]. In particular, data on postoperative pain trajectories, early recovery parameters, and complication profiles in such comparative settings are sparse [11,12].

Given the clinical importance of postoperative pain control and early recovery in laparoscopic inguinal hernia repair, there is a need for well-designed comparative studies evaluating fixation techniques that balance efficacy with patient-centered outcomes. The present study was therefore undertaken to compare multiple tack fixation with single tack plus glue fixation in laparoscopic inguinal hernia repair, with specific emphasis on postoperative pain at defined time points, intraoperative parameters, postoperative recovery outcomes, and complication rates.

2. MATERIALS AND METHODS

This retrospective comparative study was conducted in the Department of General Surgery, Chettinad Hospital and Research Institute, between January and December 2025. Ethical approval was obtained from the Institutional Human Ethics Committee (Approval No.: IHEC-I/4293/25). As this was a retrospective analysis of existing clinical data, the requirement for individual informed consent was waived by the Ethics Committee. All data were anonymized prior to analysis, and patient confidentiality was strictly maintained in accordance with the Declaration of Helsinki.

2.1 Study design and study population

A total of 60 adult male patients diagnosed with primary inguinal hernia and underwent elective laparoscopic inguinal hernia repair were included in the study. Patients were divided into two equal groups based on the mesh fixation technique used during surgery:

- **Group A (Multiple tack fixation group):** Mesh fixation performed using multiple tacks (≥3 tacks) (n = 30)
- **Group B (Single tack plus glue fixation group):** Mesh fixation performed using a single tack combined with biological glue (n = 30)

Only male patients were included in this study because inguinal hernias are significantly more prevalent in males, and the anatomical characteristics of the male inguinal canal differ from those of females. Including only male patients ensured a more homogeneous study population and minimized anatomical variability that could influence surgical outcomes, postoperative pain perception, and fixation effectiveness.

Inclusion criteria

Patients fulfilling the following criteria were included:

- Male patients aged ≥ 18 years
- Diagnosed with primary unilateral or bilateral inguinal hernia
- Underwent elective laparoscopic inguinal hernia repair
- Complete follow up medical records available

Exclusion criteria

Patients meeting any of the following criteria were excluded:

- Recurrent inguinal hernia
- Complicated hernias (strangulated or obstructed hernia)

- Emergency hernia repair
- Conversion to open surgery
- Patients with severe uncontrolled systemic illness (e.g., uncontrolled diabetes mellitus, immunosuppression, or chronic steroid use)
- Patients whose complete follow up data not available

2.2 Preoperative assessment

All patients underwent detailed clinical evaluation including demographic details such as age, comorbidities, and clinical characteristics of the hernia. Routine preoperative investigations were performed as per institutional protocol. Patients were evaluated and deemed fit for laparoscopic surgery under general anaesthesia.

2.3 Operative technique

All procedures were performed under general anaesthesia by experienced laparoscopic surgeons using standard laparoscopic techniques.

After reduction of the hernia sac and adequate dissection of the preperitoneal space, a standard polypropylene mesh was placed to cover the myopectineal orifice.

In **Group A**, the mesh was secured using multiple tacks (≥3 tacks), typically placed at key anatomical fixation points to ensure stable mesh placement.

In **Group B**, the mesh was secured using a single tack supplemented with biological glue applied at strategic locations to provide adequate mesh adherence while minimizing tissue penetration.

Care was taken in both groups to avoid injury to neurovascular structures and ensure proper mesh positioning.

2.4 Postoperative assessment and follow-up

Postoperative pain was assessed using the Visual Analog Scale (VAS), a validated scoring system ranging from 0 (no pain) to 10 (worst possible pain). Pain scores were recorded at:

- 24 hours postoperatively
- During follow-up visits as per institutional protocol

Other postoperative parameters recorded included:

- Operative time (minutes)
- Length of hospital stay (days)
- Postoperative complications such as bleeding, hematoma, or infection
- Total procedural cost

Patients were followed up to assess recovery and detect any complications.

