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Research Article

Predictors of Postoperative Seroma Formation Following Open Mesh Hernioplasty: A Prospective Comparative Cohort Study

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Abstract: ***Introduction:*** Seroma is among the most frequently reported complications of mesh-based inguinal hernia repair, with established predictors – hernia defect size, defect location, obesity, dissection technique, and mesh fixation method – described mainly in laparoscopic and registry series. Evidence on seroma incidence and evaluable predictors specific to open Lichtenstein repair, particularly from Indian tertiary-care cohorts, is comparatively limited. We aimed to determine the incidence of postoperative seroma after open Lichtenstein tension-free mesh hernioplasty and to evaluate suture material used for mesh fixation – the only candidate predictor recorded for this cohort – as a risk factor. **Methods:** In this prospective comparative (non-randomized) cohort study, 186 consecutive patients aged 16–80 years undergoing open Lichtenstein hernioplasty at a tertiary teaching hospital (August 2022–January 2024) were allocated, by patient preference, to mesh fixation with polypropylene (n=93) or polydioxanone (PDS, n=93) sutures. Seroma, diagnosed clinically with ultrasonographic confirmation of equivocal collections, was compared between groups using Fisher's exact test; given only four events, multivariable analysis was not attempted. **Results**: Seroma occurred in 4 of 186 patients overall (2.2%; 95% CI 0.8–5.4%): 2 of 93 (2.20%) in the polypropylene group and 2 of 93 (2.20%) in the polydioxanone group (p=1.0). Age group and hernia type were recorded but could not be cross-tabulated against seroma in the source dataset; body mass index, hernia defect size, comorbidities, dissection technique, and drain use were not recorded and could not be evaluated. **Conclusion:** Seroma was infrequent after open Lichtenstein hernioplasty and did not differ by suture material, the only predictor evaluable in this dataset. Established predictors identified in the wider literature – hernia size, defect location, obesity, and fixation technique – could not be assessed here and remain priorities for future, adequately powered predictor studies in open mesh hernioplasty.

Keywords: Hernia, Inguinal; Herniorrhaphy; Surgical Mesh; Seroma; Risk Factors; Sutures

INTRODUCTION

Inguinal hernia repair is among the most frequently performed operations in general surgery worldwide; the 2019 Global Burden of Disease Study estimated that inguinal, femoral, and abdominal wall hernias together represent a large and rising surgical burden across most world regions.[1] A multinational prospective cohort spanning 83 countries confirmed that mesh-based repair, now standard in high-income settings, remains inconsistently available in lower-resource settings, where emergency presentation and bowel-resection rates are correspondingly higher.[2] Surveillance work from Ghana has shown that even where mesh repair is adopted, postoperative morbidity, rather than recurrence, increasingly dominates the patient experience of hernia surgery.[3,4]

The Lichtenstein tension-free technique, in which a permanent synthetic mesh reinforces the inguinal floor and is fixed in place with either a non-absorbable or an absorbable suture, is now the reference standard for open inguinal hernia repair.[5,6,7] Seroma – a localized collection of serous fluid at the operative site, arising from disruption of subcutaneous lymphatics and the inevitable dead space between the mesh and the overlying tissue planes – is among the most frequently reported complications of mesh-based hernia repair. In randomized comparisons of fixation and closure technique within open Lichtenstein repair specifically, reported seroma rates are generally low and comparable between the techniques compared.[8,9]

By contrast, laparoscopic transabdominal preperitoneal (TAPP) and totally extraperitoneal (TEP) repairs, which create a considerably larger preperitoneal dissection plane, report seroma rates that are both higher and more variable: a single-surgeon series of 1,194 TAPP repairs recorded seroma in roughly one in ten patients,[10] a multicentre TAPP cohort recorded seroma or hematoma in 69 of 359 patients (19.2%),[11] and a national registry of 20,004 TAPP repairs found seroma rates ranging from 0.7% with no mesh fixation to 3.9% with fibrin-glue fixation, with an independent, multivariable-confirmed association between seroma and both a larger hernia defect and a medial (direct) defect location.[12] Smaller

TEP series report seroma ranging from roughly one in thirty to two in three patients, depending on the dissection technique and technology used.[13,14,15] These laparoscopic data, largely derived from multivariable or registry analyses, currently anchor most of what is known about seroma risk factors after mesh hernia repair.

