



Chronic inguinal pain post-hernioplasty. Laparo-endoscopic surgery vs lichtenstein repair: systematic review and meta-analysis

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Abstract

Purpose Annually, over 20 million patients worldwide undergo inguinal hernia repair procedures. Surgery stands as the recommended treatment, however, a consensus on the optimal method is lacking. This study aims to conduct an updated systematic review and meta-analysis to compare the risk of chronic inguinal pain and recurrence between laparo-endoscopic mesh repair (TAPP and TEP) versus Lichtenstein repair for inguinal hernia.

Methods Searches were conducted in Ovid MEDLINE, PubMed, EBSCO, Cochrane, and Google Scholar. Inclusion criteria encompassed randomized controlled trials (RCTs) involving adults, published in English and Spanish, comparing surgical outcomes among the Lichtenstein open technique, TAPP, and/or TEP. Adherence to the PRISMA guidelines was maintained in the methodology, and the CASP tool was employed to assess the quality of the articles. Statistical analysis involved mean [\pm standard deviation (SD)], Odds Ratio (OR), and Confidence Interval (CI).

Results Eight RCTs encompassing 1,469 patients randomized to Lichtenstein repair ($n = 755$) and laparo-endoscopic repair ($n = 714$) were included. Laparo-endoscopic repair was associated with a lower likelihood of chronic inguinal pain compared to Lichtenstein repair (OR = 0.28, 95% CI [0.30–0.56], $p = 0.0001$). There were no significant differences in recurrence rates between the laparo-endoscopic and the Lichtenstein group (OR = 1.03, 95% CI [0.57–1.86], $p = 0.92$).

Conclusions This systematic review and meta-analysis demonstrate that laparo-endoscopic hernia surgery leads to a lower incidence of chronic inguinal pain compared to Lichtenstein repair, while maintaining similar rates of recurrence.

Keywords Inguinal hernia · Chronic pain · Lichtenstein · TEP · TAPP

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Introduction

Inguinal hernia constitutes 75% of all abdominal wall hernias, with an incidence of 27% in males and 3% in females. These hernias typically manifest with symptoms, and surgical intervention represents the sole curative option thus far [1, 2]. The high prevalence rate of 20 million patients per year result in inguinal hernia repairs to be one of the most common surgical procedures globally [1].

The surgical procedure, hernioplasty, presents substantial challenges, both in economic terms, with costs varying between 126 and 4116 USD per patient [1], and from a societal perspective due to work absenteeism and the emergence of complications.

Common primary complications [1]

- Recurrence: Notably, some series report recurrence rates as high as 15% [1].
- Wound infection following surgery.
- Chronic postoperative inguinal pain (CPIP): CPIP, lacks a universally agreed-upon definition concerning its duration, spanning from 3 months to one year [1]. Nevertheless, certain authors have utilized a criterion of pain persisting for six months or more in their systematic reviews concerning mesh-based hernia repairs [1]. This condition is estimated to afflict 10–12% of patients following surgery, with 1–3% of cases experiencing incapacitating pain [1].

The Lichtenstein technique is universally recognized as the gold standard for open repair of primary inguinal hernias, primarily owing to its minimal recurrence rates, which fall below 1% [3, 4]. Nevertheless, its limitations are manifested in the risk of chronic pain development, which can ascend to 63% in certain series, with moderate to severe pain manifesting in 5–10% of cases [1].

Laparo-endoscopic approaches have garnered increased favor in recent years, with certain surgeons reporting a markedly lower incidence of long-term postoperative pain, ranging between 0% and 3% for severe pain [1, 2, 5, 6]. However, select publications have reported that the

extraperitoneal or endoscopic approach (TEP) associates with a heightened risk of recurrence compared to open surgery, particularly when the follow-up data exceeded the three-year mark [4]. Conversely, the laparoscopic approach (TAPP) appears to entail a heightened risk of perioperative complications, including some of a more severe nature, when contrasted to open surgery. Recent studies have illuminated equivalent recurrence rates [4, 7].

Considering the substantial volume of patients undergoing inguinal hernia repair annually, potentially elevating this procedure to one of the most frequently performed interventions in the realm of general surgery, and the potential for postoperative complications, inclusive of CPIP which could afflict one in ten patients [1], becomes imperative to conduct a contemporary systematic review and meta-analysis. The objective is to discern, within the ambit of commonly employed surgical techniques, the method that yields the least CPIP and fewest recurrence during the course of follow-up.

Objectives

- Primary objective: To assess the risk of chronic inguinal pain in laparo-endoscopic repair (TEP or TAPP) versus the Lichtenstein repair for inguinal hernia.
- Secondary objective: To evaluate the recurrence rates of inguinal hernia according to the different techniques.

Methodology

This systematic review and meta-analysis follows the preferred reporting items for systematic reviews and meta-analyses (PRISMA) protocol [8].

PICO question

Detailed in Table 1.

Table 1 Description of the PICO question

P (patient)	I (intervention)	C (comparison)	O (outcome)
Over 18 years old with an inguinal hernia.	Patients operated for inguinal hernia.	Laparo-endoscopic hernioplasty (TEP and TAPP) versus open approach (Lichtenstein).	<ul style="list-style-type: none"> • Assessment of rates of post-hernioplasty chronic inguinal pain in both techniques. • Evaluation of local recurrence.

Can the laparo-endoscopic approach reduce the rates of CPIP compared to the open approach in patients over 18 years of age?

Eligibility criteria

The studies analyzed consisted of randomized controlled trials (RCTs) providing the highest level of scientific evidence.