2.5 Outcome measures

Primary outcome:

- Postoperative pain assessed using Visual Analog Scale (VAS)

Secondary outcomes:

- Operative time
- Length of hospital stay
- Postoperative complications

2.6 Statistical analysis

All data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) software, version 26.0 (IBM Corp., Armonk, NY, USA).

Continuous variables were expressed as mean ± standard deviation (SD), and categorical variables were expressed as frequencies and percentages.

The independent samples t-test was used to compare continuous variables between the two groups. The Chi-square test was used to compare categorical variables. Fisher's exact test was applied when expected frequencies were less than 5.

A p-value of less than 0.05 was considered statistically significant.

3. RESULTS

A total of 60 patients underwent analysis, with 30 in the multiple tacks group and 30 in the single tack plus glue group. Baseline demographics and clinical features were comparable across groups, as shown in Table 1.

Table 1. Baseline demographic and clinical characteristics of study groups

Variable	Multiple Tacks (n=30)	Single Tack + Glue (n=30)	Statistical test	p-value
Age (years), mean ± SD	50.80 ± 10.32	49.70 ± 11.13	Independent t-test	0.693
Diabetes mellitus, n (%)	8 (26.7%)	7 (23.3%)	Fisher's exact	1.000
Hypertension, n (%)	5 (16.7%)	6 (20.0%)		
DM + HTN, n (%)	4 (13.3%)	5 (16.7%)		
No comorbidity, n (%)	13 (43.3%)	12 (40.0%)		

Values are mean ± SD or n (%); $p < 0.05$ significant.

Mean age was similar between the two groups at 50.80 ± 10.32 years for multiple tacks versus 49.70 ± 11.13 years for single tack plus glue (independent t-test, p=0.693), indicating no meaningful difference in this key demographic factor that could skew postoperative outcomes.

Comorbidities also showed no imbalances that might influence recovery or pain scores: diabetes mellitus affected 26.7% in the multiple tacks group (8/30 patients) compared to 23.3% in the single tack plus glue group (7/30); hypertension alone was seen in 16.7% (5/30) versus 20.0% (6/30); the combination of diabetes and hypertension appeared in 13.3% (4/30) versus 16.7% (5/30); and patients with no comorbidities made up 43.3% (13/30) versus 40.0% (12/30). Overall, these distributions were statistically equivalent (Fisher's exact test, p=1.000).

Table 2. Comparison of postoperative pain scores between study groups

Time point	Multiple Tacks (n=30) Median (IQR)	Single Tack + Glue (n=30) Median (IQR)	Statistical test	p-value
VAS at 24 hours	3 (IQR 1)	2 (IQR 0)	Mann–Whitney U	**<0.001**
VAS at 1 week	2 (IQR 1)	1 (IQR 0)	Mann–Whitney U	**<0.001**
VAS at 1 month	1 (IQR 0)	1 (IQR 0)	Mann–Whitney U	**0.078**

VAS = Visual Analog Scale. Values expressed as median (interquartile range).

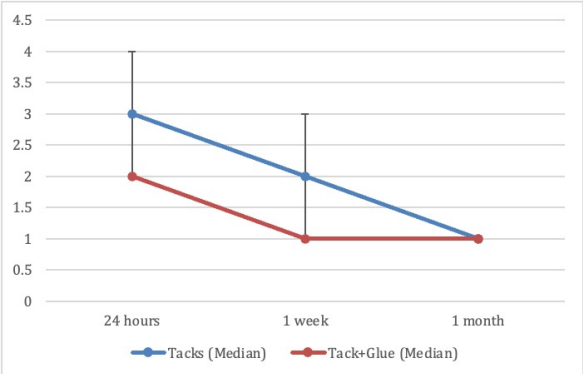

Fig. 1 Trend of postoperative pain scores over follow-up period in the Multiple Tacks and Single Tack + Glue groups. Median visual analog scale (VAS) scores are plotted at 24 hours, 1 week, and 1 month postoperatively. Error bars represent interquartile ranges.