Beyond dissection plane and fixation technique, obesity and hernia-defect size have independently predicted early complications, including seroma, in both inguinal and incisional hernia repair: a recent multivariable analysis of TEP repair found obesity (body mass index ≥30 kg/m²) and a hernia defect ≥25 mm to be independent predictors of early complications, with age over 65 years showing a non-significant trend,[16] and a large series of complex incisional hernia repairs found each unit increase in body mass index to raise the odds of postoperative complications, including seroma, by 9%.[17] Surgical drains have been shown, in a systematic review pooling three trials, to reduce seroma formation substantially after laparoscopic inguinal hernia repair (2.1% with drains versus 23.8% without).[18] Mesh fixation method more broadly – suture versus fibrin glue versus self-gripping mesh – has been examined in network meta-analyses and randomized trials, with inconsistent effects on seroma and other complications across studies.[19,20,21]

Within this literature, the specific question of whether the suture material used to fix the mesh in open Lichtenstein repair – rather than the fixation method (suture versus glue versus a mechanical device) – independently affects seroma risk has received comparatively little attention. Indian comparative series of polypropylene versus polydioxanone suture fixation in Lichtenstein repair have consistently reported seroma as an infrequent, non-significantly different secondary outcome between the two materials,[22,23,24,25] but none of these studies, nor the wider literature summarized above, evaluated suture material alongside the multivariable predictors – hernia size, defect location, body mass index, dissection technique – identified as important in laparoscopic series.

Most seroma-predictor evidence, therefore, is drawn from laparoscopic repair, where the preperitoneal dissection plane itself is a major determinant of fluid accumulation; whether any of these predictors, or suture material specifically, are relevant to seroma formation after open Lichtenstein repair in an Indian tertiary-care population is comparatively under-studied. We therefore aimed to determine the incidence of postoperative seroma after open Lichtenstein tension-free mesh hernioplasty in this cohort, and to evaluate the association between suture material used for mesh fixation – the only candidate predictor recorded for all participants – and seroma formation.

MATERIALS AND METHODS

Study design, setting, and relationship to companion analysis

We conducted a prospective comparative (non-randomized) cohort study, reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement for cohort studies.[26] As in the companion analysis of this cohort, patients were counselled on the reported advantages and disadvantages of polypropylene and polydioxanone sutures, and the suture material actually used was assigned according to each patient's stated preference rather than a random allocation sequence; this is therefore reported as a non-randomized, patient-preference cohort. The study was conducted in the Department of General Surgery, Employees' State Insurance Corporation Medical College, PGIMSR and Model Hospital, Rajajinagar, Bengaluru, Karnataka, India, between August 2022 and January 2024, with a mean follow-up of six months. This report uses the same prospectively assembled cohort, at the same institution and over the same study period, as a companion analysis of chronic groin pain and surgical site infection following the same procedures ,the present report is restricted to seroma formation and its evaluable predictors, and the chronic-pain and infection results are not repeated here.

Participants

Consecutive patients admitted with a clinical diagnosis of inguinal hernia during the study period were screened using a consecutive sampling technique. Eligible patients were aged 16–80 years and willing to undergo elective surgery. Patients with an obstructed or incarcerated hernia, those who declined consent or were unable to cooperate with follow-up, and those who ultimately opted out of surgery were excluded. All patients, or the parents of participants aged under 18 years, provided written informed consent after Institutional Ethics Committee approval.

Surgical technique

All operations were performed as open Lichtenstein tension-free hernioplasty under the direct supervision of the lead investigator, using a standardized technique, with a polypropylene mesh placed to reinforce the inguinal floor and reconstruct the internal ring. The only planned difference between groups was the suture used to fix the mesh to the pubic tubercle, the conjoint tendon/internal oblique aponeurosis, and the shelving edge of the inguinal ligament: Group A (n=93) received a non-absorbable polypropylene monofilament suture and Group B (n=93) an absorbable polydioxanone (PDS) monofilament suture.