Inclusion criteria

- a) Patients aged 18 and above.
- b) Studies written in English and Spanish published between 2017 and May 8, 2023.
- c) Studies comparing surgical outcomes in Lichtenstein repair, TAPP and/ or TEP techniques for inguinal hernia repair.
- d) Inclusion of chronic inguinal pain as a variable in the study.

Exclusion criteria

- a) Studies analyzing herniorrhaphies or repairs without mesh.
- b) Robotic approaches.
- c) Open hernioplasties other than the Lichtenstein technique.
- d) Patients undergoing emergency surgery due to incarceration or strangulation.
- e) Femoral hernias.

Eligibility assessment was performed by two authors in an unblinded manner. Disagreements were resolved by consensus.

Sources of information

The searched was conducted in electronic databases including Ovid MEDLINE, PubMed, EBSCO, Cochrane and Google Scholar, with the latest search date being May 8, 2023.

Search strategy

A combination of the following Medical Subject Headings (MeSH) terms, using Boolean operators ‘AND’ and ‘OR’ was employed as keywords: “inguinal hernia”, “Lichtenstein”, “open repair techniques”, “laparoscopy”, “TEP”, “TAPP”, “inguinal hernia repair” and “chronic pain”.

Selection process

Two researchers searched independently the reviews based on the pre-specified criteria in the research protocol, placing any screened citations into a database. Initially, the researchers screened the titles and abstracts identified by the search strategy. Any screening-related disagreement was resolved by a third author.

Data collection process

Two authors extracted and examined the data independently. A third author eventually reviewed the database. Discrepancies were clarified by consensus. If an RCT had been reported in more than one publication, the most recent publication that reported the trial was used as the reference article.

Data items

The following data was retrieved from main text, tables and graphs and was recorded in an Excel: author, year of publication, country, study design, number of patients, sex, age, surgical approach, material mesh, weight of mesh, mesh fixation and type of mesh fixation, pubis fixation and type of pubis fixation, neurectomy, chronic inguinal pain and hernia recurrence.

Quality and study risk of bias assessment

To evaluate the methodological quality and conduct a quality analysis of the information within the studies included in this systematic review, the CASP [9] (Critical Appraisal Skills Program) scale was employed. The risk of bias in the included studies was assessed using the Cochrane Collaboration tool [10] and the Cochrane Handbook for Systematic Reviews of Interventions [11]. All included RCTs were evaluated by two reviewers who individually evaluated the quality and the bias of RCTs. Any disagreements were discussed with and resolved by a third author.

Effect measures

A statistical analysis was performed for continuous variables, presenting results as mean [\pm standard deviation (SD)] or median [interquartile range (IQR)], as appropriate. Categorical variables are expressed as percentages.

Meta-analysis statistical analysis was conducted using RevMan version 5.4 (The Nordic Cochrane Center, The Cochrane Collaboration, Copenhagen) [12]. Clinical outcomes were analyzed using a random-effects model following DerSimonian and Laird. Pooled odds ratios (OR) with

a 95% confidence interval (CI) were calculated to measure the effect of each type of procedure, Lichtenstein repair and laparo-endoscopic surgery (TEP and TAPP), for dichotomous variables.

Heterogeneity was assessed by calculating I^2 values and Cochrane's Q test. Regarding the I^2 value heterogeneity was classified as low (25%) moderate (50%) or high (75%) and considered significant when $p < 0.1$ [13].

Publication bias was evaluated visually by assessing funnel plot symmetry and numerically using Rosenthal's Fail-Safe N or Rosenthal's Tolerance Index.

Results

Study selection

A flow chart (Fig. 1) outlining the study selection process in this systematic review and meta-analysis is presented in accordance with PRISMA (Preferred Reporting Items for Systematic Reviews) [8]. Initially, a search strategy was conducted in electronic databases including PubMed, Cochrane, EBSCO, Ovid, and Google Scholar, resulting in the identification of 252 records. After removing duplicated, 201 titles and abstracts were reviewed for eligibility. Of these, 64 articles were selected for full-text review. After a thorough examination of the remaining 64 articles, 56 did not meet inclusion criteria were excluded.

Ultimately, a total of 8 articles reporting on randomized controlled trials (RCTs) met the eligibility criteria and were included in the review [14–21].

Study characteristics

The articles incorporated into this systematic review were published between 2017 and 2022, and all of them were randomized clinical trials (RCTs). The overall sample size comprised 1,469 patients who were randomly assigned to two treatment groups: Lichtenstein repair with 51.4% ($n = 755$) and laparo-endoscopic repair (TAPP or TEP) with 48.6% ($n = 714$). The mean age of the participants was 54.52 years with a standard deviation of 3.54.

Only five articles considered the participation of women, resulting in a total of 92% ($n = 1357$) men and 5.4% ($n = 79$) women (Table 2).

Regarding the type of anesthesia used (Table 3), it is noteworthy that in the 714 patients who underwent laparo-endoscopic procedures, general anesthesia was employed. Of the total cases where the type of anesthesia in Lichtenstein surgery was recorded ($n = 680$), 1.03% of the surgeries were performed under local anesthesia, 57.5% under regional anesthesia and 41.47% under general anesthesia.

