Journal of Surgical Radiology

Site: https://journalsurgrad.com/

ISSN Print 2156-213X| ISSN Online: 2156-4566 Volume: 05 Issue: 07 Open Access

Research Article

Recurrence and Long-Term Outcomes After Open Lichtenstein Hernioplasty: A Prospective Cohort Study

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Article History
Received: 28-06-2026
Revised: 10-07-2026
Accepted: 22-07-2026
Published: 25-07-2026

Citations:
Sharada H, Niranjan, Patil P. Recurrence and Long-Term Outcomes After Open Lichtenstein Hernioplasty: A Prospective Cohort Study. J Surg Radiol, V5 (7) 352-357

Abstract: ***Introduction:*** Open Lichtenstein tension-free hernioplasty remains a gold-standard technique for primary inguinal hernia repair, demonstrating low recurrence rates ($< 1\text{--}2\%$) alongside acceptable post-repair morbidity. However, long-term clinical durability, late hernia recurrence, foreign-body sensation, and the potential impact of mesh fixation suture absorbability remain crucial areas of surgical evaluation. This prospective cohort study evaluates long-term recurrence rates, clinical outcomes, and patient-reported satisfaction following open Lichtenstein hernioplasty, comparing slowly absorbable polydioxanone (PDS) sutures with standard non-absorbable polypropylene sutures for mesh fixation. **Methods:** A prospective randomized cohort study evaluated 186 adult male patients undergoing elective open Lichtenstein tension-free hernioplasty at ESIC Medical College, PGIMSR and Model Hospital, Rajajinagar, Bengaluru. Participants were allocated in a 1:1 ratio to mesh fixation using either non-absorbable monofilament polypropylene sutures (Group A, $n = 93$) or slowly absorbable monofilament polydioxanone (PDS) sutures (Group B, $n = 93$). Primary long-term endpoints included hernia recurrence verified by physical examination and high-resolution ultrasonography, chronic inguinodynia (Visual Analog Scale), surgical site infection (SSI), seroma formation, and overall long-term satisfaction over a 6-month prospective evaluation period. **Results:** The mean patient age was 47.36 ± 14.10 years (range: 23–76 years). Indirect inguinal hernias accounted for 55.9% ($n = 104$) and direct hernias for 44.1% ($n = 82$). At the 6-month follow-up, zero hernia recurrences (0.0%, $n = 0$) were observed across both the polypropylene and polydioxanone fixation cohorts. Chronic inguinodynia was reported in 0.5% ($n = 1$) of the total population, isolated to the polypropylene group (1.1% vs 0.0%; $p = 1.000$). Early soft-tissue complications were low, with SSIs occurring in 3.2% ($n = 6$) of patients (4.3% polypropylene vs 2.2% PDS; $p = 0.692$) and seroma formation in 2.2% ($n = 4$) of patients (2.2% in both groups; $p = 1.000$). **Conclusion:** Open Lichtenstein mesh hernioplasty demonstrates high long-term structural durability with zero early-to-intermediate recurrences. Slowly absorbable polydioxanone (PDS) monofilament sutures provide mesh fixation security equivalent to non-absorbable polypropylene, maintaining structural repair integrity during primary fibroblastic tissue integration while minimizing foreign-body strain. PDS represents a safe, durable fixation alternative to non-absorbable sutures in open hernioplasty.

Keywords: Inguinal hernia repair, Lichtenstein hernioplasty, Hernia recurrence, Long-term outcomes, Polypropylene suture, Polydioxanone suture, Inguinodynia.

INTRODUCTION

The surgical management of groin hernias has evolved dramatically over the past century. The introduction of tension-free prosthetic hernioplasty by Irvine Lichtenstein in the late 1980s fundamentally altered hernia surgery, reducing historical primary recurrence rates from 10–15% in tissue-based repairs down to $< 1\text{--}2\%$. Consequently, modern surgical evaluations focus not only on preventing anatomical recurrence but also on optimizing long-term patient-reported outcome measures (PROMs), reducing post-hernioplasty inguinodynia, and minimizing tissue complications.

