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Surgical Technique and Chronic Postoperative Inguinal Pain in Patients Undergoing Open Inguinal Hernioplasty in Portugal: A Prospective Multicentric Cohort Study

Técnica Cirúrgica e Dor Crónica Inguinal Pós-Operatória em Doentes Submetidos a Hernioplastia Inguinal por Via Aberta em Portugal: Uma Coorte Prospetiva Multicêntrica

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ABSTRACT

Introduction: Evidence about the advantage of Lichtenstein's repair, the guidelines' recommended technique, is scarce regarding postoperative chronic inguinal pain (CPIP). The primary aim of this study was to compare CPIP in patients undergoing Lichtenstein *versus* other techniques.

Methods: Prospective multicentric cohort study including consecutive adults undergoing elective inguinal hernia repair in Portuguese hospitals (October - December 2019). Laparoscopic and mesh-free hernia repairs were excluded. The primary outcome was postoperative pain at three months, defined as a score of ≥ 3/10 in the European Hernia Society Quality of Life score pain domain. The secondary outcome was 30-day postoperative complications.

Results: Eight hundred and sixty-nine patients from 33 hospitals were included. Most were men (90.4%) and had unilateral hernias (88.6%). Overall, 53.6% (466/869) underwent Lichtenstein's repair, and 46.4% (403/869) were treated with other techniques, of which 83.9% (338/403) were plug and patch. The overall rate of CPIP was 16.6% and 12.2% of patients had surgical complications. The unadjusted risk was similar for CPIP (OR 0.76, p = 0.166, CI 0.51 - 1.12) and postoperative complications (OR 1.06, p = 0.801, CI 0.69 - 1.60) between Lichtenstein and other techniques. After adjustment, the risk was also similar for CPIP (OR 0.83, p = 0.455, CI 0.51 - 1.34) and postoperative complications (OR 1.14, p = 0.584, CI 0.71 - 1.84).

Conclusion: The Lichtenstein technique was not associated with lower CPIP and showed comparable surgical complications. Further investigation assessing long term outcomes is necessary to fully assess the benefits of the Lichtenstein technique regarding CPIP.

Keywords: Chronic Pain/etiology; Hernia, Inguinal/surgery; Herniorrhaphy/methods; Pain, Postoperative; Portugal

RESUMO

Introdução: A evidência sobre a vantagem da técnica de Lichtenstein, recomendada pelas normas de orientação clínica é insuficiente relativamente à dor inguinal crónica pós-operatória (CPIP). O objetivo principal deste estudo foi comparar CPIP em doentes submetidos a Lichtenstein *versus* outras técnicas.

Métodos: Estudo coorte multicêntrico prospetivo que incluiu adultos consecutivamente submetidos a hernioplastia eletiva em hospitais portugueses (outubro - dezembro 2019). Abordagens laparoscópicas e sem prótese foram excluídas. O *outcome* primário foi a dor pós-operatória aos três meses, definida pelo *score* de ≥ 3/10 no domínio de dor do *score* da *European Hernia Society Quality of Life*. O *outcome* secundário foram complicações pós-operatórias aos 30 dias.

Resultados: Foram incluídos 869 doentes de 33 hospitais. A maioria eram homens (90,4%), com hérnias unilaterais (88,6%). Do total, 53,6% (466/869) foram submetidos a Lichtenstein e 46,4% (403/869) a outras técnicas, das quais 83,9% (338/403) *plug and patch*. A proporção geral de CPIP foi 16,6% e 12,2% tiveram complicações pós-operatórias. O risco não ajustado foi semelhante para CPIP (OR 0,76, p = 0,166, CI 0,51 - 1,12) e complicações pós-operatórias (OR 1,06, p = 0,801, CI 0,69 - 1,60) entre Lichtenstein e outras técnicas. Após ajuste, o risco manteve-se semelhante para CPIP (OR 0,83, p = 0,455, CI 0,51 - 1,34) e complicações pós-operatórias (OR 1,14, p = 0,584, CI 0,71 - 1,84).

Conclusão: A técnica Lichtenstein não está associada a menor CPIP e mostrou complicações cirúrgicas comparáveis. Mais estudos para avaliar *outcomes* a longo prazo são necessários para avaliar a real vantagem desta técnica relativamente à CPIP.

Palavras-chave: Dor Crónica/etiologia; Dor Pós-Operatória; Hérnia Inguinal/cirurgia; Herniorrafia/métodos; Portugal

INTRODUCTION

Inguinal hernia repair is one of the most common procedures performed by general surgeons.[1] Women have a lifetime risk of developing inguinal hernia of 3% - 6% and men have a risk of 27% - 43%.[1]

The only curative treatment for inguinal hernias is surgical repair.[2] One-third of patients are asymptomatic[3] and, despite going through a watch-and-wait approach, 70% undergo surgery within five years.[2]

A prevalent comorbidity of inguinal hernia repair is chronic postoperative inguinal pain (CPIP), affecting around 10% - 12% of patients.[4,5] This complication also has an impact on quality of life.[6] Chronic postoperative inguinal pain is defined as pain lasting more than three months after inguinal hernia repair.[7,8] Several characteristics have been reported as risk factors for CPIP, such as young age, female sex, high preoperative pain, early high postoperative pain, recurrent hernia, and open repair.[9-12]

Current guidelines state that surgery is indicated for all symptomatic patients.[13] Even though there is a recommendation to watch-and-wait in asymptomatic or minimally symptomatic patients,[2,3,14] most patients will develop symptoms and undergo surgery. The standard surgical techniques utilized are the Lichtenstein[15] and laparo-endoscopic approaches.[16,17]

Despite the preference for the Lichtenstein technique, the results regarding CPIP and recurrence are comparable with other open techniques with mesh.[18-20] The main criteria used to distinguish Lichtenstein from the other techniques focused on the smaller amount of foreign material used, the anatomical planes affected by the surgery, reduced cost, simplicity and reproducibility in comparison with other techniques.[13] Data comparing CPIP outcomes between the various surgical techniques is still scarce,[18-20] especially regarding open pre-peritoneal approaches.[21-23]

The Portuguese INguinal hErnia cohort (PINE) study analyzed outcomes related with inguinal hernia surgery in Portugal, and this study aimed to compare postoperative pain in patients undergoing open mesh repair of inguinal hernia by Lichtenstein *versus* other techniques.