Concerning the type of mesh and techniques performed during open surgery, as depicted in Table 4, studies recording mesh material predominantly opted for polypropylene. Only one article described the weight of the mesh, which was of low weight [17]. In all instances where the open (Lichtenstein) surgical procedure was described, mesh fixation to the pubis was achieved through sutures. The prophylactic neurectomy is only mentioned in the work of Shah MY et al. [18], while in the rest of the articles, either it is not described [14, 19], or the approach of identifying and preserving the nerves has been chosen [15, 17, 20, 21] (Table 4). Similarly, the type of mesh and techniques performed during laparo-endoscopic surgery are detailed in Table 5. It is notable that studies recording mesh material also opted for polypropylene. Mesh weight was only described in the study by Gutlic et al. [17], and it was of high weight. In contrast to Lichtenstein repair, mesh fixation to the pubis was achieved with staples in only one study [21]. Neurectomy was not performed in laparo-endoscopic surgery.

According to the term "recurrence," only one study, Yang B et al. [14], defines recurrence as a palpable bulge on examination on the same side as the repair; the remaining articles do not. As for CPIP, four studies [17–20] define it as No pain, Mild, Moderate, and Severe.

Methodological quality and risk of Bias

The methodological quality of the included studies is depicted in Table 6. The included trials can be regarded as high-quality (Fig. 2: a and b). Concealment of allocation is well described in 5 out of 8 studies. Except for one study, the remaining studies had issues with blinding of personnel but not patients. Moreover, 2 articles achieved the blinding of the assessor.

Pain results

The definition of chronic pain varied across the studies, with some defining it starting at three months, others at six months and others at the first year. A total of 1,469 patients were followed to assess chronic pain. Regarding open surgery (Lichtenstein), CPIP was observed in 21.1% ($n = 159$) of patients. On the other hand, in laparo-endoscopic surgery, pain was reported in 8.1% ($n = 58$) of patients undergoing this intervention, as shown on Table 7.

In the random-effects analysis, laparo-endoscopic repair was associated with reduced odds of chronic pain compared to Lichtenstein repair (M-H OR = 0.28, 95% CI [0.30–0.56], $p = 0.0001$). There was some heterogeneity among the studies, with an $I^2 = 63\%$ and a p -value of 0.009 for the Cochrane Q test (Fig. 3). Upon visual analysis of the funnel plot no evidence of publication bias was found (Fig. 4), a