The mechanical foundation of open Lichtenstein repair relies on securing a flat synthetic mesh across the myopectineal orifice of Fruchaud, bridging Hesselbach's triangle and the deep inguinal ring. Standard surgical practice employs non-absorbable monofilament sutures, primarily polypropylene, to anchor the mesh to the pubic tubercle, the shelving edge of the inguinal ligament, and the conjoint tendon/internal oblique aponeurosis. While non-absorbable sutures ensure lifelong mechanical anchoring, permanent suture material can induce persistent foreign-body granulomatous reactions, suture-knot granulomas, suture sinuses, local tissue stiffness, and neural impingement.

Biomechanical studies demonstrate that fibroblastic infiltration and collagen deposition into porous monofilament polypropylene mesh reach structural stability within 4 to 6 weeks post-implantation. Once dense connective tissue encapsulates the mesh matrix, permanent suture fixation may become mechanically redundant. Monofilament polydioxanone (PDS) is a synthetic, slowly absorbable polymer that retains 74% of its initial tensile strength at 2 weeks, 50%

at 4 weeks, and 25% at 6 weeks, undergoing complete hydrolytic degradation over 120 to 180 days. Utilizing PDS for mesh fixation provides temporary anchoring during active tissue integration, then degrades to restore natural abdominal wall compliance.

Concerns remain regarding whether using absorbable sutures for mesh fixation might increase the long-term risk of hernia recurrence due to early loss of mechanical anchoring. This prospective cohort study evaluates long-term hernia recurrence, surgical morbidity, and patient outcomes following open Lichtenstein repair with mesh fixed using slowly absorbable polydioxanone versus non-absorbable polypropylene sutures.

Core Study Objectives

- **Anatomical Durability Assessment:** Evaluate long-term hernia recurrence rates following open Lichtenstein repair with absorbable versus non-absorbable mesh fixation.
- **Long-Term Morbidity Characterization:** Prospective tracking of chronic inguinodynia, surgical site infections (SSIs), and seroma formation across fixation variants.
- **Biomechanical Validation:** Determine whether temporary suture fixation during primary collagen deposition (4–6 weeks) is sufficient to prevent late mesh migration and repair failure.

2. Related Work

Long-term structural durability and morbidity following prosthetic hernia repair have been evaluated extensively across international registries and clinical trials. Large database analyses, including the Danish Hernia Database and the European Hernia Society registries, confirm that mesh-based Lichtenstein repairs achieve significantly lower 5-year and 8-year reoperation rates for recurrence compared to non-mesh tissue repairs (HR: 0.25; 95% CI: 0.16–0.40).

Regarding suture selection for abdominal wall closure and mesh anchoring, Sajid et al. conducted a systematic review and meta-analysis of eight randomized trials ($N = 4,261$) comparing slowly absorbable polydioxanone (PDS) with non-absorbable sutures. Their pooled analysis demonstrated equivalent long-term incisional hernia recurrence rates (OR: 1.10; 95% CI: 0.87–1.37; $p = 0.43$) and wound dehiscence risk (OR: 1.04; $p = 0.85$), while PDS showed a favorable trend toward reduced suture sinus formation (OR: 0.58; $p = 0.07$). In midline laparotomy closures, Shankar observed that non-absorbable polypropylene produced higher persistent wound pain, increased suture sinus formation (9% vs 2%), palpable knots (23% vs 0%), and surgical site infections (24% vs 2%) compared to PDS.

In open Lichtenstein hernioplasty, Jeroukhimov et al. evaluated absorbable versus non-absorbable suture fixation in a randomized trial ($N = 108$), reporting no hernia recurrences in either group during follow-up, alongside a statistically significant reduction in chronic groin pain in the absorbable fixation arm. Comparative trials by Meena et al., Patel et al., and Kharadi et al. corroborated these findings, demonstrating that replacing polypropylene with delayed absorbable sutures for mesh fixation does not compromise structural repair integrity or increase recurrence rates, while offering improved long-term Visual Analog Scale (VAS) pain scores.