METHODS

Study design

The PINE was a Portuguese prospective multicentric cohort study. All Portuguese hospitals performing elective hernia repair surgery were eligible.

Each participating hospital included consecutive patients being operated on during one or more periods of 14-days (7th - 18th October, 28th October - 8th November, 18th November - 29th November, 29th November - 13th December 2019).

In all participating hospitals the study was approved by the local ethics committee, and, per national ethics regulations, individual patient consent was collected for all patients.

The PINE was registered at Clinicaltrials.gov with the reference NCT04328597 and the protocol was made available as a preprint.[24]

Inclusion and exclusion criteria

All patients aged over 18 years old undergoing elective inguinal hernia repair were included. The exclusion criteria were defined as: patients who underwent urgent surgery, laparoscopic surgery, and mesh-free hernia repairs.

Study aims and outcome measures

The primary aim of the study was to compare postoperative pain at three months after surgery in patients undergoing Lichtenstein *versus* other techniques.

The secondary aim was to assess the safety of Lichtenstein *versus* other techniques, and the secondary outcome was 30-day postoperative complications.

Outcome measures

Primary outcome

The European Hernia Society Quality of Life (EuraHS-QoL) score was used to assess chronic postoperative inguinal pain. The CPIP was defined as a score of ≥ 3/10 in any of the questions of the pain domain of the three-month questionnaire of the EuraHS-QoL score [complete description of the score in Appendix 1 (Appendix 1: https://www.actamedicaportuguesa.com/revista/index.php/amp/article/view/20277/15438)].

Secondary outcome

The Clavien-Dindo classification was used to describe postoperative complications. It was categorized as "No complications" when the Clavien-Dindo classification was 0, and "With complications" when the classification was I/II/III/IV/V [complete description of the categories in Appendix 1 (Appendix 1: https://www.actamedicaportuguesa.com/revista/index.php/amp/article/view/20277/15438)].

Data variables and definitions

Preoperative variables

The preoperative data variables analyzed included: age (≤ 60 years old *versus* > 60 years old), sex (female *versus* male), body mass index (BMI) [normal, underweight, overweight and obese, complete description of the categories in Appendix 1 (Appendix 1: https://www.actamedicaportuguesa.com/revista/index.php/amp/article/view/20277/15438)], American Society of Anesthesiologists (ASA) physical status [ASA 1 - 2 *versus* ASA 3 - 4, complete description of the categories in Appendix 1 (Appendix 1: https://www.actamedicaportuguesa.com/revista/index.php/amp/article/view/20277/15438)], hernia size (≤ 1.5 cm *vs* > 1.5 cm), previous ipsilateral inguinal hernia repair, preoperative inguinal pain (was defined as a score of ≥ 3/10 in any of the questions of the pain domain of the EuraHS-QoL score at the preoperative assessment), and history of non-inguinal chronic pain (including migraine, osteoarticular disease, fibromyalgia, post-traumatic pain, cancer-related pain, post-surgical pain or nerve injury/compression).

Intraoperative variables

Regarding the intraoperative variables, the surgical technique was categorized, in the primary analysis of the primary aim, as Lichtenstein *versus* other techniques, which included plug and patch, prolene hernia system (PHS), trans inguinal pre-peritoneal (TIPP), trans rectal pre-peritoneal (TREPP), and variations of these techniques. In the secondary analysis of the primary aim, the surgical technique was categorized as Lichtenstein *versus* plug and patch *versus* remaining techniques, which included PHS, TIPP, TREPP, and variations of these techniques if the surgeon considered it to differ significantly from the standard approach. Other intraoperative variables analyzed were the type of mesh fixation (absorbable *versus* non-absorbable materials) and nerve section (nerve section *versus* no nerve section).

Data collection and management

Data were collected and stored on Research Electronic Data Capture (REDCap), a secure anonymized platform. The pre- and intra-operative patient data were collected in person with the patient after consent at the time of surgery and from admission. Unless there was a planned in-person visit with the surgical team, the data collection for one and three months after surgery was done by telephone.

Missing data

Missing data were fully reported in the figures and tables for all variables. The adjusted models only included patients without missing data for the included variables, and this is reported in the model outputs.

Statistical analysis

A descriptive analysis of categorical variables was presented with frequency tables and the chi-squared test was used to test significant differences between surgical techniques regarding the predefined variables. For age as a continuous variable, summary metrics (mean and standard deviation) were performed. The chi-squared test was used to test for significant differences between surgical techniques regarding CPIP and post-operative complications.

A logistic regression model was performed to identify independent predictors of CPIP at three months after surgery. The explanatory factors to be included in the models were identified *a priori*, as per the clinical plausibility of their impact on CPIP, and the variables included were age, sex, ASA grade, BMI, hernia size, previous ipsilateral inguinal hernia repair, preoperative inguinal pain, non-inguinal chronic pain, nerve section, mesh fixation and type of mesh. A logistic regression model was performed to identify independent predictors of postoperative complications at three months after surgery.

Model goodness-of-fit was assessed using the Hosmer–Lemeshow statistic.

The statistical significance level was predefined as $p < 0.05$.

The statistical analysis was performed using R studio V 4.2.2.