Outcome, candidate predictors, and their evaluability

The outcome of interest was postoperative seroma, diagnosed clinically with ultrasonography used to

confirm equivocal collections, and recorded as present or absent at follow-up. Candidate predictor variables recorded for the cohort were age (in three groups: 21–40, 41–60, and 61–80 years), type of hernia (direct versus indirect), and suture material used for mesh fixation (non-absorbable polypropylene versus absorbable polydioxanone). Established predictors reported elsewhere in the literature – body mass index, comorbidity burden (e.g., diabetes, chronic obstructive pulmonary disease), hernia defect size, smoking status, mesh fixation technique other than suture type (e.g., fibrin glue, mechanical fixation), surgical drain use, and detailed dissection technique – were not recorded in the source dataset and could therefore not be evaluated as predictors in this analysis (see Limitations). Of the three recorded variables, only suture material was cross-tabulated against seroma formation in the original study database; age group and hernia type, although recorded for all participants, were not tested against seroma occurrence, and the patient-level linkage required to do so post hoc was not available to the present authors. Age group and hernia type are therefore reported here as descriptive cohort characteristics only, not as evaluated predictors.

Data collection and quality control

Baseline demographic and clinical data, operative details, and follow-up findings were recorded prospectively on a pre-structured proforma and transcribed to a master chart; data confidentiality was maintained throughout. All 186 enrolled patients completed the six-month follow-up and were included in the analysis; no participant was lost to follow-up or withdrawn after enrolment. Patients were reviewed at 1, 3, and 6 months, with clinical examination of the operative site at each visit.

Statistical analysis

Data were entered in Microsoft Excel (Microsoft Office Home and Student 2021) and analysed using IBM SPSS Statistics version 23 (IBM Corp., Armonk, NY, USA). Categorical variables are presented as frequencies and percentages; quantitative variables as mean ± standard deviation. The association between suture material and seroma was tested using Fisher's exact test, given an expected cell count below five; a two-sided p-value <0.05 was considered statistically significant. A post hoc Wilson score 95% confidence interval was calculated for the seroma proportion overall and within each suture-material group, using the reported numerators and denominators. Given only four seroma events among 186 patients, a multivariable logistic regression model was not attempted: with fewer than ten events per candidate variable, logistic-regression coefficient estimates become biased and unreliable, with confidence intervals that do not achieve proper coverage.[27] Age group and hernia type could not, in any case, be cross-tabulated against seroma from the data available to the present authors (see above), so no adjusted or multivariable analysis of any kind was performed.

Ethical considerations

The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Ethics Committee of ESIC Medical College, PGIMSR and Model Hospital, Bengaluru. Written informed consent, including parental consent for minors, was obtained from all participants.

RESULTS

Participant flow and baseline characteristics

Following the eligibility and exclusion criteria described above, 186 consecutive patients undergoing open Lichtenstein tension-free inguinal hernia repair were enrolled between August 2022 and January 2024. Ninety-three patients (50.0%) chose mesh fixation with polypropylene sutures (Group A) and 93 (50.0%) chose polydioxanone sutures (Group B); all 186 completed the six-month follow-up (Table 1). Age ranged from 23 to 76 years, with a mean of 47.36 ± 14.099 years; most patients (75/186, 40.3%) were aged 41–60 years. Indirect inguinal hernia was more common (104/186, 55.9%) than direct hernia (82/186, 44.1%) (Table 1). Age group and hernia type are reported here as cohort characteristics only: neither was cross-tabulated against seroma occurrence in the source dataset, and so neither is reported below as an evaluated predictor (see Methods and Limitations).

Incidence of seroma

Seroma occurred in 4 of 186 patients overall (2.2%; 95% CI 0.8–5.4%) (Table 2).

Suture material and seroma

By suture material, seroma occurred in 2 of 93 patients (2.20%) fixed with polypropylene and 2 of 93 patients (2.20%) fixed with polydioxanone (Table 2); this difference was not statistically significant (Fisher's exact test, p=1.0). Suture material was the only candidate predictor that could be evaluated against seroma occurrence in this dataset.

Candidate predictors: availability and evaluability

Table 3 summarizes the candidate predictors identified in the published literature (see Introduction and Discussion) alongside their availability and evaluability in the present dataset. Of the ten candidate variables considered, three (age group, hernia type, suture material) were recorded for all participants, and only one (suture material) could be tested against seroma occurrence; the remaining seven variables – body mass index, hernia defect size, comorbidity burden, smoking status, alternative mesh fixation methods, surgical drain use, and detailed dissection technique – were not recorded and could not be evaluated.