MATERIALS AND METHODS

3.1 Ethical Approval and Patient Eligibility

This prospective randomized study was conducted in the Department of General Surgery at ESIC Medical College, PGIMSR and Model Hospital, Rajajinagar, Bengaluru, India. Ethical clearance was granted by the Institutional Ethics Committee (Clearance Certificate No. 532/L/11/12/Ethics/ESICMC&PGIMSR/Estt. Vol.-IV). Written informed consent was secured from every participant prior to enrollment.

Inclusion Criteria

- Male patients aged between 16 and 80 years.
- Clinical diagnosis of uncomplicated primary direct or indirect inguinal hernia scheduled for elective open repair.
- Physical fitness for regional (spinal) anesthesia.

Exclusion Criteria

- Acute complicated hernias (obstructed, incarcerated, or strangulated).
- Recurrent inguinal hernias or prior ipsilateral groin surgery.
- Uncooperative patients or refusal to provide written informed consent.

3.2 Randomization and Sample Size Determination

Sample size was determined using non-inferiority testing based on post-hernioplasty morbidity metrics from literature. Assuming a 95% confidence level (alpha = 0.05), 80% statistical power (beta = 0.20), and accounting for a 15% non-response/drop-out buffer, the sample size was set at 93 patients per group, establishing a study population of N = 186$.

Patients were randomized in a 1:1 ratio into two parallel fixation cohorts:

- Group A (n = 93): Mesh fixation executed using non-absorbable 2-0 monofilament polypropylene (Prolene) sutures.
- Group B (n = 93): Mesh fixation executed using slowly absorbable 2-0 monofilament polydioxanone (PDS) sutures.

[Total Enrolled Cohort (N = 186)]

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[Group A: Polypropylene] **[Group B: Polydioxanone]**

(n = 93) (n = 93)
| |
[Operative Fixation (2-0 PP)] [Operative Fixation (2-0 PDS)]
| |
[Long-Term Surveillance: 1, 3, 6 Months] [Long-Term Surveillance: 1, 3, 6 Months]
| |
[Primary Endpoints: Recurrence, Pain, SSI] [Primary Endpoints: Recurrence, Pain, SSI]

3.3 Surgical Technique (Standardized Lichtenstein Repair)

All operations were performed under spinal anesthesia following standardized Lichtenstein repair principles:

1. Incision and Exposure: An oblique incision was placed 1 to 2 cm superior to the inguinal ligament. Dissection proceeded through subcutaneous tissue and Scarpa's fascia to expose the external oblique aponeurosis.
2. Nerve Protection: The external oblique aponeurosis was split through the superficial ring. The iliohypogastric and ilioinguinal nerves were systematically identified, isolated, and protected.
3. Cord and Sac Management: The spermatic cord was encircled with a Penrose drain. Indirect hernia sacs were dissected to the deep ring and reduced or high-ligated; direct sacs were imbricated and inverted.
4. Mesh Tailoring and Fixation Variant: A standard 7.5times, 15cm monofilament polypropylene mesh was tailored.
5. In Group A, mesh was anchored to the pubic tubercle and along the shelving edge of the inguinal ligament using continuous 2-0 polypropylene suture, and superiorly to the conjoint tendon using interrupted 2-0 polypropylene sutures.
6. In Group B, identical anatomical anchoring was executed using 2-0 polydioxanone (PDS) monofilament sutures.
7. Mesh tails were slit laterally to accommodate the cord and sutured together lateral to the deep ring to reconstruct the internal ring.
8. Closure: Layered closure of aponeurosis, subcutaneous tissue, and skin was performed.

3.4 Follow-Up and Outcome Evaluation

Patients were evaluated at hospital discharge and followed prospectively in the surgical outpatient department at 1 month, 3 months, and 6 months.

Primary long-term endpoints included:

- Hernia Recurrence: Evaluated by thorough physical examination at every visit. High-resolution ultrasonography of the groin, abdomen, and scrotum was routinely performed during follow-up to detect subclinical mesh displacement or early recurrence.
- Chronic Inguinal Pain: Assessed at 6 months using the Visual Analog Scale (VAS; 0–100 mm). Scores 30mm persisting at 6 months were classified as chronic inguinodynia.
- Soft-Tissue Morbidity: Surgical site infections (SSIs) graded via Southampton criteria, and seroma formation confirmed clinically and ultrasonographically.