RESULTS

Patients and procedures

This is a pre-specified sub-analysis of the PINE study (which included direct, indirect, and mixed inguinal hernia, femoral hernia, bilateral hernia, laparoscopic surgery, open mesh-free repairs, and open repairs with mesh). For this analysis, the patients with femoral hernia who underwent laparoscopic surgery or open mesh-free repairs were excluded, as the research question focused on the Lichtenstein and other open mesh repairs. The diagram describing the inclusion and exclusion criteria is in Fig. 1.

Overall, 869 patients were included from the 33 participating hospitals. Most patients were men [90.4% (784/867)], with mild to moderate comorbidities [81.4% ASA grade 1 - 2 (705/866)] and the mean age was 61.1 years old (SD 14.3). In 88.6% (751/848) of the cases the hernia was unilateral. Full preoperative details are shown in Table 1.

Of the 869 patients included in the study, 466 underwent Lichtenstein's mesh repair (53.6%), and the remaining 403 patients underwent other techniques (46.4%). Of those patients, 338 underwent plug and patch (83.9%) and the remaining 65 patients (16.1%) underwent the remaining techniques (eight patients to PHS, ten to TIPP, two to TREPP and 45 to variations of the techniques).

The two groups of patients (Lichtenstein *versus* other techniques) were similar. However, patients undergoing Lichtenstein were less likely to have undergone a previous ipsilateral hernia repair (3.7% *vs* 8.4%, $p = 0.004$), were more likely to have the mesh fixated with non-absorbable suture (50.9% *vs* 27.8%, $p < 0.001$), and were less likely to have the nerve sectioned during surgery (79.4% *vs* 91.0%, $p < 0.001$).

Secondary analysis of the primary outcome

A supplementary analysis was made to compare the Lichtenstein technique, the plug and patch technique and the remaining techniques. The full perioperative data regarding this analysis is shown in Appendix 2 (Appendix 2: https://www.actamedicaportuguesa.com/revista/index.php/amp/article/view/20277/15439).

Chronic postoperative inguinal pain

The overall rate of postoperative chronic inguinal pain was 16.6%. The unadjusted rates of postoperative pain were similar across surgical techniques (18.4% for Lichtenstein *versus* 14.6% for other techniques, $p = 0.166$).

After adjustment for the defined co-variables, the odds ratio (OR) between Lichtenstein and other techniques for postoperative chronic inguinal pain was 0.83 [$p = 0.455$, CI 95 (0.51 - 1.34)]. Chronic postoperative inguinal pain was only independently associated with preoperative inguinal pain [19.7% for patients with preoperative inguinal pain in

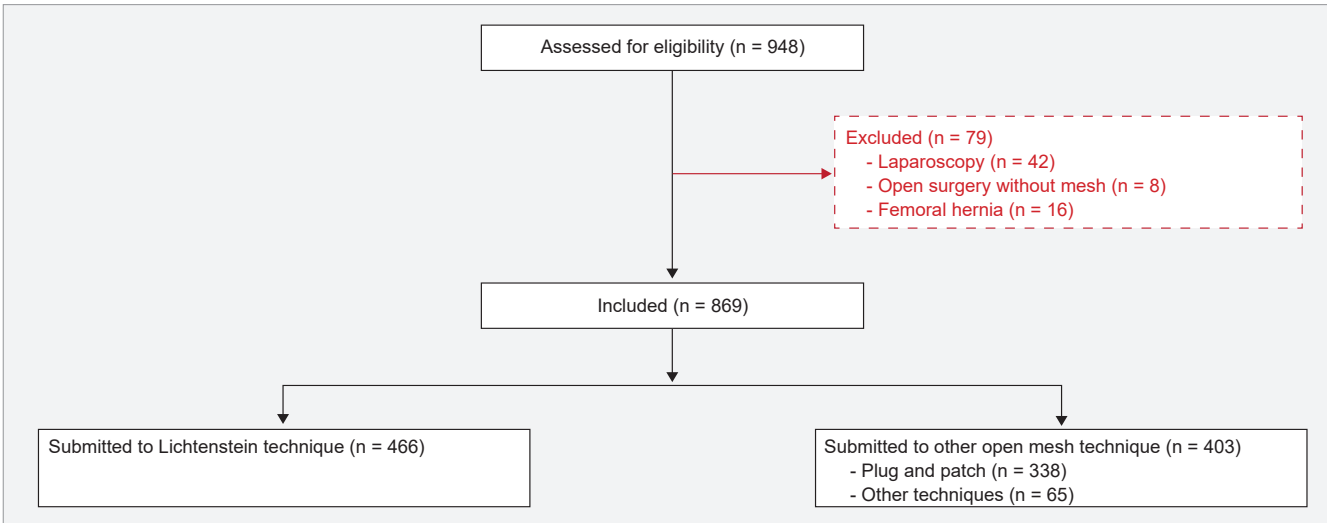

Figure 1 – Diagram of the PINE study patients included in the analysis

Table 1 – Pre and Intraoperative details of the patients included in the analysis

