

Predictive factors of recurrence and chronic pain in inguinal hernia repair in a tertiary multicenter study: Lichtenstein versus transabdominal preperitoneal versus totally extraperitoneal approach

Facteurs prédictifs de la récurrence et de la douleur chronique dans la réparation de la hernie inguinale dans une étude multicentrique tertiaire : Lichtenstein versus TAPP versus TEP

Mohamed Ali Chaouch¹, Mohamed Zayati¹, Ahmed Saidani², Ahmed Hadj Taieb¹, Mohamed Noomen³, Sadok Ben Jabra¹, Ramzi Ben Letaifa³, Amine Ben Slimane³, Ibtissem Korbi¹, Besma Gafsi³, Faouzi Ben Salem³, Faouzi Chebbi², Faouzi Noomen¹

1. Department of Visceral and Digestive Surgery, Monastir University Hospital, Monastir, Tunisia
2. Department of Visceral and Digestive Surgery, Ariana Hospital, Ariana, Tunisia
3. Department of Anesthesia, Monastir University Hospital, Monastir, Tunisia

ABSTRACT

Objective: To compare the postoperative outcomes of inguinal hernia repair using Lichtenstein, transabdominal preperitoneal (TAPP), and totally extraperitoneal (TEP) techniques, focusing on the incidence and predictive factors of recurrence and chronic postoperative pain.

Methods: This cohort study included patients operated on for inguinal hernia at Monastir and Ariana University Hospitals between January 2020 and November 2023. The primary outcomes measured were postoperative morbidity and its risk factors, with secondary endpoints including chronic pain and recurrence. Data were analyzed using Pearson's χ^2 test, Student's t-test, Mann-Whitney test, and multivariate analysis.

Results: This cohort study included 308 patients. The patients were divided into three groups: Lichtenstein ($n=124$), TAPP ($n=117$), and TEP ($n=67$). The Lichtenstein patients were older (52.02 ± 11.11 years) and had a higher BMI (26.45 ± 3.60 kg/m²) compared to TAPP (48.02 ± 15.62 years, 20.89 ± 5.1 kg/m²), and TEP (46.19 ± 13.52 years, 20.11 ± 2.13 kg/m²). Lichtenstein had the highest morbidity (12.09%) compared to TAPP (8.54%) and TEP (7.46%). Grade II and III complications were significantly more frequent in the Lichtenstein group. Recurrence was higher in the Lichtenstein group (8.06%) compared to TAPP (3.41%) and TEP (2.98%). Chronic pain was more common in Lichtenstein (9.67%) compared to TAPP (1.70%) and TEP (0%). For predictive factors, age >50 years (OR=1.7), BMI >30 kg/m² (OR=1.9), and comorbidities (OR=1.8) were significant predictors of recurrence. The Lichtenstein technique (OR=5.5), wound complications (OR = 3.2), and smoking (OR=2.0) were key predictors of chronic pain.

Conclusions: In this retrospective study, statistically significant differences were observed between groups: the Lichtenstein group showed higher rates of morbidity, recurrence, and chronic pain, while the totally extraperitoneal approach showed lower rates of recurrence and complications. These findings highlight differences in outcomes across techniques but do not establish causal relationships. Randomized controlled trials are required to confirm these observations.

Keywords: inguinal hernia repair, Lichtenstein procedure, TEP, TAPP, chronic pain, morbidity, recurrence

RÉSUMÉ

Objectif : Comparer les résultats postopératoires de la réparation de la hernie inguinale utilisant des techniques de Lichtenstein, de préperitonéale transabdominale (TAPP) et totalement extrapéritonéale (TEP), en se concentrant sur l'incidence et les facteurs prédictifs de la récurrence et de la douleur postopératoire chronique.

Méthodes : Cette étude de cohorte a inclus des patients opérés pour hernie inguinale aux hôpitaux universitaires Monastir et Ariana entre janvier 2020 et novembre 2023. Les critères principaux mesurés étaient la morbidité postopératoire et ses facteurs de risque, avec des critères secondaires incluant la douleur chronique et la récurrence.