Comparison with published series

Table 4 places the present incidence in the context of previously published series (Figure 3). The seroma rate observed here (2.2%) is consistent with the low end of the range reported for open Lichtenstein repair using either suture-based mesh-fixation technique compared in randomized trials,[8,9] and is lower than rates typically reported after laparoscopic TAPP or TEP repair, which range from approximately 3% to 19% depending on series and dissection technique.[10,11,12,13,14,15]

Table 1. Baseline characteristics of study participants (N = 186).

Characteristic	n	%
Age group, 21–40 years	74	39.8
Age group, 41–60 years	75	40.3
Age group, 61–80 years	37	19.9
Mean age ± SD (years), range 23–76	47.36 ± 14.099	—
Type of hernia, direct inguinal	82	44.1
Type of hernia, indirect inguinal	104	55.9
Suture material, polypropylene (Group A)	93	50.0
Suture material, polydioxanone/PDS (Group B)	93	50.0

Abbreviation: SD, standard deviation. Percentages are of the total cohort (N = 186). Age and hernia-type distributions were not cross-tabulated against seroma occurrence in the source dataset (see Methods, Limitations).

Table 2. Incidence of seroma overall and by suture material.

Group	Seroma present, n (%)	Seroma absent, n (%)	95% CI / p-value
Overall (N = 186)	4 (2.2)	182 (97.8)	0.8–5.4%*
Polypropylene (n = 93)	2 (2.20)	91 (97.80)	p = 1.0†
Polydioxanone/PDS (n = 93)	2 (2.20)	91 (97.80)	

***Wilson score 95% confidence interval, calculated post hoc from the reported numerator and denominator. †Fisher's exact test.**

Table 3. Candidate predictors of seroma formation and their evaluability in this cohort.

Candidate predictor	Recorded in this cohort?	Tested against seroma?	Result
Age group	Yes	No‡	Not evaluated
Type of hernia (direct/indirect)	Yes	No‡	Not evaluated
Suture material (polypropylene vs. PDS)	Yes	Yes	No significant association (p = 1.0)
Body mass index / obesity	No	—	Not recorded
Hernia defect size	No	—	Not recorded
Comorbidities (diabetes, COPD, etc.)	No	—	Not recorded
Smoking status	No	—	Not recorded
Mesh fixation method (glue/mechanical)	Not applicable§	—	Not applicable
Surgical drain use	No	—	Not used/not recorded
Dissection technique detail	No	—	Not recorded

‡Recorded for descriptive purposes but not cross-tabulated against seroma in the source dataset; patient-level linkage to do so post hoc was not available to the present authors. §All participants received suture fixation of the mesh; no glue or mechanical fixation was used.

Table 4. Comparative incidence of seroma across published series.

Study	Technique	N	Seroma incidence	Predictor(s) identified
Present study	Open Lichtenstein (sutured mesh)	186	2.2%	None (suture material only factor tested; not significant)
Li J et al. 2014 [9]	Open Lichtenstein (self-gripping vs. sutured)	1353	No significant difference (OR 0.89)	Fixation method (no effect)
Evans et al. 2023 [8]	Open Lichtenstein (sac invagination vs. ligation)	843	No difference (OR 1.00)	Sac management technique (no effect)
Kostov & Dimov 2021 [13]	Laparoscopic TEP	61	3.44%	—
Köckerling et al. 2017 [12]	Laparoscopic TAPP (registry)	20,004	0.7–3.9% (fixation-dependent)	Fixation method, defect size, medial location
Morito et al. 2021 [11]	Laparoscopic TAPP	359	19.2%	Defect size, hernia type (JHS)
Castorina et al. 2012 [10]	Laparoscopic TAPP	1194	~10%	—
Liu et al. 2020 [14]	Laparoscopic TEP	103	11–12%	Dissection technique
Misra et al. 2008 [15]	Laparoscopic TEP	56	17.9–64.3% (technique-dependent)	Dissection technique

Bracketed numbers refer to the reference list. OR, odds ratio; TAPP, transabdominal preperitoneal repair; TEP, totally extraperitoneal repair; JHS, Japan Hernia Society classification.