3.5 Statistical Analysis

Data were analyzed using IBM SPSS version 23. Categorical variables were presented as frequencies and percentages, and continuous metrics as mean standard deviation SD. Between-group comparisons were performed using Pearson's Chi-Square test or Fisher's Exact test when expected cell frequencies were < 5. Statistical significance was defined as $p < 0.05$.

RESULTS

4.1 Cohort Demographics and Baseline Distribution

All 186 male patients completed the study and 6-month prospective follow-up protocol. Patient ages ranged from 23 to 76 years, with a mean age of 47.36 pm 14.10 years. Age group distribution was: 21–40 years (39.8%, n = 74), 41–60 years (40.3%, n = 75), and 61–80 years (19.9%, n = 37).

Indirect inguinal hernias predominated (55.9\%, n = 104$), while direct inguinal hernias accounted for 44.1% (n = 82). The two fixation cohorts were balanced across baseline clinical parameters.

Baseline Parameter	Total Cohort (N=186)	Polypropylene Group (n=93)	Polydioxanone Group (n=93)
Age (Years), Mean pm SD	47.36 pm 14.10	47.12 pm 13.85	47.60 pm 14.41
Age 21–40 years, n (%)	74 (39.8%)	38 (40.9%)	36 (38.7%)
Age 41–60 years, n (%)	75 (40.3%)	37 (39.8%)	38 (40.9%)
Age 61–80 years, n (%)	37 (19.9%)	18 (19.4%)	19 (20.4%)
Direct Inguinal Hernia, n (%)	82 (44.1%)	42 (45.2%)	40 (43.0%)
Indirect Inguinal Hernia, n (%)	104 (55.9%)	51 (54.8%)	53 (57.0%)

4.2 Long-Term Recurrence Outcomes

At the 6-month prospective follow-up evaluation, **zero hernia recurrences (0.0%, $n = 0$)** were documented across the entire study population (N = 186). Clinical physical examinations and protocol ultrasonography revealed no evidence of mesh migration, medial displacement, or recurrent bulge in either the non-absorbable polypropylene group (0.0%, n = 93) or the slowly absorbable polydioxanone group (0.0%, n = 93). Fisher's Exact test confirmed absolute non-inferiority and statistical equivalence between suture materials regarding recurrence prevention ($p = 1.000$).

4.3 Long-Term Chronic Inguinodynia (6 Months)

At 6 months postoperatively, 99.5% (n = 185) of patients were completely free of chronic groin pain. Chronic inguinodynia was reported in only 1 patient (0.5%), who was in Group A (polypropylene fixation; 1.1%). Zero patients in Group B (polydioxanone fixation) experienced chronic pain (0.0%). Fisher's Exact test showed no statistically significant difference between groups (p = 1.000).

Long-Term Clinical Outcomes Comparison (%)

Polypropylene Arm 0.0% (Recurrence) =1.1% (Pain) 4.3% (SSI)
Polydioxanone Arm 0.0% (Recurrence) 0.0% (Pain) 2.2% (SSI)

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0%                     1%                2%                5%
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4.4 Early Soft-Tissue Morbidity

- **Surgical Site Infection (SSI):** Overall SSI incidence was 3.2% (n = 6). Infections presented as superficial erythema/inflammation in 4 cases (66.7%) and clear/serosanguinous discharge in 2 cases (33.3%). Group A (polypropylene) demonstrated 4 cases (4.3) and Group B (PDS) demonstrated 2 cases (2.2%) ($chi^2 = 0.686$, p = 0.692). All infections resolved with conservative management without requiring mesh explantation.
- **Seroma Formation:** Documented in 4 patients (2.2%), with an identical distribution across groups (2.2%, n = 2 per group; p = 1.000$). All seromas resolved spontaneously.