Résultats : Nous avons inclus 308 patients. Les patients ont été divisés en trois groupes : Lichtenstein ($n=124$), TAPP ($n=117$) et TEP ($n=67$). Les patients Lichtenstein étaient plus âgés ($52,02 \pm 11,11$ ans) et présentaient un IMC plus élevé ($26,45 \pm 3,60$ kg/m²) comparé à TAPP ($48,02 \pm 15,62$ ans, $20,89 \pm 5,1$ kg/m²) et TEP ($46,19 \pm 13,52$ ans, $20,11 \pm 2,13$ kg/m²). Lichtenstein présentait la morbidité la plus élevée (12,09 %) comparée à TAPP (8,54 %) et TEP (7,46 %). Les complications de grade II et III étaient significativement plus fréquentes dans le groupe Lichtenstein. La récurrence était plus élevée dans le groupe Lichtenstein (8,06 %) comparé à TAPP (3,41 %) et TEP (2,98 %). La douleur chronique était plus fréquente chez Lichtenstein (9,67 %) comparée à TAPP (1,70 %) et TEP (0 %). Pour les facteurs prédictifs, l'âge >50 ans (OR = 1,7), l'IMC >30 kg/m² (OR = 1,9) et les comorbidités (OR = 1,8) étaient des prédicteurs significatifs de la récurrence. La technique Lichtenstein (OR = 5,5), les complications de la plaie (OR = 3,2) et le tabagisme (OR = 2,0) étaient des indicateurs clés de la douleur chronique.

Conclusions : La technique Lichtenstein est associée à une augmentation de la morbidité postopératoire, de la récurrence et de la douleur chronique. La TEP a démontré les meilleurs résultats en termes de récurrence plus faible et moins de complications, ce qui soutient la préférence pour les approches laparoscopiques pour la réparation de la hernie inguinale.

Mots clés : Réparation de la hernie inguinale, Procédure de Lichtenstein, TEP, TAPP, Douleur chronique, Morbidité, Récurrence

Correspondance

Mohamed Ali Chaouch

Department of Visceral and Digestive Surgery, Monastir University Hospital, Monastir, Tunisia

Email: docmedalichaouch@gmail.com

INTRODUCTION

Worldwide, more than 20 million patients undergo elective repair of inguinal hernia annually (1). Hernia repair surgery is a common procedure performed in Tunisia, using open and laparoscopic techniques. In Tunisia, several studies have compared the results of this type of surgery, focusing on factors such as postoperative pain, recovery time, and complication rates (2–4). With the growing interest in minimally invasive surgery, it is essential to evaluate whether laparoscopic repair offers significant advantages over traditional open techniques in the Tunisian context. Lichtenstein tension-free repair is the most commonly used procedure, boasting a low incidence and complication (5). Since its initial description in the early 1990s and with the advent of cutting-edge surgical platforms, the surgical technique has evolved, giving rise to laparoscopic transabdominal preperitoneal (TAPP) (6) repair and total extraperitoneal repair (TEP) (7). Compared to the Lichtenstein technique, minimally invasive approaches appear to be associated with a reduced risk of wound-related complications, early postoperative pain, and faster return to work/activities (8). During TEP repair, all the procedures are performed without violating the peritoneal cavity, as the entire procedure is performed within the preperitoneal space. In contrast, TAPP repair involves a transperitoneal approach and a pneumoperitoneum is created. This procedure provides the benefit of no technical / space restrictions and a panoramic view of the myopectineal orifice, which facilitates the detection of unsuspected contralateral hernias with adequate dissection of the preperitoneal space. Despite previous studies and meta-analyses that presented conflicting results in the comparison of the Lichtenstein procedure vs. TAPP vs. TEP, a definitive indication for the superior surgical option for inguinal hernia remains controversial (9–11). Currently, the main outcomes after inguinal hernia repair are recurrence and chronic postoperative pain, both of which significantly affect long-term quality of life (12,13).

This study aims to compare the postoperative outcomes of inguinal hernia repair using Lichtenstein, TAPP, and TEP techniques, specifically evaluating the incidence and predictive factors of recurrence and chronic postoperative pain.

METHODS

This clinical cohort study included patients operated on for inguinal hernia repair between January 2020 and November 2023 at Monastir University Hospital and Ariana University Hospital and aimed to investigate the results of the Lichtenstein technique and laparoscopic hernia repair. An additional subgroup comparison was performed between laparoscopic repair of the inguinal hernia using transabdominal preperitoneal (TAPP) and total extraperitoneal (TEP) procedures.

Population

Adults older than 16 years operative for simple primary hernia of the groin.

Inclusion criteria

Patient selection criteria included a clinically diagnosed simple and symptomatic inguinal hernia that underwent mesh hernia repair.

Exclusion criteria

Exclusions were made for patients with significant comorbidities, insufficient general anesthesia, complicated hernias, previous abdominal surgeries, and suspected intraabdominal or pelvic malignancy.