DISCUSSION

In this cohort of 186 patients undergoing open Lichtenstein tension-free inguinal hernia repair, postoperative seroma occurred in 2.2% of patients and did not differ significantly by the suture material used to fix the mesh – the only candidate predictor available for testing in this dataset. This incidence sits at the lower end of the range reported across the hernia-repair literature and is consistent with open, suture-fixed mesh repair carrying a lower seroma risk than laparoscopic preperitoneal repair, in which a considerably larger dissection plane is created.[8,9,10,11,12,13,14,15]

Suture material is conceptually distinct from fixation method: our study and four Indian comparative series all tested material (polypropylene versus polydioxanone) within a single fixation method (suture), and all found no significant association with seroma,[22,23,24,25] echoing null findings for fixation-adjacent open-Lichtenstein comparisons of sac management technique and self-gripping versus sutured mesh.[8,9] By contrast, studies that compared fixation method categories – suture versus tacks versus fibrin glue versus non-fixation – in large laparoscopic registries and meta-analyses have found real, sometimes substantial, differences in seroma risk, together with independent effects of hernia defect size and defect location.[12,19,20,21] Taken together, this pattern suggests that once a suture-based fixation method is chosen, as in the Lichtenstein technique studied here, the specific suture material may matter comparatively little for seroma risk, while the anatomical and technique-level factors identified in laparoscopic series – defect size, defect location, dissection plane, and fixation method category – are more plausible drivers of seroma and were not evaluable in the present dataset.

Two further factors identified elsewhere as independent predictors of seroma or related early complications – obesity and hernia defect size – were not recorded in this cohort. A recent multivariable analysis of endoscopic inguinal hernia repair found both obesity (body mass index ≥30 kg/m², odds ratio 2.8) and a hernia defect ≥25 mm (odds ratio 2.9) to be independent predictors of early complications, with an additional non-significant trend for age over 65 years,[16] and a large incisional-hernia series found each unit increase in body mass index to raise complication odds, including seroma, by 9%.[17] Surgical drains have also been shown, in a pooled analysis of three trials, to reduce seroma formation substantially after laparoscopic inguinal hernia repair,[18] although drains were not used in the present cohort and their role in open Lichtenstein repair specifically remains less well studied than in laparoscopic repair. None of body mass index, hernia defect size, or drain use was recorded for this cohort, and none could therefore be tested here, even though each has a stronger evidence base as a seroma predictor than suture material itself.

The very low number of seroma events observed here (n=4) is itself informative about the limits of what a study of this size can establish. Simulation work on logistic regression indicates that fewer than ten events per candidate variable produces biased coefficient estimates and confidence intervals with poor coverage;[27] with only four events, this study – and, by extension, most single-centre open-Lichtenstein suture-comparison studies of a similar size in the literature – is structurally unable to support multivariable predictor modeling, and is adequately powered only to detect a very large effect of suture material on seroma risk, which we did not find.

Strengths

This study applied a standardized surgical technique across both groups, followed patients prospectively to six months with structured clinical assessment at three time , and – rather than presenting a nominal "predictors" analysis beyond what the data can support – explicitly tabulates which candidate predictors were and were not evaluable (Table 3), a transparency step that is often absent from single-centre suture-comparison reports.

Limitations

Several limitations apply. First, suture material was not randomly allocated: patients selected their procedure after counselling, so the two groups could differ in unmeasured ways not compared statistically in the source dataset, carrying a risk of selection bias and confounding not present in a true randomized trial. Second, and most importantly for a "predictors" analysis, only one candidate variable – suture material – was recorded and cross-tabulated against seroma; established predictors with a stronger evidence base elsewhere – body mass index, hernia defect size, comorbidities, smoking status, dissection technique, drain use, and fixation method other than suture type – were not recorded and could not be evaluated, so this study cannot identify independent predictors of seroma in the way its title's literature comparators can. Third, only four seroma events occurred in the entire cohort, yielding wide confidence intervals and precluding any multivariable modeling, per the events-per-variable considerations above. Fourth, age group and hernia type, although recorded for descriptive purposes, could not be tested against seroma because the patient-level linkage needed to do so was not available to the present authors; this is a data-access limitation of the present analysis rather than a design flaw in the original data collection, and it should be corrected in any future secondary analysis of the original master chart. Fifth, this was a single-centre study with six-month follow-up, which may not capture delayed fluid collections. Finally, this cohort overlaps with a companion analysis of chronic groin pain and surgical site infection from the same 186 patients [INSERT: companion manuscript citation]; readers should treat the two reports as descriptions of different outcomes from one shared cohort rather than as independent replications, and any citation of both papers together should make this relationship explicit.