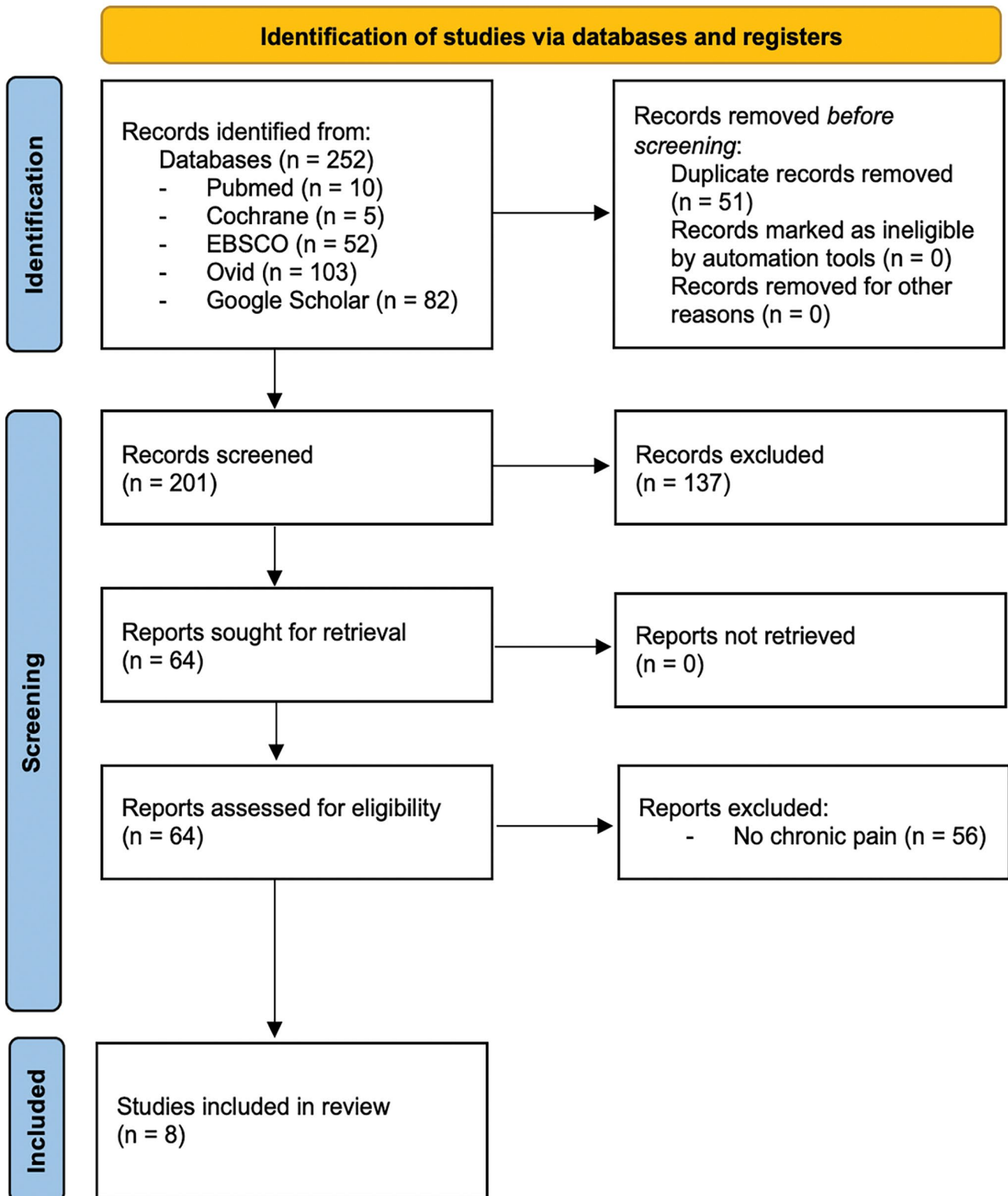


Fig. 1 PRISMA 2020 [8] flow diagram. *n* = number

Table 2 Description and demographics of the articles selected

Author	Country	Year	Study type	Number of patients		M ^{**} / F ^{***}	Age in years	Age SD ^{****}
				Open (total)	L-E* (total)			
Yang Bet al. [14]	China	2018	RCT	59 (122)	63 (122)	117/5	57.95	14.85
Ielpo Bet al. [15]	Spain	2018	RCT	61 (134)	73 (134)	116/7	53.35	-
Sevinç Bet al. [16]	Turkey	2019	RCT	147 (302)	155 (302)	273/29	48.15	13.56
Gutlic Net al. [17]	Sweden	2019	RCT	188 (396)	208 (396)	396/0	54.5	12
Shah MYet al. [18]	India	2022	RCT	88 (174)	86 (174)	169/5	48.73	13.93
Elmessiry MMet al. [19]	Egypt	2020	RCT	54 (105)	51 (105)	72/33	54.44	11.57
Sawarkar Pet al. [20]	India	2017	RCT	75 (150)	75 (140)	128/0	54.5	-
Yen FVet al. [21]	Malaysia	2017	RCT	42 (86)	44 (86)	86/0	50.62	14.92

* Laparo-endoscopic

** Male

*** Female

**** Standard Deviation

Table 3 Description of the type of anesthesia used for open and laparo-endoscopic surgery

	Lichtenstein			Laparo-endoscopic		
	Local N* (%)**	Regional n (%)	General n (%)	Local n (%)	Regional n (%)	General n (%)
Yang Bet al. [14]	7 (11.1)	42 (67.7)	14 (22.2)	0	0	59 (100)
Ielpo Bet al. [15]	0	73 (100)	0	0	0	61 (100)
Sevinç Bet al. [16]	0	155 (100)	0	0	0	147 (100)
Gutlic Net al. [17]	0	0	208 (100)	0	0	188 (100)
Shah MYet al. [18]	0	83 (96.5)	3 (3.5)	0	0	88 (100)
Elmessiry MMet al. [19]	0	38 (74.5)	13 (25.5)	0	0	51 (100)
Sawarkar Pet al. [20]	Not described	Not described	Not described	0	0	75 (100)
Yen FVet al. [21]	0	0	44 (100)	0	0	42 (100)

* number of cases

** percentage of cases

Table 4 Materials and techniques in the Lichtenstein approach

	Material mesh	Weight of mesh	Mesh fixation	Type of mesh fixation	Pubis fixation	Type of pubis fixation	Neurectomy
Yang Bet al. [14]	PP*	ND**	YES	Sutures	YES	Sutures	ND
Ielpo Bet al. [15]	ND	ND	YES	Staples	ND	ND	Identify and preserve.
Sevinç Bet al. [16]	ND	ND	ND	ND	ND	ND	Identify and preserve.
Gutlic Net al. [17]	PP	Low weight	YES	Sutures	YES	Sutures	Identify and preserve.
Shah MYet al. [18]	PP	ND	YES	Sutures	ND	ND	Prophylactic
Elmessiry MMet al. [19]	PP	ND	YES	Sutures	ND	ND	ND
Sawarkar Pet al. [20]	PP	ND	YES	Sutures	YES	Sutures	Identify and preserve.
Yen FVet al. [21]	PP	ND	YES	Sutures	YES	Sutures	Identify and preserve.

* Polypropylene

** Not described

finding supported by Rosenthal's tolerance test with a value of $n = 106$.

Recurrence results

Recurrence rates were reported in the eight trials with varying follow-up periods. Some studies followed up for the first year, while others extended follow-up to two years. In

total, 1,469 patients were analyzed. Concerning Lichtenstein surgery, a recurrence rate of 3% ($n = 23$) was observed in patients, while in laparo-endoscopic surgery, a 3.1% ($n = 22$) recurrence rate was reported (Table 8).

After applying the fixed-effects model, no significant differences were found when comparing laparo-endoscopic repair with Lichtenstein repair (M-H OR = 1.03; 95% CI [0.57–1.86], $p = 0.92$) (Fig. 5). There was no heterogeneity

Table 5 Materials and techniques in the laparo-endoscopic approach

	Mesh material	Mesh weight	Mesh fixation	Type of fixation	Type of pubis fixation	Neurectomy
Yang Bet al. [14]	PP*	ND**	YES	Staples/ fibrin sealants	NO	NO
Ielpo Bet al. [15]	PP	ND	YES	Staples	NO	NO
Sevinç Bet al. [16]	PP	ND	YES	Staples	NO	NO
Gutlic Net al. [17]	PP	High weight	NO	NO	NO	NO
Shah MYet al. [18]	PP	ND	NO	NO	NO	NO
Elmessiry MMet al. [19]	PP	ND	YES	Staples	NO	NO
Sawarkar Pet al. [20]	PP	ND	YES	Staples	YES	NO
Yen FVet al. [21]	PP	ND	NO	NO	NO	NO

* Polypropylene

** Not described

Table 6 CASP scale (critical appraisal skills program) for the assessment of methodological quality of the articles