Surgical procedures

Lichtenstein group:

A horizontal or oblique incision was made on the inguinal canal for the Lichtenstein procedure. The incision exposes the inguinal canal and allows the surgeon to visualize the hernia sac and surrounding structures. The hernia sac was carefully dissected and resected or reduced back into the abdominal cavity. The surgeon identifies key anatomical structures, including the spermatic cord in males or the round ligament in females. A polypropylene mesh is placed over the inguinal canal. The mesh extends beyond the borders of the inguinal canal to cover the myopectineal orifice and was fixed using absorbable or non-absorbable sutures. The incision was closed using sutures. The closure was done in layers, ensuring a secure and strong closure.

TAPP group:

In the TAPP procedure, a pneumoperitoneum was created, and a 10-mm umbilical trocar was inserted for laparoscopy, followed by two additional 5-mm trocars. The preperitoneal plan was opened using a scissor coupled to a monopolar coagulator. The dissection of the preperitoneal plan was started on the lateral side, followed by the dissection of the medial side of the hernia sac. The hernia sac was dissected and reduced. A 15*12 cm polypropylene mesh was introduced and positioned to cover the myopectineal orifice. The mesh was fixed using three knots of 2.0 Vicryl suture. The peritoneal flap was closed with a running suture using the same thread.

TEP group:

For the TEP procedure, a 10-mm umbilical trocar was inserted for laparoscopy below the umbilicus. An insufflator was activated. The clear dissection created a preperitoneal space using the optic to provide a wide medial dissection of the Retzius space. An additional 5 mm trocar was made in the homolateral low quadrant to the inguinal hernia. The preperitoneal plan was dissected and the hernia sac was reduced. The 15*12 cm mesh was introduced and spread to cover the myopectineal orifice. CO2 was released, fascial defects were closed, and the

mesh was not fixed.

Outcomes

For postoperative outcomes, the main endpoint was general postoperative morbidity that occurred within 30 days after surgery and its risk factors. Secondary endpoints included chronic pain and its risk factors. Chronic pain was defined as pain that persists for three months or more after surgical repair of a hernia (14).

Data collection

Data was collected from the medical records of the two hospitals. For the descriptive study, qualitative variables were described using observed numbers and frequencies (%). For quantitative variables, the data distribution was studied using skewness and kurtosis coefficients and normality tests. These variables were described by means and standard deviation in the case of a normal distribution and by medians and interquartile ranges in the opposite case. For the analytical study, to analyze the association between two qualitative variables, we used Pearson's χ^2 test to compare two frequencies if the conditions for application were met and Fischer's test if they were not. To analyze the association between a qualitative variable and a quantitative variable, we used Student's t-test to compare two means in the case of a normal distribution, and the nonparametric Mann-Whitney test in the opposite case. The significant threshold was established at 0.05. A multivariate analysis was performed to determine the risk factors for postoperative morbidity and chronic pain. Statistical analysis was performed using SPSS software version 22.

RESULTS

Study population

Our studies included 308 patients (Figure 1): 124 patients in the Lichtenstein group (40.4%), 177 patients in the TAPP group (37.9%), and 67 patients in the TEP group (21.7%). Table 1 compares the clinical characteristics of patients undergoing inguinal hernia repair between the Lichtenstein (open surgery) group and the laparoscopic groups (TAPP and TEP). Patients in the Lichtenstein group were older (52.02 ± 11.11 years) compared to the laparoscopic groups (TAPP: 48.02 ± 15.62 years, TEP: 46.19 ± 13.52 years), with a significant p-value ($p=0.04$). The Lichtenstein group also had a higher BMI (26.45 ± 3.60 kg/m²) compared to the TAPP (20.89 ± 5.1 kg/m²) and TEP (20.11 ± 2.13 kg/m²) groups ($p=0.02$). In terms of comorbidities, hypertension was significantly more frequent in the Lichtenstein group (18.18%) compared to the laparoscopic groups (TAPP: 6.9%, TEP: 3.95%), with a p-value of 0.03. Similarly, diabetes was more prevalent in the Lichtenstein group (12.98%) versus TAPP (4.93%) and TEP (2.82%), with a significant p-value of 0.04. Smoking (tobacco use) was more common in the Lichtenstein group (42.20%) compared to the laparoscopic groups

Chaouch & al. Predictive factors of recurrence and chronic pain in inguinal hernia repair in a tertiary multicenter study (TAPP: 16.03%, TEP: 9.18%), with a p-value of 0.01. Other risk factors such as heavy lifting and dysuria also showed a higher prevalence in the Lichtenstein group compared to laparoscopic techniques, with statistically significant differences. In general, the comparison indicates that the patients selected for the Lichtenstein procedure were generally older, had a higher BMI, more comorbidities (such as hypertension and diabetes) and more risk factors (like smoking and heavy lifting) compared to those undergoing laparoscopic repairs.