Clinical implications

Within these constraints, the very low seroma incidence observed after open Lichtenstein repair with either suture material is reassuring, and does not, on this evidence, support choosing one suture material over the other specifically to reduce seroma risk. Attention to the anatomical and patient-level predictors identified in larger laparoscopic and registry series – hernia defect size, defect location, and obesity – is likely to be more clinically productive than a focus on suture material.[12,16,17]

Future research

Future studies of suture-material comparisons in open Lichtenstein repair, at this centre and elsewhere, should prospectively record body mass index, hernia defect size, comorbidity burden, and drain use alongside suture material, to allow adequately powered multivariable analysis of seroma predictors specific to open repair. Given the low event rate observed here and in comparable open-technique series,[8,9,22,23,24,25] such studies will likely require multicentre recruitment or registry-scale data, following the model already established for laparoscopic repair.[12]

CONCLUSION

In this prospective comparative cohort of 186 patients undergoing open Lichtenstein hernioplasty, postoperative seroma was infrequent (2.2%) and did not differ by suture material, the only predictor evaluable in this dataset. Established predictors from the wider literature – hernia defect size, defect location, obesity, and dissection or fixation technique – could not be assessed here and remain the more promising targets for future, adequately powered predictor research in open mesh hernioplasty.

DECLARATIONS

Related publications

This manuscript reports the seroma outcome from the same prospectively assembled cohort of 186 patients used in a companion analysis of chronic postoperative groin pain and surgical site infection following the same procedures. [INSERT: full citation and, if already assigned, DOI/manuscript number of the companion paper before submission.] Both manuscripts should disclose this shared cohort to editors at submission, consistent with ICMJE guidance on redundant/secondary publication.

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Conflicts of interest

The authors declare no competing interests.

Data availability

The datasets generated and analysed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Ethics Committee of ESIC Medical College, PGIMSR and Model Hospital, Bengaluru. Written informed

consent, including parental consent for minors, was obtained from all participants.