Postoperative pain scores (VAS; Table 2) favored single tack plus glue fixation in the early period, aligning with the primary objective of assessing pain and comfort post-LIHR. At 24 hours, median scores were lower at 2 (IQR, 0) versus 3 (IQR, 1) (Mann-Whitney U, $p < 0.001$)—a clinically relevant reduction during peak discomfort and analgesic dependence. This persisted at 1 week: 1 (IQR, 0) versus 2 (IQR, 1) ($p < 0.001$), consistent with less tissue/nerve irritation from reduced tacks. At 1 month, scores converged at 1 (IQR, 0) for both ($p = 0.078$), indicating equivalent long-term outcomes. These findings support hybrid fixation for reduced early pain without chronic compromise, with implications for recovery and practice. Figure 1 illustrates the trend.

Table 3. Comparison of intraoperative and postoperative recovery outcomes between study groups

Outcome	Multiple Tacks (n=30)	Single Tack + Glue (n=30)	Statistical test	p-value
Operative time (minutes), mean ± SD	117.30 ± 26.96	115.90 ± 24.13	Independent t-test	0.833
Hospital stay (days), mean ± SD	5.93 ± 0.94	5.00 ± 0.95	Independent t-test	**<0.001**
No complication, n (%)	25 (83.3%)	30 (100%)	Fisher's exact	**0.052**
Minimal bleeding, n (%)	5 (16.7%)	0 (0.0%)	Fisher's exact	

Table 3 presents key intraoperative and postoperative recovery outcomes between the two fixation groups. Mean operative time showed no meaningful difference (117.30 ± 26.96 minutes for multiple tacks versus

115.90 ± 24.13 minutes for single tack plus glue; independent t-test, p = 0.833), confirming procedural efficiency was comparable despite the different fixation approaches. Hospital stay, however, was notably shorter in the single tack plus glue group (5.00 ± 0.95 days) compared to multiple tacks (5.93 ± 0.94 days; p < 0.001). This nearly one-day reduction aligns with the observed early pain benefits and carries clear clinical implications for resource utilization and patient throughput.

Regarding complications, all 30 patients (100%) in the single tack plus glue group had an uneventful recovery, compared to 25 (83.3%) in the multiple tacks group (Fisher's exact test, p = 0.052). The five cases of minimal bleeding in the multiple tacks group (16.7%) versus none in the hybrid group further support a favorable safety profile, though low event rates limited statistical power for definitive significance. These secondary outcomes reinforce the hybrid technique's advantages in accelerating recovery and minimizing adverse events, as visually depicted in Figure 2, while maintaining operative times equivalent to standard tack fixation.

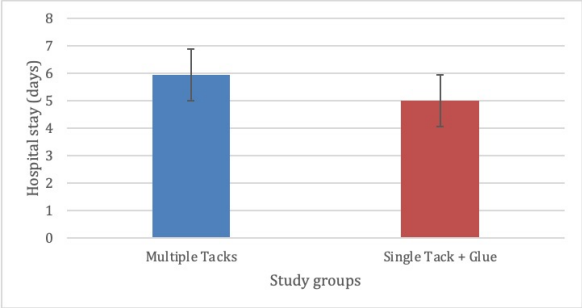

Fig. 2 Comparison of postoperative hospital stay between study groups. Bars represent mean duration of hospital stay in days, and error bars indicate standard deviation.

4. DISCUSSION

This prospective comparative study evaluated mesh fixation techniques in LIHR, demonstrating that single tack plus biological glue (hybrid) fixation resulted in significantly lower early postoperative VAS pain scores (24 hours and 1 week; p<0.001), shorter hospital stays (5.00 ± 0.95 vs. 5.93 ± 0.94 days; p<0.001), and a non-significant trend toward fewer complications (p=0.052) compared to multiple tacks. Operative times were equivalent (p=0.833). These findings align closely with the study's primary objective of assessing postoperative pain/comfort and secondary endpoints of recovery metrics, contributing pragmatic data on hybrid fixation's role in minimizing acute morbidity. Early pain reduction with hybrid fixation mirrors patterns in recent meta-analyses. Kitching et al. (2025) [11] reported significantly lower acute VAS scores with glue versus tackers in LIHR (pooled mean difference favoring glue; trial sequential analysis confirmed sufficiency), alongside reduced hematoma/seroma risks paralleling our bleeding trend, though our low events (5 cases) precluded significance. Similarly, Raja et al. (2024) [10] found glue superior for postoperative day 1 pain (RR 0.40 for chronic pain overall; 11 RCTs, n=1505) and total complications versus tacks, attributing benefits to less neuralgia; our 1-week persistence and 1-month convergence extend this, suggesting hybrid tack+glue retains acute advantages without pure glue's potential fixation concerns.