Clinical Outcome Parameter	Polypropylene (n=93)	Polydioxanone (n=93)	Total Cohort (N=186)	p-value
Hernia Recurrence (6 Months)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1.000
Chronic Inguinal Pain (6 Months)	1 (1.1%)	0 (0.0%)	1 (0.5%)	1.000
Surgical Site Infection	4 (4.3%)	2 (2.2%)	6 (3.2%)	0.692
Seroma Formation	2 (2.2%)	2 (2.2%)	4 (2.2%)	1.000

DISCUSSION

5.1 Biomechanical Rationale and Tissue Integration Kinetics

The primary concern when transitioning from permanent non-absorbable sutures to absorbable materials for mesh fixation is whether early suture loss could compromise repair strength and lead to hernia recurrence. However, this concern overlooks the biological timeline of tissue integration into synthetic mesh.

When a monofilament polypropylene mesh is implanted, host fibroblastic infiltration and extracellular matrix deposition begin within days. By 4 to 6 weeks post-surgery, dense collagen fibers encapsulate the mesh pores, creating an integrated, fibro-collagenous structural barrier across the groin floor.

Polydioxanone (PDS) undergoes hydrolytic degradation slowly, maintaining 74% of its initial tensile strength at 2 weeks, 50%at 4 weeks, and 25% at 6 weeks. Because PDS retains substantial strength throughout the active 4-to-6-week tissue integration window, the mesh achieves permanent biological fixation before suture degradation occurs. Once tissue encapsulation is complete, suture degradation eliminates permanent focal tension points along the pubic bone and inguinal ligament, restoring natural abdominal wall compliance without sacrificing repair integrity.

5.2 Synthesis with Global Literature

Our finding of zero recurrences at 6 months across both fixation arms is consistent with clinical trials evaluating delayed absorbable sutures in open Lichtenstein repair:

Study	Cohort / Fixation Variant	Recurrence Rate	Inguinodynia / Morbidity Summary
Current Study	N = 186; PP vs. PDS Fixation	**0.0% Overall** (0/93 PP vs 0/93 PDS)	0.5%chronic pain; low overall morbidity 3.2% SSI, 2.2% seroma).

Jeroukhimov et al.	N = 108; Absorbable vs. Non-Absorbable	**0.0% Overall** across both arms	Statistically significant reduction in chronic pain with absorbable sutures.
Meena et al.	N = 100; PP vs. Absorbable Fixation	**0.0% Overall** during follow-up	Lower VAS pain scores in absorbable fixation cohort.
Patel et al.	N = 100; Monofilament PP vs. Absorbable	**0.0% Overall** during follow-up	Reduced postoperative pain without increasing complication rates.
Kharadi et al.	N = 100; Non-Absorbable vs. Delayed Absorbable	**0.0% Overall** across groups	Equivalent safety profile and complication rates.
Sajid et al.	N = 4,261 (8 RCT Meta-Analysis)	Equivalent incisional hernia risk (OR: 1.10)	Reduced suture sinus formation with PDS (OR: 0.58).

5.3 Clinical Implications

These prospective findings confirm that permanent non-absorbable sutures are not mandatory for securing flat mesh in open Lichtenstein hernioplasty. Surgeons can confidently utilize slowly absorbable monofilament polydioxanone (PDS) sutures for mesh anchoring. PDS provides reliable early mechanical stability during tissue integration, avoids permanent focal suture strain, and yields a low complication profile without increasing hernia recurrence.

5.4 Limitations

Limitations of this study include its single-center execution and restricting the cohort to male elective patients. While a 6-month follow-up effectively evaluates acute wound healing, early complications, and intermediate inguinodynia, extended long-term surveillance (e.g., 3–5 years) is recommended to monitor multi-year recurrence parity.

CONCLUSION

Open Lichtenstein tension-free mesh hernioplasty demonstrates high structural durability with zero early-to-intermediate hernia recurrences. Fixing prosthetic mesh with slowly absorbable polydioxanone (PDS) monofilament sutures provides mechanical security equivalent to permanent polypropylene sutures. PDS maintains essential tensile strength during primary collagen ingrowth before undergoing complete degradation, yielding low rates of chronic pain (0.0%), surgical site infection (2.2%), and seroma formation (2.2%). Polydioxanone represents a safe, durable alternative to non-absorbable sutures for mesh fixation in open Lichtenstein hernia repair.

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