International Surgery Journal
Raju TR et al. Int Surg J. 2026 Aug;13(8):1419-1425
https://www.ijsurgery.com
pISSN 2349-3305 | eISSN 2349-2902

Original Research Article

DOI: https://dx.doi.org/10.18203/2349-2902.isj20262465

Double strip fascial reinforcement of inguinal hernia: optimized tissue repair technique

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Received: 24 June 2026
Accepted: 21 July 2026

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ABSTRACT

Background: Inguinal hernia repair has evolved from tissue-based techniques to mesh repair, the current standard of care. However, mesh-related complications have renewed interest in tissue-based repairs. This study evaluates the outcomes of tissue-based inguinal hernia repair and its effectiveness as an alternative to mesh repair.
Methods: This prospective study conducted at Department of Surgery, Seethalakshmi Hospital, Tamil Nadu, from January 2015 to July 2018. Total of 208 patients with primary inguinal hernia underwent optimized tissue repair (OTR). Outcomes assessed included postop pain, ambulation time, hospital stay, seroma formation and recurrence.
Results: A total of 208 patients with inguinal hernia were analysed, including 132 (63.47%) indirect, 52 (25.0%) direct, and 24 (11.53%) combined hernias. The mean age was 51.1 years (range: 18-70 years), with a male predominance (181; 87.02%). Early ambulation within 6-9 hours was achieved in 198 (95.19%) patients. On postoperative day one, 200 (96.15%) patients reported mild pain, while 8 (3.85%) had moderate pain; by day two, all patients had only mild pain. Most patients required only oral analgesics (196; 94.23%) and resumed oral intake within 6 hours (185; 88.94%). Early discharge was achieved in 202 (97.11%) patients on postoperative day one, with a mean hospital stay of 1 day. Postoperative complications were minimal, with seroma in 11 (5.28%), superficial surgical site infection in 4 (1.92%), and hematoma in 2 (0.96%) patients, all managed conservatively. No intraoperative complications or chronic postoperative groin pain were observed. During the 7-year follow-up period, two patients developed clinical recurrence and subsequently underwent mesh repair.
Conclusions: OTR appears to be a safe and effective tissue-based option for primary inguinal hernia repair, with favorable short- and long-term outcomes.

Keywords: Optimized tissue repair, Inguinal hernia, Desarda's technique, Shouldice technique

INTRODUCTION

Inguinal hernia is a common surgical condition, with an estimated incidence of 5-7%, and occurs more frequently in developing nations.[1] The evolution of inguinal hernia repair represents a landmark in the history of surgery, spanning over a century, yet an ideal technique with uniformly optimal outcomes remains elusive. The

introduction of mesh-based repair has significantly reduced recurrence rates; however, this benefit has been accompanied by mesh-related complications, particularly chronic postoperative inguinal pain (inguinodynia), which can substantially impair quality of life. Additional mesh-associated issues include foreign body sensation, stiffness, and persistent groin discomfort. The morbidity associated with mesh-related complications has prompted renewed interest in tissue-based repair techniques that utilize native tissues while avoiding prosthetic materials.[2]

The declining preference for tissue-based repair in favor of mesh repair raises an important question in the evolution of inguinal hernia surgery-has this shift represented a wrong turn? Reliance on scar tissue and a static posterior wall alone may not adequately address the underlying pathophysiology of herniation. Mesh, while effective in reducing recurrence, is neither a universal nor definitive solution. The critical determinant ("X factor") in susceptibility to inguinal herniation appears to be the integrity of a strong, physiological, and dynamic posterior wall, formed by the condensed transversalis fascia and aponeurotic extensions from the transversus abdominis arch. Notably, complete coverage of the posterior wall by these aponeurotic extensions is present in only approximately 47% of the population. Contraction of the transversus abdominis muscle displaces this complex upward and laterally, generating dynamic tension that resists intra-abdominal pressure more effectively than a passive, non-tensioned wall. Herniation is uncommon in regions of the anterior abdominal wall where layered structures remain in firm apposition, underscoring the importance of dynamic anatomical support.[3]

An ideal hernia repair should restore normal anatomy by eliminating potential sites of weakness rather than relying solely on prosthetic reinforcement. The inguinal canal inherently represents a potential space for herniation. Although the external oblique aponeurosis (EOA) is relatively strong in this region, it plays a limited role in preventing herniation. Re-establishing the native anatomy of the EOA may help restore the functional integrity of anterior abdominal wall musculature at inguinal canal. In this context, we report our initial experience with OTR as a primary treatment modality for inguinal hernia.