	Yang B et al. [14]	Ielpo B et al. [15]	Sevinç B et al. [16]	Gutlic N et al. [17]	Shah MY et al. [18]	Elmes-siry MM et al. [19]	Sawarkar P et al. [20]	Yen FV et al. [21]
1. Did the study address a clearly focused research question?	YES	YES	YES	YES	YES	YES	YES	YES
2. Was the assignment of participants to interventions randomised?	YES	YES	YES	YES	YES	YES	YES	YES
3. Were all participants who entered the study accounted for at its conclusion?	YES	YES	YES	YES	YES	YES	YES	YES
4. Was blinding maintained for participants, investigators, and analyzing/ assessing personnel?	NO	NO	NO	NO	NO	NO	NO	YES
5. Were the study groups similar at the start of the RCT?	YES	YES	YES	YES	YES	YES	YES	YES
6. Apart from the study intervention, were the groups treated equally?	YES	YES	YES	YES	YES	YES	YES	YES
7. Were the effects of intervention reported comprehensively?	YES	NO	YES	NO	YES	YES	NO	NO
8. Was the precision of the estimate of the intervention effect reported?	YES	YES	YES	YES	YES	YES	YES	YES
9. Do the benefits of the experimental intervention outweigh the harms and costs?	YES	YES	YES	YES	YES	YES	YES	YES
10. Can the results be applied to your local population/in your context?	YES	YES	YES	YES	YES	YES	YES	YES
11. Do the potential benefits justify the risks and costs?	YES	YES	YES	NO	YES	YES	NO	NO

among the studies, with an I2 value of 0% and a *p*-value > 0.1 in the Cochrane Q test. Upon visual analysis of the funnel plot, no evidence of publication bias was found (Fig. 6).

Discussion

This systematic review and meta-analysis of RCTs provides updated evidence on the comparative effect of chronic inguinal pain following hernioplasty in patients undergoing laparoendoscopic repair compared to open surgery (Lichtenstein). It included 8 studies and 1469 patients demonstrating lower rates of CPIP in laparoendoscopic surgery. However, recurrence rates were the same.

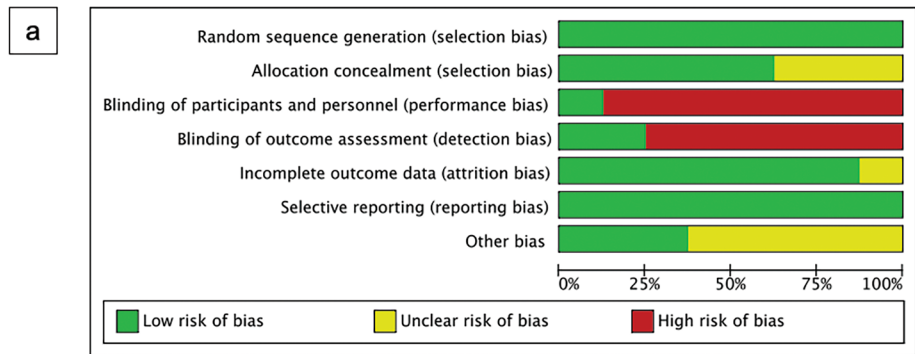
The results of this study can be significant when the surgical community contemplates current guidelines and their implementation in practice, as both the Lichtenstein procedure and minimally invasive techniques (laparo-endoscopic) are currently recommended as the best evidence-based options, particularly in the hands of experts [1].

Although this systematic review and meta-analysis differ from previous works published on this topic, primarily

because it also focus solely on unilateral primary inguinal hernia, and the definition of chronic pain varies in the literature, the results are in line with those of studies that did focus exclusively on it [3, 4, 6, 22] except for one study that conducted a Bayesian network meta-analysis, which did not find differences in CPIP [5]. This result may be due to the lower validity of indirect comparisons employed by this statistical method. In addition, this review and meta-analysis provides five RCTs not mentioned in previous meta-analyses [14, 17]- [20]. Consistent with the mentioned studies, a statistically significant difference is observed when comparing the risk of CPIP following laparo-endoscopic surgery versus open surgery. One possible explanation is the greater tissue damage and dissection of the spermatic cord and cremaster muscle in open surgery [7], while the risk of recurrence did not show statistical significance.

However, CPIP has also been associated with other perioperative factors besides surgical technique, such as the type of anesthesia. Chinchilla-Hermida et al. [23]. and Zwaan et al. [24]. demonstrated that general anesthesia is a risk factor for the development of CPIP, although this result may be biased as general anesthesia is often reserved for

Fig. 2 Risk of bias. **a)** Bias risk graph. **b)** summary of bias risk



Study	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Elmessiry MM et al. 2020	+	+	-	+	+	+	+
Gutlic N et al. 2019	+	+	-	-	+	+	+
Ielpo B et al. 2018	+	+	-	-	+	+	?
Sawarkar P et al. 2017	+	?	-	-	?	+	?
Sevinç B et al. 2019	+	+	-	-	+	+	?
Shah MY et al. 2022	+	?	-	-	+	+	?
Yang B et al. 2018	+	+	-	+	+	+	+
Yen FV et al. 2017	+	?	+	-	+	+	?

more complex patients with greater comorbidity, etc. Furthermore, in the same study by Chinchilla-Hermida et al. and the work of Crompton J et al. [25], it is reported that local trans-fascial infiltration of local anesthetics during open surgery is a factor that prevents the development of chronic pain in this type of surgery.