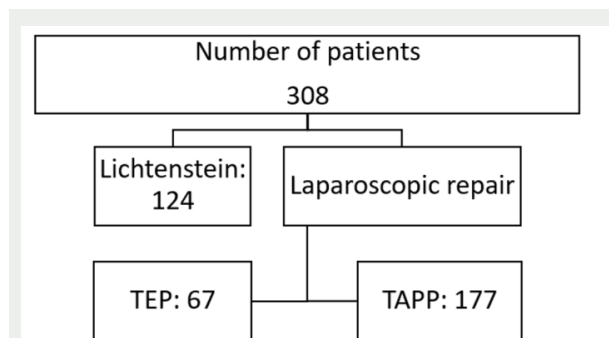


Figure 1. Flow diagram of the included patients in our study

Postoperative results

Table 2 compares postoperative outcomes between the Lichtenstein, TAPP, and TEP groups. The Lichtenstein group had the highest overall morbidity rate (12.09%) compared to TAPP (8.54%) and TEP (7.46%), suggesting more complications with the open technique, although the p-value for this comparison was not specified. According to the Clavien-Dindo classification, minor complications (grade I) were similar in all three groups (Lichtenstein 5.64%, TAPP 6.83%, TEP 5.97%), while complications requiring pharmacological treatment (grade II) were significantly more frequent in the Lichtenstein group (4.03% vs. TAPP 1.70% and TEP 1.49%, $p < 0.05$). Grade III complications, which required surgical intervention, were only present in the Lichtenstein group (2.41%, $p < 0.05$). Specific postoperative complications also revealed stark differences: bleeding was reported in 0.80% of Lichtenstein cases, without bleeding in the laparoscopic groups; wound haematoma and infection were significantly higher in Lichtenstein (4.03% each), while seroma formation was more frequent in the TEP (5.97%) and TAPP (4.27%) groups ($p < 0.05$). The operative time was the shortest in the TEP group (89 ± 18 minutes), followed by Lichtenstein (98 ± 14 minutes) and TAPP (105 ± 26 minutes), with statistically significant differences ($p < 0.05$). Recurrence rates were significantly higher in the Lichtenstein group (8.06% vs. TAPP 3.41% and TEP 2.98%, $p < 0.05$), and chronic postoperative pain was strikingly more common in Lichtenstein (9.67%) compared to TAPP (1.70%) and TEP (0%), with a significant p-value ($p < 0.05$). Conversion to open surgery occurred in 1.70% of TAPP cases and 5.97% of TEP cases. In summary, Lichtenstein was associated with higher morbidity, wound complications, recurrence rates, and chronic pain, while laparoscopic techniques, particularly TEP, demonstrated better outcomes in terms of lower

morbidity, fewer complications, and reduced chronic pain, supporting a preference for minimally invasive

approaches for inguinal hernia repair.

Table 1. Demographic data of the included patients in each group

Characteristics	Study population (308)		Lichtenstein group (124)		Laparoscopic group			
	Number	Percentage (%)	Number	Percentage (%)	TAPP group (117)		TEP group (67)	
					Number	Percentage (%)	Number	Percentage (%)
Age (years)	49.70±16.59		52.02±11.11		48.02±15.62		46.19±13.52	
Gender								
Male	273	88,63	110	35,68	104	33,67	59	19,28
Female	35	11,36	14	4,57	13	4,31	8	2,47
BMI (kg/m²)	22.51±2.35		26.45±3.60		20.89±5.1		20.11±2.13	
Past medical history								
Hypertension	56	18,18	23	7,31	21	6,90	12	3,95
Diabetes	40	12,98	16	5,22	15	4,93	9	2,82
Cardiac disease	11	3,57	5	1,43	4	1,35	2	0,77
Past surgical history								
Inguinal hernia	28	9,09	11	3,65	11	3,45	6	1,97
Umbilical hernia	12	3,89	5	1,56	5	1,48	2	0,84
Appendectomy	21	6,81	8	2,74	8	2,59	5	1,48
Herniatec disc	6	1,94	3	0,78	2	0,74	1	0,42
Cholecystectomy	20	6,49	8	2,61	8	2,46	4	1,41
Prostate adenoma	6	1,94	3	0,78	2	0,74	1	0,42
Sigmoidectomy	2	0,64	1	0,26	1	0,24	0	0
Liver hydatid cyst	6	1,94	3	0,78	2	0,74	1	0,42
Leg fracture	10	3,24	4	1,30	4	1,23	2	0,70
Amygdalectomy	8	2,59	3	1,04	3	0,98	2	0,56
Sleeve gastrectomy	4	1,29	2	0,52	2	0,49	0	0
Anal margin abscess	10	3,24	4	1,30	4	1,23	2	0,70
Hernia risk factors								
Tobacco	130	42,20	52	16,99	49	16,03	29	9,18
Heavy load port	100	32,46	40	13,07	38	12,33	22	7,06
Dysuria	63	20,45	25	8,23	24	7,77	24	4,44
Constipation	79	25,64	32	10,32	30	9,74	17	5,57
Alcohol	46	14,93	18	6,01	17	5,67	11	3,24
Type of hernia								
Inguinal hernia	277	89,93	111	36,20	105	34,16	61	19,56
Inguino-scrotal hernia	34	11,03	14	4,44	13	4,19	7	2,40
Hernia side								
Unilateral	288	93,50	116	37,64	109	35,52	63	20,34
Bilateral	20	6,49	8	2,61	8	2,46	4	1,41