METHODS

This prospective observational study was conducted in the Department of Surgery, Seethalakshmi Hospital, Gobichettipalayam, Tamil Nadu, between January 2015 and July 2018. Ethical approval was obtained from the Regional Institute Human Ethics Committee, and written informed consent was obtained from all participants. Consecutive eligible patients presenting with primary inguinal hernia during the study period were included. Data collected included demographic characteristics, hernia type, perioperative variables, postoperative pain, time to ambulation, duration of hospital stay, postoperative complications, chronic groin pain, and recurrence. The primary objective of this study was to evaluate the short- and long-term outcomes of OTR in primary inguinal hernia, including postoperative pain, recovery profile, postoperative complications, chronic groin pain, and recurrence.

Inclusion and exclusion criteria

Inclusion criteria comprised patients aged 18-70 years with primary unilateral inguinal hernia who were fit for elective surgery. Patients with recurrent or bilateral hernias, emergency presentations, weakened EOA, ASA physical status >III, participation in other clinical trials, and those at the extremes of age were excluded.

Preoperative assessment

Data were collected and recorded in a pre-specified proforma at the time of admission and during regular follow-up. Demographic details (age and sex), detailed clinical history, physical examination findings, relevant laboratory investigations, and ultrasonography findings in selected cases were documented. Obese patients were advised weight-reduction measures, and surgery was deferred to allow attainment of the targeted weight. All patients underwent surgery under spinal or local anesthesia; cases of failed spinal anesthesia were converted to general anesthesia. A single prophylactic dose of intravenous antibiotic was administered at the time of skin incision in all patients, with no additional postoperative doses given.

Surgical technique: OTR

All OTR procedures were performed using an open anterior approach by the same surgeon. The initial steps were similar to standard open hernia repair up to herniotomy, with liberal raising of flaps of the EOA, both subcutaneously and beneath the aponeurosis. Division of the transversalis fascia was performed in all cases of direct hernia, indirect hernia with a patulous deep ring, and those with a weakened posterior wall. The transversalis fascia was carefully separated from the preperitoneal fat or peritoneum by fine dissection. Redundant and weakened transversalis fascia was excised, followed by repair using continuous 1-0 polypropylene sutures until adequate tightening of the deep inguinal ring was achieved.

A longitudinal slit was created in the upper leaf of the EOA approximately 1.5-2 cm above its lower margin, forming a vascularized aponeurotic strip that remained attached medially and laterally, thereby preserving its blood supply and functional integrity (Figure 1). The inferior margin of this EOA strip was sutured to the inguinal ligament up to the deep ring using continuous 1-0 polypropylene sutures (Figure 2). Subsequently, the lower leaf of the EOA and the superior margin of the EOA strip were sutured to the conjoint tendon using

continuous or interrupted 1-0 polypropylene sutures, extending slightly lateral to the deep ring (Figure 3). The upper leaf of the EOA was then approximated to the underlying musculature without undue tension (Figure 4).

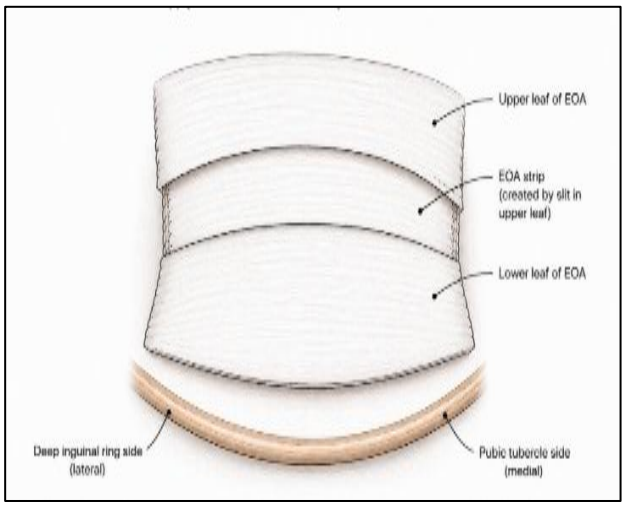

Figure 1: Longitudinal slit created in the upper leaf of the EOA.