Postoperative chronic pain has been shown to be associated with injury or entrapment of the ilioinguinal,

iliohypogastric, and genitofemoral nerves, as they can become entrapped in a mesh or undergo peri-prosthetic inflammatory processes [26]. These nerves can be damaged during open surgery, unlike in laparo-endoscopic surgery, where there is less risk, provided careful dissection is performed without placing staples [27] in the pain triangle, where the nerves of the area are in the lateral preperitoneal space of Bogros. The management of these nerves in open

Table 7 Results of chronic inguinal pain post-hernioplasty

	Lichtenstein			Laparo-endoscopy		
	CIP* 3rd month <i>n</i> ** (%)***	CIP 6th month <i>n</i> (%)	CIP ≥ 1 year <i>n</i> (%)	CIP 3rd month <i>n</i> (%)	CIP 6th month <i>n</i> (%)	CIP ≥ 1 year <i>n</i> (%)
Yang Bet al. [14]	-	-	10 (15,9)	-	-	2 (3,4)
Ielpo Bet al. [15]	9 (12,3)	-	-	1 (1,6)	-	-
Sevinç Bet al. [16]	39 (25,2)	-	-	5 (3,4)	-	-
Gutlic Net al. [17]	-	-	47 (23,5)	-	-	28 (8,8)
Shah MY et al. [18]	19 (22,1)	-	-	3 (3,4)	-	-
Elmessiry MM et al. [19]	18 (35,3)	-	-	6 (11,2)	-	-
Sawarkar Pet al. [20]	-	16 (21,7)	-	-	12 (16)	-
Yen FV et al. [21]	-	1 (2,3)	-	-	1 (2,5)	-

* Chronic inguinal pain post hernioplasty

** Number of cases

*** Percentage of cases

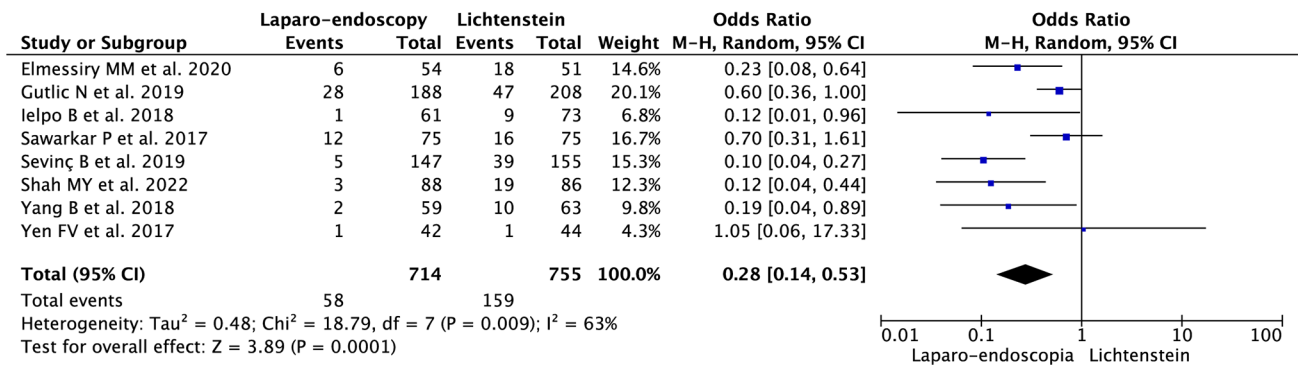


Fig. 3 Forest plot for chronic inguinal pain post-hernioplasty between laparo-endoscopy and Lichtenstein in inguinal hernia. *M-H* = Mantel-Haenszel, *CI* = confidence Interval

Fig. 4 Funnel plot of the treatment effect estimation versus the standard error of the treatment effect for chronic inguinal pain post-hernioplasty