	Lichtenstein n = 466 (53.6%)	Other techniques n = 403 (46.4%)	Total (n = 869)	Missing n	*p*-value[a]
Age					
< 60 years	229 (49.1)	179 (44.4)	408 (47.0)	0	0.173
≥ 61 years	237 (50.9)	224 (55.6)	461 (53.0)		
Sex					
Female	50 (10.7)	33 (8.2)	83 (9.6)	2	0.247
Male	416 (89.3)	368 (91.8)	784 (90.4)		
ASA grade					
ASA 1 - 2	386 (82.8)	319 (79.8)	705 (81.4)	3	0.256
ASA 3 - 4	80 (17.2)	81 (20.2)	161 (18.6)		
BMI					
Normal	220 (47.8)	159 (41.2)	379 (44.8)	23	0.260
Underweight	4 (0.9)	5 (1.3)	9 (1.1)		
Overweight	193 (42.0)	180 (46.6)	373 (44.1)		
Obese	43 (9.3)	42 (10.9)	85 (10.0)		
Hernia size					
< 1.5 cm	142 (33.6)	106 (30.5)	248 (32.2)	100	0.394
> 1.5 cm	280 (66.4)	241 (69.5)	521 (67.8)		
Previous ipsilateral inguinal hernia repair					
No	448 (96.3)	369 (91.6)	817 (94.1)	1	**0.004**
Yes	17 (3.7)	34 (8.4)	51 (5.9)		
Preoperative inguinal pain					
No pain	119 (25.9)	80 (20.2)	199 (23.2)	12	0.052
Pain	341 (74.1)	317 (79.8)	658 (76.8)		
Non-inguinal chronic pain					
No	359 (77.2)	308 (76.4)	667 (76.8)	1	0.809
Yes	106 (22.8)	95 (23.6)	201 (23.2)		
Nerve section					
Nerve section	95 (20.6)	36 (9.0)	131 (15.2)	9	**< 0.001**
No nerve section	367 (79.4)	362 (91.0)	729 (84.8)		
Mesh fixation					
Absorbable	229 (49.1)	291 (72.2)	520 (59.8)	0	**< 0.001**
Non-absorbable	237 (50.9)	112 (27.8)	349 (40.2)		
Type of mesh					
Light	295 (69.9)	216 (64.1)	511 (67.3)	110	0.102
Heavy	127 (30.1)	121 (35.9)	248 (32.7)		

[a] Chi-squared test

contrast with 7.2% in patients without preoperative inguinal pain, OR = 2.89, *p* = 0.002, CI 95 (1.54 - 5.97)] and was not associated with surgical technique.

The full logistic regression model is shown in Fig. 2 and Table 2.

Secondary analysis of the primary outcome

In the secondary analysis, the unadjusted rate of postoperative chronic inguinal pain was 18.4% with Lichtenstein, 14.7% with plug and patch, and 14.0% with the remaining techniques (*p* = 0.203 between Lichtenstein and plug and patch and *p* = 0.424 between plug and patch and the remaining techniques).

After the adjustment for the defined co-variables, the OR between Lichtenstein and plug and patch was 0.88 [*p* = 0.611, CI 95 (0.53 - 1.44)] and the OR between plug and patch and the remaining techniques was 0.58 [*p* = 0.336, CI 95 (0.16 - 1.59)]. In this secondary analysis, CPIP was only independently associated with preoperative inguinal pain [19.7% for patients with preoperative inguinal pain in contrast with 7.2% in patients without preoperative inguinal pain, OR = 2.90, *p* = 0.002, CI 95 (1.54 - 5.98)].

A complete adjusted analysis is available in Fig. 3 and Table 3.

Postoperative complications

The overall rate of postoperative complications was 12.2% and the unadjusted rates were similar across surgical techniques (13.6% for Lichtenstein, 14.3% for other techniques, *p* = 0.801).

After adjustment for the defined co-variables, the OR between Lichtenstein and other techniques was 1.14 [*p* = 0.584, CI 95 (0.71 - 1.84)]. The postoperative complications were only independently associated with a previous ipsilateral inguinal hernia repair [11.3% with no previous repair *versus* 27.7% when there was a previous repair, OR = 3.05, *p* = 0.003, CI 95 (1.41 - 6.28)] and the type of mesh fixation [9.6% with absorbable mesh fixation *versus* 16.6% with a

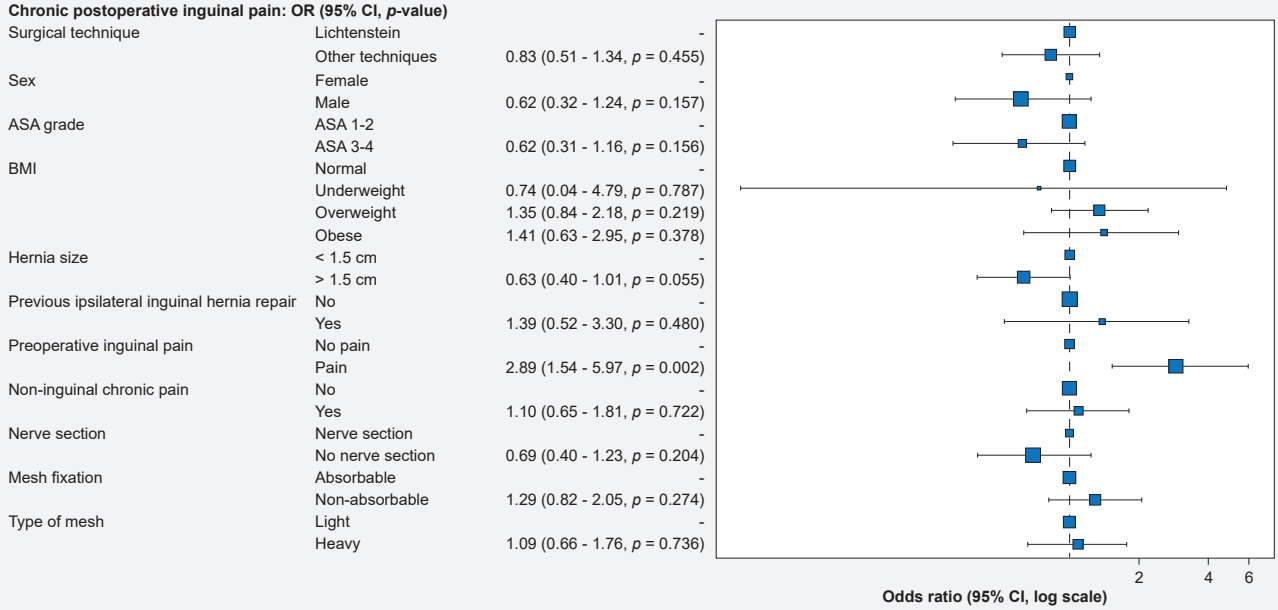

Figure 2 – Predictors of chronic postoperative inguinal pain at three months after surgery