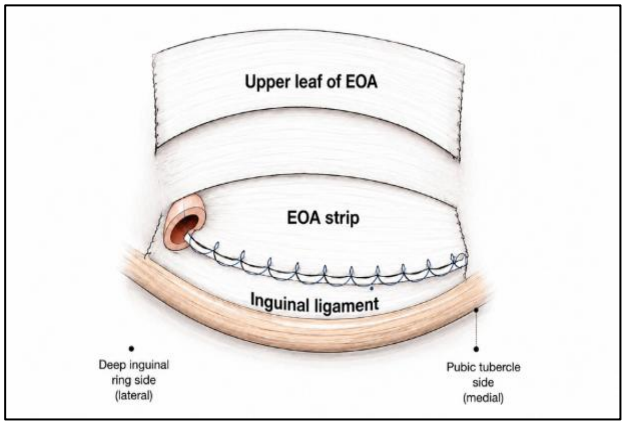

Figure 2: Inferior margin of the EOA strip sutured to the inguinal ligament.

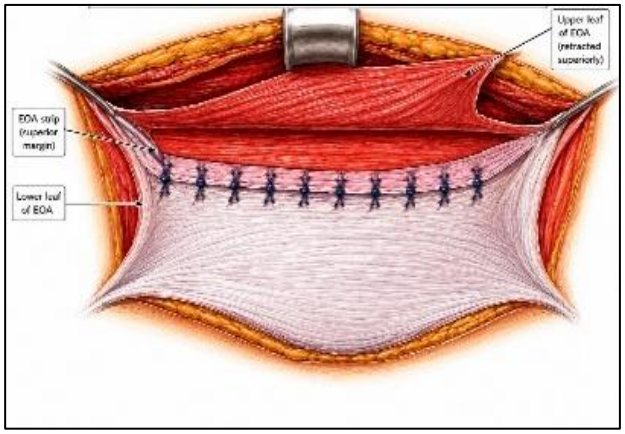

Figure 3: Lower leaf of the EOA and superior margin of the EOA strip sutured to the conjoint tendon.

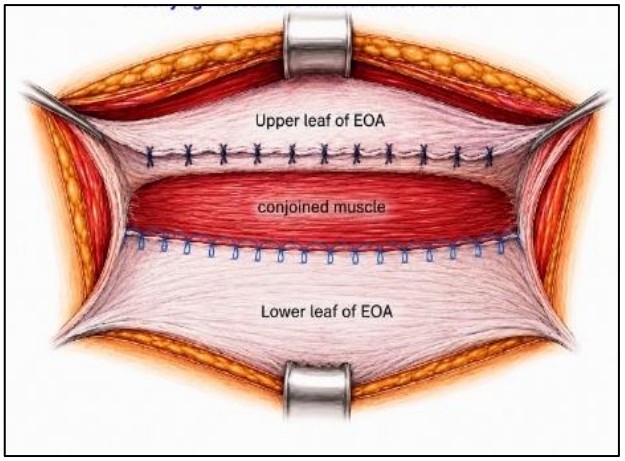

Figure 4: Upper leaf of the EOA approximated to the underlying musculature.

The ilioinguinal, iliohypogastric, and genital branch of the genitofemoral nerves were identified and preserved whenever feasible during dissection. This technique results in complete coverage of the posterior wall with a dynamic, tension-free aponeurotic layer, effectively obliterating the inguinal canal with exteriorization of the spermatic cord. The double-layered reinforcement achieved by imbrication of the EOA leaves and compartmentalization of the aponeurotic flaps within the inguinal region represents a distinctive feature of OTR compared with conventional tissue repair techniques.

Postoperative course

Postoperatively, patients were administered oral analgesics (diclofenac 50 mg twice daily), with parenteral analgesia provided when required. Early ambulation was encouraged six hours after surgery, and discharge was considered once patients were able to void independently. Patients were assessed daily during their hospital stay, and data were collected on duration of hospitalization, time to ambulation, postoperative pain, and seroma formation. Pain severity was assessed using the visual analogue scale (VAS) and categorized as mild (0-3), moderate (4-6), and severe (7-10). Patients engaged in non-strenuous office work were advised to resume duties on the fourth postoperative day. Patients were reviewed at 1 month, 6 months, and annually thereafter. Follow-up evaluation included assessment of wound-related complications, chronic groin pain, return to normal activity, and recurrence. Chronic groin pain was assessed during outpatient visits and telephonic follow-up using patient-reported symptoms persisting beyond three months after surgery. Recurrence was defined clinically as the presence of a groin bulge with a positive cough impulse.