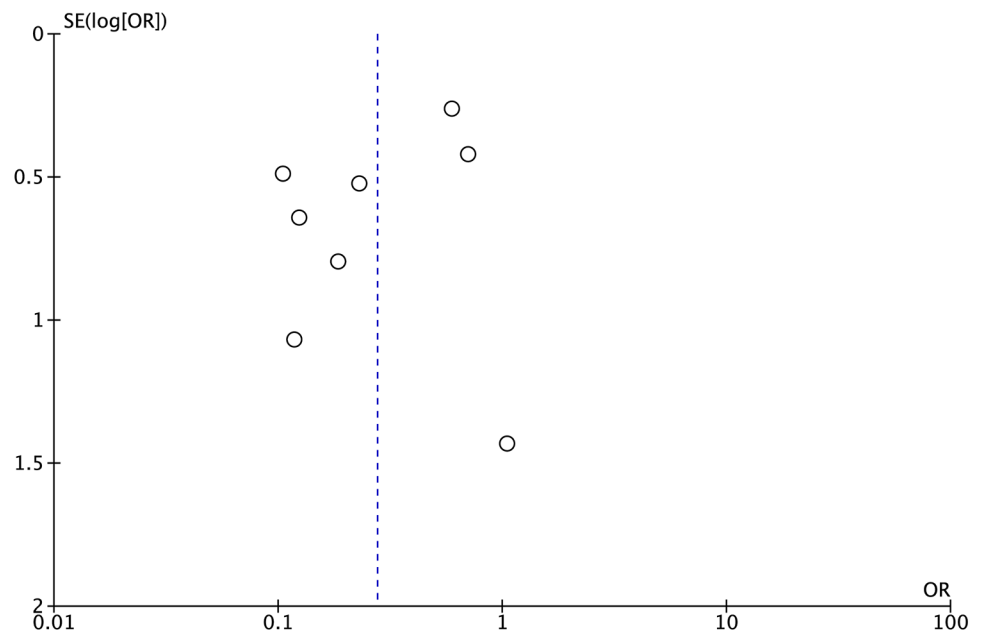


Table 8 Results of recurrence

	Lichtenstein		Laparo-endoscopy	
	Recurrence 1 year <i>n</i> * (%)**	Recurrence ≥ 2 years <i>n</i> (%)	Recurrence 1 year <i>n</i> (%)	Recurrence ≥ 2 years <i>n</i> (%)
Yang Bet al. [14]	3 (4,8)	-	1 (1,7)	-
Ielpo Bet al. [15]	4 (5,5)	-	4 (6,6)	-
Sevinç Bet al. [16]	8 (5,2)	-	5 (3,4)	-
Gutlic Net al. [17]	2 (1)	2 (1)	3 (1,6)	4 (2,2)
Shah MY et al. [18]	1 (1,6)	-	2 (2,2)	-
Elmessiry M Met al. [19]	-	1 (2)	-	2 (3,7)
Sawarkar Pet al. [20]	1 (0,8)	-	1 (0,8)	-
Yen FV et al. [21]	1 (2,3)	-	0 (0)	-

* number of cases

** percentage of cases

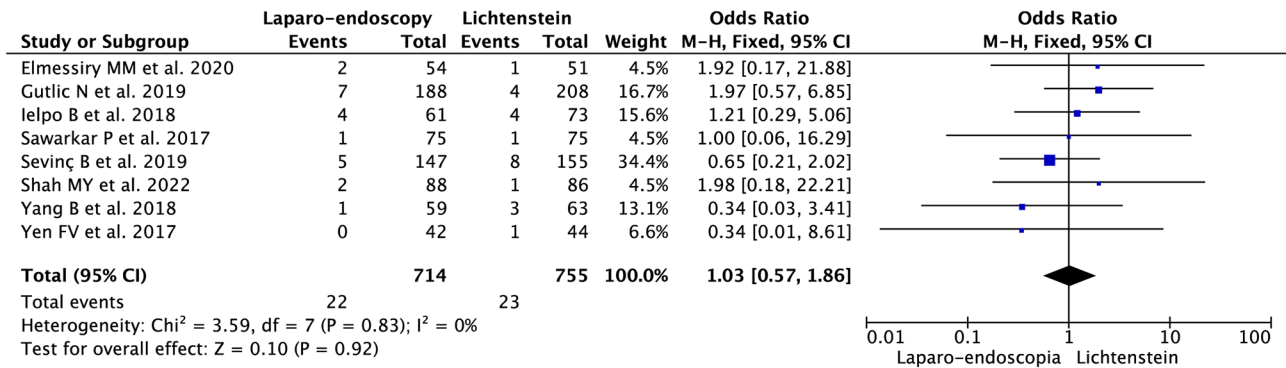
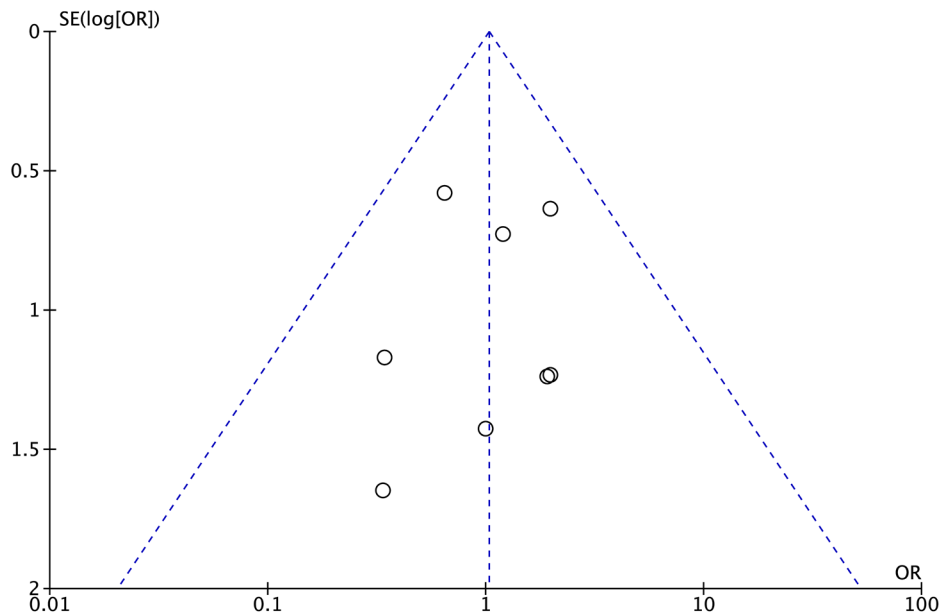


Fig. 5 Forest plot for recurrence between laparo-endoscopy and Lichtenstein in inguinal hernia. *M-H* = Mantel-Haenszel, *CI* = confidence interval

Fig. 6 Funnel plot of the treatment effect estimate versus the standard error of the treatment effect for recurrence



surgery varies according to the studies. The European Hernia Society (EHS) guideline [1] recommends identifying and preserving the nerves to reduce chronic pain. In cases of nerve injury, suspicion, or difficulty placing the mesh, pragmatic resection is recommended. The EHS [1] rejects prophylactic neurectomy; however, recent series have demonstrated that prophylactic neurectomy of the ilioinguinal nerve decreases pain at six months (not at one year), increasing paresthesia in the first six months in the study by Charalambous MP et al. [27]. and without increasing them in the studies by Cirocchi R et al. [28]. and Xu Z et al. [29]. .

In this review, only one study conducted prophylactic neurectomy [18], demonstrating a higher rate of chronic pain following Lichtenstein repair; these results are in contrast to the previously mentioned articles. The remaining articles of the review which described the process, identified and preserved the nerves.