Table 2 – Predictors of chronic postoperative inguinal pain at three months after surgery

	No pain (n = 617)	Pain (n = 123)	OR [IC 95%, *p*-value]	aOR [IC 95%, *p*-value]
Surgical technique				
Lichtenstein	324 (81.6)	73 (18.4)	Ref	Ref
Other techniques	293 (85.4)	50 (14.6)	0.76 (0.51 - 1.12, *p* = 0.166)	0.83 (0.51 - 1.34, *p* = 0.455)
Sex				
Female	53 (73.6)	19 (26.4)	**Ref**	Ref
Male	563 (84.4)	104 (15.6)	**0.52 (0.30 - 0.93, *p* = 0.021)**	0.62 (0.32 - 1.24, *p* = 0.157)
ASA grade				
ASA 1 - 2	493 (82.6)	104 (17.4)	Ref	Ref
ASA 3 - 4	123 (87.2)	18 (12.8)	0.69 (0.39 - 1.16, *p* = 0.183)	0.62 (0.31 - 1.16, *p* = 0.156)
BMI				
Normal	280 (84.8)	50 (15.2)	Ref	Ref
Underweight	6 (85.7)	1 (14.3)	0.93 (0.05 - 5.62, *p* = 0.950)	0.74 (0.04 - 4.79, *p* = 0.787)
Overweight	254 (81.2)	59 (18.8)	1.30 (0.86 - 1.97, *p* = 0.212)	1.35 (0.84 - 2.18, *p* = 0.219)
Obese	61 (84.7)	11 (15.3)	1.01 (0.48 - 1.99, *p* = 0.978)	1.41 (0.63 - 2.95, *p* = 0.378)
Hernia size				
< 1.5 cm	163 (77.3)	48 (22.7)	**Ref**	Ref
> 1.5 cm	378 (85.7)	63 (14.3)	**0.57 (0.37 - 0.86, *p* = 0.008)**	0.63 (0.40 - 1.01, *p* = 0.055)
Previous ipsilateral inguinal hernia repair				
No	583 (83.8)	113 (16.2)	Ref	Ref
Yes	34 (77.3)	10 (22.7)	1.52 (0.69 - 3.05, *p* = 0.265)	1.39 (0.52 - 3.30, *p* = 0.480)
Preoperative inguinal pain				
No pain	167 (92.8)	13 (7.2)	**Ref**	**Ref**
Pain	447 (80.3)	110 (19.7)	**3.16 (1.79 - 6.03, *p* < 0.001)**	**2.89 (1.54 - 5.97, *p* = 0.002)**
Non-inguinal chronic pain				
No	470 (84.1)	89 (15.9)	Ref	Ref
Yes	147 (81.2)	34 (18.8)	1.22 (0.78 - 1.87, *p* = 0.369)	1.10 (0.65 - 1.81, *p* = 0.722)
Nerve section				
Nerve section	85 (75.9)	27 (24.1)	**Ref**	Ref
No nerve section	527 (84.9)	94 (15.1)	**0.56 (0.35 - 0.92, *p* = 0.020)**	0.69 (0.40 - 1.23, *p* = 0.204)
Mesh fixation				
Absorbable	376 (84.9)	67 (15.1)	Ref	Ref
Non-absorbable	241 (81.1)	56 (18.9)	1.30 (0.88 - 1.92, *p* = 0.182)	1.29 (0.82 - 2.05, *p* = 0.274)
Type of mesh				
Light	357 (82.4)	76 (17.6)	Ref	Ref
Heavy	174 (82.9)	36 (17.1)	0.97 (0.62 - 1.49, *p* = 0.898)	1.09 (0.66 - 1.76, *p* = 0.736)

Ref: reference; OR: odds ratio; aOR: adjusted odds ratio
Dependent variable: chronic postoperative inguinal pain; Independent variables for adjusted model: surgical technique, sex, ASA grade, BMI, hernia size, previous ipsilateral inguinal hernia repair, preoperative inguinal pain, non-inguinal chronic pain, nerve section, mesh fixation.
Method: ENTER;
Hosmer-Lesmeshow *p*-value = 0.793