Statistical analysis

Statistical analysis was performed using SPSS version 25. Continuous variables were summarized as mean values

with ranges, whereas categorical variables were expressed as frequencies and percentages. As this was a single-arm prospective observational study, descriptive statistics were used for analysis.

RESULTS

A total of 208 patients with inguinal hernia were analysed (Table 1). Of these, 132 (63.47%) patients had indirect inguinal hernia, 52 (25.0%) had direct inguinal hernia, and 24 (11.53%) had combined (direct and indirect) hernia. The mean age was 51.1 years (range: 18-70 years), with the majority of patients in the 51-60-year age group (Table 2). There were 181 (87.02%) male and 27 (12.98%) female patients. Spinal anaesthesia was used in 183 (87.98%) patients, local anaesthesia in 23 (11.06%), and general anaesthesia in 2 (0.96%). No intraoperative complications were recorded.

Table 1: Baseline demographic and clinical characteristics.

Variables	N (%)
Total patients	208
Mean age (in years)	51.1
Male	181 (87.02)
Female	27 (12.98)
Indirect hernia	132 (63.47)
Direct hernia	52 (25.00)
Combined hernia	24 (11.53)
Spinal anaesthesia	183 (87.98)
Local anaesthesia	23 (11.06)
General anaesthesia	2 (0.96)

Table 2: Age distribution of the patients.

Age (in years)	N	Percentage (%)
18-30	28	13.46
31-40	34	16.35
41-50	46	22.12
51-60	62	29.81
61-70	38	18.27
Total	208	100

Postoperative recovery was rapid and satisfactory in the majority of patients (Table 3). Early ambulation was achieved within 6-9 hours in most patients (198; 95.19%), with a mean ambulation time of 6.30 hours, while a small proportion (10; 4.81%) were mobilized within 24 hours. Early resumption of oral intake was also observed, with 185 patients (88.94%) able to take oral feeds within 6 hours after surgery. Pain assessment on the first postoperative day showed that the majority of patients experienced only mild pain (200; 96.15%), whereas a small number reported moderate pain (8; 3.85%). By the second postoperative day, all patients (208; 100%) reported only mild pain, which subsequently resolved. Correspondingly, most patients required only oral analgesics (196; 94.23%), and a limited number required injectable analgesics (12; 5.77%).

Hospital stay was short, with most patients discharged on the first postoperative day (202; 97.11%), while a few required discharges on the second postoperative day (6; 2.89%). The mean duration of hospital stay was 1 day (range: 1-3 days). At discharge, patients reported mild discomfort without significant pain. Postoperative complications were minimal. Seroma formation was observed in 11 patients (5.28%), superficial surgical site infection in 4 patients (1.92%), and hematoma in 2 patients (0.96%). All complications were managed conservatively without the need for surgical intervention. Functional recovery was favourable, with the majority of patients returning to normal daily activities within 7 days (172; 82.69%), while the remaining patients resumed activities within 7-14 days (36; 17.31%).

During follow-up, no cases of chronic groin pain (inguinodynia) were noted at one year. During the 7-year follow-up period, patient retention gradually declined, with 96 patients (46.15%) remaining available for assessment at the final follow-up (Table 4). Follow-up was conducted through outpatient clinic visits and telephonic interviews. Two patients developed clinical recurrence during follow-up and subsequently underwent mesh repair. No additional clinically apparent recurrences were reported among remaining patients available for follow-up, suggesting favorable long-term durability of repair.

Table 3: Postoperative outcomes and follow-up of patients who underwent OTR.

Variables		N	Percentage (%)
Early ambulation	6-9 hours	198	95.19
	Within 24 hours	10	4.81
	Mean ambulation time	6.30 hours	-
Postoperative pain day-1	Mild	200	96.15
	Moderate	8	3.85
Postoperative pain day-2	Mild	208	100
Analgesic requirement	Oral analgesics only	196	94.23
	Injectable analgesics	12	5.77
Time to oral intake	Within 6 hours	185	88.94
	After 6 hours	23	11.06

Continued.