Other influential factors for postoperative chronic pain include mesh weight and the fixation method.

Regarding mesh weight, a recent study by Bakker WJ et al. [30]. showed differences favoring lightweight mesh for chronic pain, but the rates were similar for severe chronic pain, and there were no differences in the recurrence rate. In contrast, for laparo-endoscopic surgery, Xu M et al. [31]. , Bakker WJ et al. [30]. , and Hu D et al. [32]. reported no differences in pain when comparing low-weight to high-weight meshes, but they did observe an increase in the recurrence rate with low-weight meshes.

Although there are multiple fixation methods, there is no consensus on which is the “best,” so the methods used are based on surgeons’ preferences. Trauma-free fixation with adhesives appears to reduce acute postoperative pain [1]. Regarding chronic pain, a review by de Sun P et al. [33]. found significant differences when comparing adhesive fixation to suture fixation (OR 0.63, 95% CI 0.44–0.91), with a lower incidence of chronic pain in the adhesive group and the same recurrence rate. However, most recent series did not find differences in either the rate of chronic pain or recurrences when comparing adhesives to sutures and self-adhesive meshes [34, 35], or when comparing sutures to self-adhesive meshes [36–38].

It is important to mention the fixation of the mesh to the pubis, which the EHS [1] discourages, as it can increase the incidence of chronic pain, due to the highly innervated periosteum of the pubic bone. If damaged by sutures or staples, it is likely to result in intense and long-lasting pain [1].

Although the aim of this study is not to compare mesh fixation versus non-fixation, it is worth mentioning that in the Lichtenstein repair, the articles describing the surgical procedure fix the mesh with sutures or staples, and those mentioning the fixation of the mesh to the pubis do so with sutures. Only Yang B et al. [14]. reports less chronic pain

in laparo-endoscopic surgery, while the remaining articles [17, 20, 21] do not show differences between fixing or not the mesh. Among these, the study by Sawarkar P et al. [20]. stands out, being the only one that secures the mesh to the pubis in laparo-endoscopic surgery, resulting in the RCT with the highest percentage of cases of CPIP in this technique.

In the laparo-endoscopic repair of inguinal hernia, the EHS [1] finds significant differences regarding chronic pain when not fixing the mesh or fixing it in a trauma-free manner (with adhesives/self-adhering) or mechanically (with sutures/staples). However, it recommends not fixing the mesh in most types of hernias, except in large medial defects (EHS M3 classification), where mesh fixation is recommended to decrease recurrence [1].

The literature shows variability in results regarding fixation in laparo-endoscopic surgery. In the Swedish study by Gutlic N et al. [39]. , no differences were found in postoperative chronic pain and recurrence between non-fixation, trauma-free fixation (adhesive), and mechanical fixation in TEP.

However, in the work of Habib Bedwani NaR et al. [40]. , it is reported that there are differences in favor of trauma-free fixation (adhesive) over mechanical fixation in both TEP and TAP (RR = 0.43, 95% CI [0.27–0.86]). Additionally, the review by Wang D et al. [41] describes a lower incidence of chronic pain with self-adhesive meshes (trauma-free) compared to conventional ones (mechanical) (OR 0.43, 95% CI 0.20–0.93, $P=0.03$). Both studies demonstrated that there were no differences in terms of the risk of recurrence.

In this review, all of the studies examined opted to fix the mesh in laparo-endoscopic surgery with staples [14–16, 19, 20], except for two which did not do so [17, 18]. It is worth noting that the study by Yang B et al. [14]. , which used adhesive in cases of defects smaller than 3 centimeters. It is difficult to know the relevance of these techniques. The current trend is only to fix the mesh in M3 hernias [1].

Finally, it is relevant to note that this systematic review and meta-analysis grouped both the TEP and TAPP techniques because the literature shows that both have similar risks in terms of complications, incidence of acute and chronic postoperative pain, as well as recurrence rates.

There are several limitations that could influence the results. These limitations include the exclusion of articles in languages other than English and Spanish, what could cause the omission of important articles, the absence of multi-center studies, the specific characteristics and practices of a particular center (such as mesh fixation technique and its location, the point of fixation in Lichtenstein repair to the pubic tubercle, and the material used, as well as the type of mesh employed), the lack of blinding for surgeons and evaluators, and different methods of random assignment.

All of these factors contribute to a high level of heterogeneity among the studies. Moreover, the studies obtained do not follow up beyond 5 years to adequately assess recurrence.

Two studies analyzed (Ielpo B et al. [18] and Elmessiry M.M et al. [19]) only include patients operated on for bilateral inguinal hernia and analyze patients presenting with CPIP without differentiating whether it is unilateral or bilateral pain, which implies it is a confounding variable.

In conclusion, the laparo-endoscopic techniques (TAPP and TEP) present a lower risk of CPIP compared to Lichtenstein repair. This study did not find differences in the recurrence rates between laparo-endoscopic repair (TAPP and TEP) and open repair (Lichtenstein).

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Declarations

Guillermo Lillo-Albert, Elvira Buch Villa, Andrea Boscà-Robledo, Omar Carreño-Sáenz, José Bueno-Lledó, Jesús Martínez-Hoed, Salvador Pous-Serrano declare that they have no conflict of interest.

There is not conflict of interest, including but not limited to direct, indirect financial or personal relationships.

Approval from the institutional review board was not required for this study.

This article is a systematic review and meta-analysis contains data collected through literature review. It does not include research directly involving human or animal participation.

For this literature review, formal consent is not required.

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