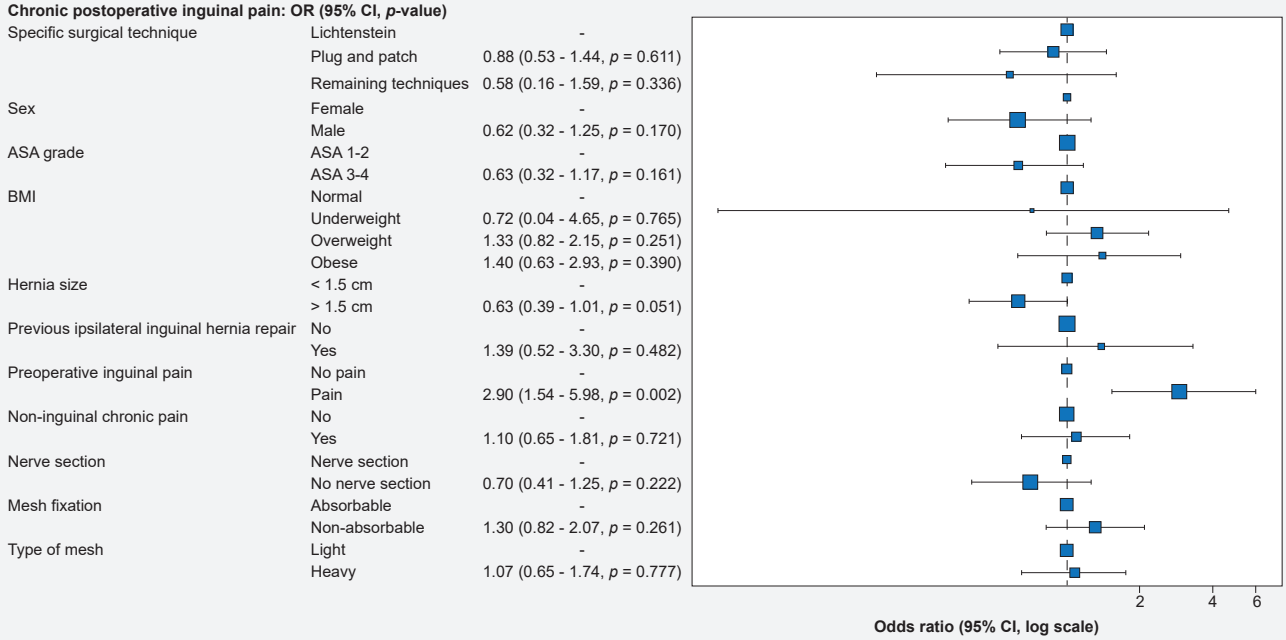

Figure 3 – Predictors of chronic postoperative inguinal pain at three months after surgery with the surgical technique categorized into Lichtenstein, plug and patch and remaining techniques

non-absorbable mesh fixation, OR = 2.0, *p* = 0.004, CI 95 (1.26 - 3.20)].

The full adjusted analysis is shown in Fig. 4 and Table 4.

DISCUSSION

This study aimed to compare chronic postoperative pain in patients undergoing open mesh repair of inguinal hernia by Lichtenstein *versus* other techniques. This criterion is important to establish the rates of CPIP with the various techniques, an important factor in surgical decision-making.

This study showed no statistically significant difference in CPIP at three months between the Lichtenstein technique and other techniques [18.4% *vs* 14.6%, OR = 0.83 *p* = 0.455, CI 95 (0.51 - 1.34)]. Secondly, the multivariable analysis showed that the only factor associated with CPIP was preoperative inguinal pain. The secondary analysis of the primary outcome, comparing specifically Lichtenstein, plug and patch and the remaining techniques, also did not reveal significant differences between the groups (18.4% *vs* 14.7% *vs* 14.0%, *p* = 0.611 and *p* = 0.336). Neither was there a statistically significant difference in postoperative complications between Lichtenstein and other techniques [12.0% *vs* 12.5%, OR = 1.14, *p* = 0.584, CI 95 (0.71 - 1.84)]. The multivariable analysis showed that the only factors associated with postoperative complications were a previous ipsilateral inguinal hernia repair and non-absorbable mesh fixation.

Current hernia surgery guidelines lack robust evidence to recommend a specific surgical technique.[13] Previous studies have shown that the technique in open repair approaches seems to have no influence on the rates of CPIP[18-20] and the results of our analysis are consistent with this.

A secondary analysis of the primary outcome was performed to verify if there could be any bias – given the residual volume of the remaining techniques compared with plug and patch – that could be concealing any change to the results, but the results remained not statistically significant, which supports the conclusion that surgical technique is not likely to be a predictor of CPIP.

On the other hand, our finding that preoperative inguinal pain was a predictor of CPIP is also consistent with the current knowledge, as preoperative inguinal pain was already described[9-12] and included in the European Guidelines[13] as a risk factor for CPIP.

In our study, the multivariable analysis showed that a previous ipsilateral inguinal hernia was associated with postoperative complications [11.3% *vs* 27.7%, OR = 3.05, *p* = 0.003, CI 95 (1.41 - 6.28)] as well as the type of mesh fixation [9.3% *vs* 16.6%, OR = 2.0, *p* = 0.004, CI 95 (1.26 - 3.20)]. The two identified predictive factors are useful to inform patients about their additional risk of postoperative complications when undergoing a hernia re-intervention and may aid in decision-making regarding the type of mesh fixation in high-risk patients.

In this cohort, only 53.6% of patients underwent hernia repair using the Lichtenstein technique (the open technique

Table 3 – Predictors of chronic postoperative inguinal pain at three months after surgery with the surgical technique categorized into Lichtenstein, plug and patch and remaining techniques

	No pain (n = 617)	Pain (n = 123)	OR [IC 95%, *p*-value]	aOR [IC 95%, *p*-value]
Specific surgical technique				
Lichtenstein	324 (81.6)	73 (18.4)	Ref	Ref
Plug and patch	244 (85.3)	42 (14.7)	0.76 (0.50 - 1.15, *p* = 0.203)	0.88 (0.53 - 1.44, *p* = 0.611)
Remaining techniques	49 (86.0)	8 (14.0)	0.72 (0.31 - 1.52, *p* = 0.424)	0.58 (0.16 - 1.59, *p* = 0.336)
Sex				
Female	53 (73.6)	19 (26.4)	Ref	Ref
Male	563 (84.4)	104 (15.6)	**0.52 (0.30 - 0.93, *p* = 0.021)**	0.62 (0.32 - 1.25, *p* = 0.170)
ASA grade				
ASA 1 - 2	493 (82.6)	104 (17.4)	Ref	Ref
ASA 3 - 4	123 (87.2)	18 (12.8)	0.69 (0.39 - 1.16, *p* = 0.183)	0.63 (0.32 - 1.17, *p* = 0.161)
BMI				
Normal	280 (84.8)	50 (15.2)	Ref	Ref
Underweight	6 (85.7)	1 (14.3)	0.93 (0.05 - 5.62, *p* = 0.950)	0.72 (0.04 - 4.65, *p* = 0.765)
Overweight	254 (81.2)	59 (18.8)	1.30 (0.86 - 1.97, *p* = 0.212)	1.33 (0.82 - 2.15, *p* = 0.251)
Obese	61 (84.7)	11 (15.3)	1.01 (0.48 - 1.99, *p* = 0.978)	1.40 (0.63 - 2.93, *p* = 0.390)
Hernia size				
< 1.5 cm	163 (77.3)	48 (22.7)	Ref	Ref
> 1.5 cm	378 (85.7)	63 (14.3)	**0.57 (0.37 - 0.86, *p* = 0.008)**	0.63 (0.39 - 1.01, *p* = 0.051)
Previous ipsilateral inguinal hernia repair				
No	583 (83.8)	113 (16.2)	Ref	Ref
Yes	34 (77.3)	10 (22.7)	1.52 (0.69 - 3.05, *p* = 0.265)	1.39 (0.52 - 3.30, *p* = 0.482)
Preoperative inguinal pain				
No pain	167 (92.8)	13 (7.2)	Ref	Ref
Pain	447 (80.3)	110 (19.7)	**3.16 (1.79 - 6.03, *p* < 0.001)**	**2.90 (1.54 - 5.98, *p* = 0.002)**
Non-inguinal chronic pain				
No	470 (84.1)	89 (15.9)	-	-
Yes	147 (81.2)	34 (18.8)	1.22 (0.78 - 1.87, *p* = 0.369)	1.10 (0.65 - 1.81, *p* = 0.721)
Nerve section				
Nerve section	85 (75.9)	27 (24.1)	Ref	Ref
No nerve section	527 (84.9)	94 (15.1)	**0.56 (0.35 - 0.92, *p* = 0.020)**	0.70 (0.41 - 1.25, *p* = 0.222)
Mesh fixation				
Absorbable	376 (84.9)	67 (15.1)	Ref	Ref
Non-absorbable	241 (81.1)	56 (18.9)	1.30 (0.88 - 1.92, *p* = 0.182)	1.30 (0.82 - 2.07, *p* = 0.261)
Type of mesh				
Light	357 (82.4)	76 (17.6)	Ref	Ref
Heavy	174 (82.9)	36 (17.1)	0.97 (0.62 - 1.49, *p* = 0.898)	1.07 (0.65 - 1.74, *p* = 0.777)