Variables		N	Percentage (%)
Return to normal activity	Within 7 days	172	82.69
	7-14 days	36	17.31
Hospital stays	Discharged day 1	202	97.11
	Discharged day 2	6	2.89
	Mean stay	1 day (1-3 days)	-
Wound-related complications	Seroma	11	5.28
	Superficial SSI	4	1.92
	Hematoma	2	0.96
Chronic pain (Inguinodynia)	At 1 year	0	0
Long-term outcome	Recurrence (7 years)	2	0.96%

Table 4: Cumulative follow-up status and recurrence assessment.

Follow-up interval	Follow-up, N (%)	Mode of interview (clinical/ telephonic)	Lost to follow-up	Recurrence
1 month	208	208/0	0	0
6 months	208	208/0	0	0
1st year	192	172/20	16 (7.69%)	0
2nd year	180	158/22	28 (13.46%)	0
3rd year	172	110/62	36 (17.30%)	0
4th year	156	84/72	52 (25%)	0
5th year	134	44/90	74 (35%)	1 (0.48%)*
6th year	112	21/91	96 (46.15%)	1 (0.48%)*
7th year	96	16/80	112 (53.84%)	0

*(Recurrence percentage calculated using the total study population, (n=208).

DISCUSSION

Classical tissue-based repairs such as Bassini, Shouldice, and McVay have demonstrated good and comparable outcomes; however, all these techniques require extensive dissection and excision of the inguinal floor. The Shouldice repair, when performed in specialized centers, has been associated with recurrence rates of approximately 1-4%. Subsequent modifications by many surgeons involved omission of key technical steps, leading to inferior outcomes.[4,5] Traditional tissue repairs often place the reconstructed tissues under excessive tension, resulting in a predominantly mechanical repair rather than restoration of normal anatomy and physiological function. Simply approximating the abdominal wall muscles to the inguinal ligament to reinforce the posterior wall lacks functional synergy and may further weaken the repair. Current concepts in inguinal hernia surgery recognize that effective tissue reconstruction without excessive tension is difficult to achieve, which may explain the higher recurrence rates observed with tissue repair techniques compared with mesh-based repairs.

Lichtenstein mesh repair is widely accepted as the standard technique for inguinal hernia repair; however, this acceptance has been accompanied by recognition of mesh-related complications. Reported recurrence rates range from approximately 1% in highly specialized centers to 4% in community hospitals.[6] Chronic groin pain remains a significant concern, with reported incidences ranging from 28.7% to 43.3% following mesh repair. Failure of meshplasty may occur due to migration or displacement of the mesh from its fixation site. In the event of postoperative sepsis, mesh removal is often required.[7,8] Fibrotic reaction following mesh implantation can result in entrapment of inguinal nerves, contributing to chronic pain syndromes. As a foreign material, the mesh does not fully integrate with host tissues and may induce a persistent inflammatory response, which has been demonstrated on positron emission tomography imaging and may lead to progressive deterioration of mesh integrity over time.[9]

In contrast, laparoscopic hernia repair is associated with greater technical complexity and a steep learning curve. The cost of laparoscopic and robotic techniques remains high, and the financial burden on patients, along with limited infrastructure, remains a significant concern in developing countries such as India. Although laparoscopic repair is more time-consuming, it offers the advantage of earlier postoperative recovery. Reported complications include seroma and hematoma formation-particularly with the totally extraperitoneal approach-trocar-related issues, and the risk of major vascular injury. Despite these limitations, laparoscopic repair is considered the preferred approach for recurrent and bilateral inguinal hernias.[1]

The distinguishing feature of OTR is the double-layered reinforcement created by imbrication of the EOA and repair of the transversalis fascia. Unlike conventional tissue repairs, approximation of the internal oblique and transversus abdominis muscles to the inguinal ligament is avoided, minimizing tension on the repair. Complete obliteration of the inguinal canal and reinforcement of the posterior wall may have contributed to the low recurrence rate observed during follow-up.