REFERENCES

1. Ma Q, Jing W, Liu X, Liu J, Liu M, Chen J. The global, regional, and national burden and its trends of inguinal, femoral, and abdominal hernia from 1990 to 2019: findings from the 2019 Global Burden of Disease Study - a cross-sectional study. Int J Surg. 2023;109(3):333-42.
2. NIHR Global Health Research Unit on Global Surgery and the Portuguese Hernia and Abdominal Wall Society. Access to and quality of elective care: a prospective cohort study using hernia surgery as a tracer condition in 83 countries. Lancet Glob Health. 2024;12(7):e1094-103.
3. Beard JH, Oresanya LB, Ohene-Yeboah M, Dicker RA, Harris HW. Characterizing the global burden of surgical disease: a method to estimate inguinal hernia epidemiology in Ghana. World J Surg. 2013;37(3):498-503.
4. Beard JH, Ohene-Yeboah M, Tabiri S, Amoako JKA, Abantanga FA, Sims CA, et al. Outcomes after inguinal hernia repair with mesh performed by medical doctors and surgeons in Ghana. JAMA Surg. 2019;154(9):853-9.
5. O'Connell PR, McCaskie AW, Sayers RD, editors. Bailey & Love's Short Practice of Surgery. 28th ed. Boca Raton: CRC Press; 2023.
6. Schein M. [Review of] Schwartz's Principles of Surgery, 9th ed., edited by Brunicardi FC, Andersen DK, Billiar TR, Dunn DL, Hunter JG, Matthews JB, Pollock RE. World J Surg. 2010;34(4):871-3.
7. Townsend CM, Beauchamp RD, Evers BM, Mattox KL. Sabiston Textbook of Surgery: The Biological Basis of Modern Surgical Practice. Philadelphia: Elsevier; 2016.
8. Evans L, Hajibandeh S, Hajibandeh S. Sac invagination versus sac ligation in open Lichtenstein repair of indirect inguinal hernia: a systematic review and meta-analysis of randomized controlled trials. Surgery. 2023;174(2):268-76.
9. Li J, Ji Z, Li Y. The comparison of self-gripping mesh and sutured mesh in open inguinal hernia repair: the results of meta-analysis. Ann Surg. 2014;259(6):1080-5.
10. Castorina S, Luca T, Privitera G, El-Bernawi H. An evidence-based approach for laparoscopic inguinal hernia repair: lessons learned from over 1,000 repairs. Clin Anat. 2012;25(6):687-96.
11. Morito A, Kosumi K, Kubota T, Yumoto S, Matsumoto T, Mima K, et al. Investigation of risk factors for postoperative seroma/hematoma after TAPP. Surg Endosc. 2021;36(7):4741-7.
12. Köckerling F, Bittner R, Adolf D, Fortelny R, Niebuhr H, Mayer F, et al. Seroma following transabdominal preperitoneal patch plasty (TAPP): incidence, risk factors, and preventive measures. Surg Endosc. 2017;32(5):2222-31.
13. Kostov GG, Dimov RS. Total extra peritoneal inguinal hernia repair: a single-surgeon preliminary findings report. Folia Med (Plovdiv). 2021;63(2):183-8.
14. Liu JW, Chen KJ, Xu XH, Deng Y, Zhang H, Chan FSY, et al. Does the use of monopolar energy as the preferred mode of dissection effectively reduce seroma formation in laparoscopic total extra peritoneal hernioplasty? A prospective double-blinded randomized control trial. Hernia. 2020;24(4):821-9.
15. Misra MC, Kumar S, Bansal VK. Total extraperitoneal (TEP) mesh repair of inguinal hernia in the developing world: comparison of low-cost indigenous balloon dissection versus direct telescopic dissection: a prospective randomized controlled study. Surg Endosc. 2008;22(9):1947-58.
16. Atalay S. Tailored surgical planning in TEP inguinal hernia repair: a multivariate analysis of obesity and hernia defect size. Acta Chir Belg. 2026:1-7.
17. Nielsen KA, Tulloh B, de Beaux A, Pedersen AK, Petersen SR, Jogvansson B, et al. Evaluation of risk factors associated with the peritoneal flap hernioplasty for complex incisional hernia repair - a retrospective review of 327 cases. Hernia. 2024;28(6):2301-9.
18. Li J, Gong W, Liu Q. Intraoperative adjunctive techniques to reduce seroma formation in laparoscopic inguinal hernioplasty: a systematic review. Hernia. 2019;23(4):723-31.
19. Jiang WR, Zhang XB, Wang R, Cao D, Yu YJ. Mesh fixation techniques in Lichtenstein tension-free repair: a network meta-analysis. ANZ J Surg. 2022;92(10):2442-7.
20. Rönkä K, Vironen J, Kössi J, Hulmi T, Silvasti S, Hakala T, et al. Randomized multicenter trial comparing glue fixation, self-gripping mesh, and suture fixation of mesh in Lichtenstein hernia repair (FinnMesh Study). Ann Surg. 2015;262(5):714-9.
21. Phoa S, Chan KS, Lim SH, Oo AM, Shelat VG. Comparison of glue versus suture mesh fixation for primary open inguinal hernia mesh repair by Lichtenstein technique: a systematic review and meta-analysis. Hernia. 2022;26(4):1105-20.
22. Jeroukhimov I, Wiser I, Karasic E, Nesterenko V, Poluksht N, Lavy R, et al. Reduced postoperative chronic pain after tension-free inguinal hernia repair using absorbable sutures: a single-blind randomized clinical trial. J Am Coll Surg. 2014;218(1):102-7.
23. Patel KR, Jain AP, Shah SC, Rathwa R, Gosai K. A comparative study of inguinal hernia using monofilament non-absorbable suture versus monofilament absorbable suture in Lichtenstein tension free hernia repair at tertiary care government hospital. Int Surg J. 2019. [Volume, issue and page numbers not stated in the retrieved source; to be confirmed before submission.]
24. Kharadi A, Shah V. Comparative study of mesh fixation with non-absorbable v/s delayed absorbable

suture in open inguinal hernia. Int Surg J. 2016:1180-3.

25. H KS. A comparative study of outcome of the absorbable suture polydioxanone and nonabsorbable suture polypropylene in laparotomy wound closure. Int J Res Med Sci. 2017. [Volume, issue and page numbers not stated in the retrieved source; to be confirmed before submission.]
26. Von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP; STROBE Initiative. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. Lancet. 2007;370(9596):1453-7.
27. Peduzzi P, Concato J, Kemper E, Holford TR, Feinstein AR. A simulation study of the number of events per variable in logistic regression analysis. J Clin Epidemiol. 1996;49(12):1373-9.