Hospital stay shortening (0.93 days) exceeds slight reductions (0.06-0.37 days) in Techapongsatorn et al.'s (2022) [8] umbrella review of 10 SRMAs for LIHR no-fixation/tack comparisons (some significant favoring non-penetrative), and contrasts null findings in open repairs. Shi et al. (2017) [13] corroborated our operative time equivalence (SMD 0.80, non-significant; 4 RCTs/6 non-RCTs, n=9067) for fibrin glue vs. staples in TAPP, noting no rise in recurrence/seroma reinforcing hybrid feasibility without prolonging surgery. Complication trends (100% vs. 83.3% uneventful) align with adhesive benefits in Giordano et al. (2024) [12], who meta-analyzed in vivo fixation strength across open/laparoscopic approaches, showing glue's atraumatic bonding reduces bleed/hematoma versus mechanical methods. Our minimal bleeding (16.7% multiple tacks) echoes this, but underpowering limits inference larger trials are needed, as power calculations in Kitching et al. (2025) [11] highlight for rare events. Mechanistically, reduced penetrations likely lessen ilioinguinal/iliohypogastric irritation, as inferred from pain meta-analyses, though direct neurohistology is absent here. No recurrence (short follow-up) or failures occurred, matching safety in Shi et al. (2017) [13]. Strengths include baseline matching (Table 1), standardized VAS timing, surgeon uniformity (experienced hands), and hybrid novelty bridging tacks/glue. Limitations: Single-center (n=60) risks bias/generalizability; VAS subjectivity; 1-month follow-up misses chronic pain/recurrence (gold standard >12 months); no cost/formal power for complications. Multicenter RCTs are warranted. In summary, hybrid fixation offers early pain/stay benefits akin to pure glue studies, with tack security guiding elective LIHR toward patient-centered

optimization. Extended trials will solidify chronic/cost outcomes.

5. CONCLUSION

Single tack plus glue fixation reduced early (24 hours) and intermediate (1 week) postoperative VAS pain scores ($p<0.001$) and shortened hospital stays by nearly 1 day ($p<0.001$) compared to multiple tacks in laparoscopic inguinal hernia repair, without prolonging operative time ($p=0.833$) or raising complications ($p=0.052$ trend favoring hybrid). Well-matched baselines and identical surgical approaches (Table 1) isolate these gains to fixation technique, likely from less penetrative trauma, a practical edge in minimally invasive hernia surgery, where early pain drives satisfaction and recovery. These results position glue-assisted fixation as a safe, effective alternative for elective cases. Multicenter RCTs with extended follow-up (>12 months) should confirm chronic pain, recurrence, and cost benefits to guide widespread adoption.

Statements and Declarations

Competing Interests

The authors declare that they have no financial or non-financial interests that are directly or indirectly related to the work submitted for publication.

Code availability: Not applicable

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Ethics Approval

The study was approved by the Institutional Ethics Committee of Chettinad Hospital and Research Institute **(IHEC-I/4293/25)** and was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

Consent for Publication

Not applicable.

Availability of Data and Material

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

CRediT Author Contribution Statement

Mukes Saravanan: Conceptualization, Methodology, Data curation, Investigation, Formal analysis, Visualization, Writing – original draft preparation.

R. Anantharamakrishnan: Methodology, Validation, Supervision, Writing – review and editing.

K. Senthil Kumar: Conceptualization, Supervision, Project administration, Validation, Writing – review and editing, Corresponding author.

Shahid Ibrahim: Investigation, Data curation, Literature review, Validation, Writing – review and editing.

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