It is recognized that aponeurotic extensions from the transversus abdominis arch to the posterior wall contribute significantly to the structural integrity of the inguinal region and play a key role in preventing inguinal herniation. In approximately 53% of individuals, these extensions are absent and the posterior wall strength is compensated by surrounding muscular components; however, when these muscles are weak, this protective mechanism may be insufficient.[10] In the present technique, a newly created strip of the EOA reinforces the posterior wall. Subsequent suturing of the lower leaf of the EOA and the upper border of the EOA strip to the conjoint tendon provides additional reinforcement. Externalization of the cord structures superficial to the EOA results in obliteration of the inguinal canal, thereby eliminating a potential site of weakness. The double-breasting of the EOA strip creates an artificial insertion for the deficient conjoint muscles, enhancing their functional strength. During contraction of the lower abdominal muscles, the strip is dynamically displaced laterally and superiorly, generating graded tension proportional to muscular activity. In the resting state, the double-layered strip remains tension-free. This dynamic reinforcement restores a strong, physiologically functional posterior wall and provides sustained protection against hernia formation.

In comparison with the Desarda's technique, which is a tissue-based method utilizing a single strip of the EOA to reinforce the posterior wall, the present technique offers additional structural support. In Desarda's repair, the transversalis fascia is not addressed, despite its central role in the posterior wall and its emphasis in the Shouldice technique. Repair of the transversalis fascia, particularly after excision of redundant fascia, provides important reinforcement and is especially relevant in the management of direct inguinal hernias, where posterior wall weakness is the primary pathology. Mere inversion of the direct sac contributes minimally to long-term repair strength. While Desarda's technique relies on a single EOA strip, the present technique employs a double EOA strip to reinforce the posterior wall and simultaneously tighten the deep inguinal ring, thereby offering greater strength and stability. Consequently, this approach provides an added mechanical and functional advantage. Previous studies have reported no recurrence following this technique, with outcomes comparable to those observed in the present study.[10,11]

The Shouldice technique involves multilayered repair of the transversalis fascia, whereas in the present study the transversalis fascia was repaired in a single layer. Unlike the shouldice repair, which approximates the internal oblique and transversus abdominis muscles to the inguinal ligament, our technique avoids this step by employing a free-flap method, thereby minimizing tension at the repair site. Additionally, externalization of the spermatic cord in our technique results in complete obliteration of the inguinal canal, which may further reduce the risk of recurrence. The Shouldice technique is associated with a low incidence of chronic pain, which is comparable to the outcomes observed in the present study. While published series report a recurrence rate of approximately 1% with the Shouldice technique, only two patients in the present study developed clinical recurrence during follow-up and subsequently underwent mesh repair.[4,12] Despite the low recurrence rate observed, more than half of the study population was lost to follow-up by 7 years, which may have resulted in underestimation of the true recurrence rate.

In the present study, OTR was associated with early ambulation, short hospital stays, and low postoperative morbidity. During follow-up, only two patients developed clinical recurrence and were subsequently managed with mesh repair, while no further recurrences were observed among the remaining patients available for follow-up. These findings compare favorably with published outcomes of other tissue-based repairs and suggest that restoration of posterior wall integrity using native tissues may provide durable repair while avoiding the potential complications associated with prosthetic mesh implantation.

Limitations

This study has certain limitations that should be considered while interpreting the results. First, it was a single-center study without a control group, limiting direct comparison with established techniques such as mesh-based repair. Second, although the sample size of 208 patients is reasonable, randomized controlled trials with larger populations would provide stronger evidence. A formal sample size calculation was not performed because this study was designed as an exploratory prospective observational evaluation of a novel tissue-based repair technique. Third, the study excluded recurrent, bilateral, and complicated hernias, which may limit the generalizability of the findings to all types of inguinal hernia. Additionally, outcomes such as postoperative pain were assessed using subjective measures, which may introduce observer and patient-related bias. Finally, despite long-term follow-up, loss to follow-up and lack of objective imaging in all cases may affect the accuracy of recurrence assessment. Further multicentric, randomized studies are required to validate these findings.

CONCLUSION

OTR appears to be a safe and effective tissue-based technique for primary inguinal hernia repair, providing early recovery and low postoperative morbidity. During long-term follow-up, clinical recurrence was observed in two patients, both of whom were successfully managed with mesh repair. The overall low recurrence rate among patients available for follow-up suggests favorable long-term durability of the technique; however, larger comparative studies with more complete follow-up are required to establish its long-term efficacy.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Regional Institute Ethics Committee

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Cite this article as: Raju TR, Kandhasamy SC, Sahoo AK, Nelson T, Naik D, Reddy GK, et al. Double strip fascial reinforcement of inguinal hernia: optimized tissue repair technique. Int Surg J 2026;13:1419-25.