Ref: reference; OR: odds ratio; aOR: adjusted odds ratio
Dependent variable: chronic postoperative inguinal pain; Independent variables for adjusted model: surgical technique, sex, ASA grade, BMI, hernia size, previous ipsilateral inguinal hernia repair, preoperative inguinal pain, non-inguinal chronic pain, nerve section, mesh fixation.
Method: ENTER;
Hosmer-Lesmeshow *p*-value = 0.913

most uniformly recommended by hernia guidelines).[13] However, the rates of CPIP are within those described in the literature. In the meta-analysis performed by Zhao *et al*,[19] which included 10 randomized controlled trials (RCT) from 1989 to 2008, there was no statistically significant difference between Lichtenstein, plug and patch and PHS regarding CPIP nor post-operative complications. There is also the meta-analysis from Yu *et al*,[18] which included 11 RCT comparing Lichtenstein and plug and patch up until 2020, that also showed no statistically significant differences between techniques regarding these outcomes. In the meta-analysis performed by Decker *et al*,[20] seven RCT comparing Lichtenstein and PHS found no differences regarding the same outcomes. This may lead to the hypothesis that the surgeons' experience and the standardization of a specific technique may be more important in avoiding CPIP and postoperative complications than the surgical technique itself.

This study has limitations, as it is not a randomized study, which leads to an inevitable selection bias in the choice of technique, yet has the advantage of dealing with real-world data.

The exclusion criteria defined in this study also represent a limitation since they neglect an important group of patients that undergo hernia surgery. We decided to exclude patients that underwent urgent surgery, given that surgery within this context is associated with increased rates of postoperative complications,[25-30] as well as mesh-free hernia repairs, since these techniques are not recommended and are usually reserved for specific circumstances.[9,11,12,31-33] Regarding laparoscopic surgery, we chose not

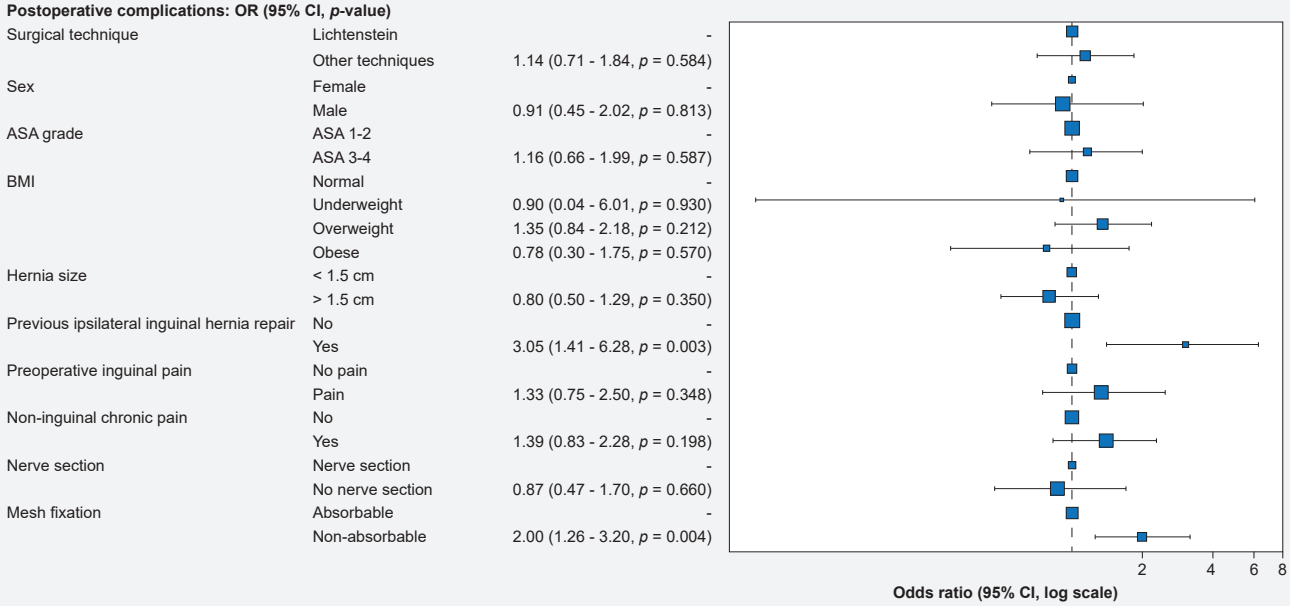

Figure 4 – Predictors of postoperative complications at one month after surgery

Table 4 – Predictors of Postoperative complications at one month after surgery

	No complications (n = 718)	With complications (n = 100)	OR [IC 95%, *p*-value]	aOR [IC 95%, *p*-value]
Surgical technique				
Lichtenstein	383 (88.0)	52 (12.0)	-	-
Other techniques	335 (87.5)	48 (12.5)	1.06 (0.69 - 1.60, *p* = 0.801)	1.14 (0.71 - 1.84, *p* = 0.584)
Sex				
Female	69 (87.3)	10 (12.7)	-	-
Male	648 (87.8)	90 (12.2)	0.96 (0.50 - 2.04, *p* = 0.905)	0.91 (0.45 - 2.02, *p* = 0.813)
ASA grade				
ASA 1 - 2	585 (88.5)	76 (11.5)	-	-
ASA 3 - 4	131 (84.5)	24 (15.5)	1.41 (0.84 - 2.29, *p* = 0.175)	1.16 (0.66 - 1.99, *p* = 0.587)
BMI				
Normal	321 (88.9)	40 (11.1)	-	-
Underweight	7 (87.5)	1 (12.5)	1.15 (0.06 - 6.68, *p* = 0.900)	0.90 (0.04 - 6.01, *p* = 0.930)
Overweight	299 (85.7)	50 (14.3)	1.34 (0.86 - 2.10, *p* = 0.195)	1.35 (0.84 - 2.18, *p* = 0.212)
Obese	74 (91.4)	7 (8.6)	0.76 (0.30 - 1.66, *p* = 0.521)	0.78 (0.30 - 1.75, *p* = 0.570)
Hernia size				
< 1.5 cm	197 (85.3)	34 (14.7)	-	-
>1.5 cm	436 (87.9)	60 (12.1)	0.80 (0.51 - 1.26, *p* = 0.327)	0.80 (0.50 - 1.29, *p* = 0.350)
Previous ipsilateral inguinal hernia repair				
No	684 (88.7)	87 (11.3)	-	-
Yes	34 (72.3)	13 (27.7)	**3.01 (1.48 - 5.79, *p* = 0.001)**	**3.05 (1.41 - 6.28, *p* = 0.003)**
Preoperative inguinal pain				
No pain	169 (89.4)	20 (10.6)	-	-
Pain	547 (87.2)	80 (12.8)	1.24 (0.75 - 2.13, *p* = 0.424)	1.33 (0.75 - 2.50, *p* = 0.348)
Non-inguinal chronic pain				
No	554 (88.4)	73 (11.6)	-	-
Yes	164 (85.9)	27 (14.1)	1.25 (0.77 - 1.99, *p* = 0.358)	1.39 (0.83 - 2.28, *p* = 0.198)
Nerve section				
Nerve section	105 (88.2)	14 (11.8)	-	-
No nerve section	607 (87.6)	86 (12.4)	1.06 (0.60 - 2.01, *p* = 0.843)	0.87 (0.47 - 1.70, *p* = 0.660)
Mesh fixation				
Absorbable	447 (90.7)	46 (9.3)	-	-
Non-absorbable	271 (83.4)	54 (16.6)	**1.94 (1.27 - 2.96, *p* = 0.002)**	**2.00 (1.26 - 3.20, *p* = 0.004)**

Ref: reference; OR: odds ratio; aOR: adjusted odds ratio
Dependent variable: chronic postoperative inguinal pain; Independent variables for adjusted model: surgical technique, sex, ASA grade, BMI, hernia size, previous ipsilateral inguinal hernia repair, preoperative inguinal pain, non-inguinal chronic pain, nerve section, mesh fixation.
Method: ENTER;
Hosmer-Lesmeshow *p*-value = 0.129

to include these patients, given the fact that this surgical approach is associated with a different set of complications and lower rates of CPIP, and patients usually present different risk factors for postoperative pain.[34-39] Nevertheless, this is a group of emergent techniques in Portugal and will, in the future, be a major variable to take into account.

This study was originally designed to include a six-month follow-up period for a more complete categorization of CPIP without the potential bias associated with the inflammatory process still present at three-months.[9] Unfortunately, this period coincided with the first wave of COVID-19 in Portugal which led to a severe change of healthcare services and availability of surgeons to participate in the data collection. Consequently, this period was canceled, and we remained with the three-month follow-up (described as the minimal amount of time to define CPIP).

This study was of major importance to understand and optimize the current approach to inguinal hernia in Portugal. The approach to inguinal hernia management in Portugal was previously unknown, with the most recent survey encompassing the years between 2001 and 2005.[40] The PINE study has the advantage of being the biggest study of its kind in Portugal, with a significant sample and the first prospective cohort study evaluating the current practices of hernia repair in Portugal.

CONCLUSION

The Lichtenstein technique was not associated with lower CPIP and showed comparable surgical complications. However, other factors, such as the recurrence rate (not assessed here), may affect these conclusions if better outcomes with the Lichtenstein technique were to be demonstrated. Further studies with long-term outcomes are necessary to improve the knowledge of long-term pain and recurrence rates.

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AUTHOR CONTRIBUTIONS

All authors contributed equally to this manuscript.

PROTECTION OF HUMANS AND ANIMALS

The authors declare that the procedures were followed according to the regulations established by the Clinical Research and Ethics Committee and to the Helsinki Declaration of the World Medical Association updated in 2013.

DATA CONFIDENTIALITY

The authors declare having followed the protocols in use at their working center regarding patients' data publication.

COMPETING INTERESTS

The authors have declared that no competing interests exist.

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