Predictive factors of recurrence

Table 3 reported the predictive factors for recurrence after inguinal hernia repair, comparing Lichtenstein, TAPP, and TEP procedures. Patients older than 50 years (OR=1.7; [1.2-2.5], p=0.03), have a BMI greater than 30 Kg/m² (OR=1.9; CI95% [1.3-2.8]; p=0.02), or have comorbidities (OR=1.8; CI95% [1.1-2.9]; p=0.04) are more likely to experience recurrence. These findings emphasise that factors like age, BMI, and underlying health conditions contribute to the least favorable in terms of recurrence outcomes. All factors are statistically significant, with p-values below 0.05, confirming their importance in

predicting recurrence.

Predictive factors of chronic pain

Table 4 reported the predictive factors for chronic pain after hernia repair. Data show that the Lichtenstein technique greatly increases the risk of chronic pain, with an OR of 5.5 compared to laparoscopic techniques (TAPP/TEP), and this is highly statistically significant (p < 0.001). Wound complications, such as haematoma or infection, also increase the probability of chronic pain by more than three times (OR 3.2), while smoking doubles the risk (OR 2.0).

These results suggest that the open surgical approach, particularly Lichtenstein, and certain postoperative

Table 2. Postoperative results of the study population, Lichtenstein group, TAPP group, and TEP group

Characteristics	Study population (308)		Lichtenstein group (124)		Laparoscopic group			
					TAPP group (117)		TEP group (67)	
	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
Morbidity (%)	30	9,74	15	12,09	10	8,54	5	7,46
Calvien Dindo Classification								
Grade I	19	6,16	7	5,64	8	6,83	4	5,97
Grade II	8	2,59	5	4,03	2	1,70	1	1,49
Grade III	3	0,97	3	2,41	0	0	0	0
Grade IV	0	0	0	0	0	0	0	0
Grade V	0	0	0	0	0	0	0	0
Bleeding	1	0,32	1	0,80	0	0	0	0
Wound Heamatoma	6	1,94	5	4,03	1	0,85	0	0
Wound infection	5	1,62	5	4,03	0	0	0	0
Seroma	9	2,92	0	0	5	4,27	4	5,97
Operative time (min)	101±18		98±14		105±26		89±18	
Hospital stay (days)	2±			0		0		0
Recurrence	16	5,19	10	8,06	4	3,41	2	2,98
Chronic pain	14	4,54	12	9,67	2	1,70	0	0
Conversion	6	1,94	0	0	2	1,70	4	5,97

Table 3. Predictive factors of recurrence after repair of the inguinal hernia

Predictive factor	Odds Ratio (OR)	95% Confidence Interval	P-value
Age (>50 years)	1.7	1.2-2.5	0.03
BMI (>30 kg/m ²)	1.9	1.3-2.8	0.02
Comorbidities	1.8	1.1-2.9	0.04

Table 4. Predictive factors for chronic pain following hernia repair

Predictive factor	Odds Ratio (OR)	95% Confidence Interval	P-value
Lichtenstein technique	5.5	3-10	<0.001
Wound complication	3.2	1.9-5.4	0.005
Smoking	2	1.3-3.1	0.02

DISCUSSION

This bicentric retrospective study comparing the open and laparoscopic approaches for inguinal hernia repair concluded that among 308 patients, the Lichtenstein group had the highest morbidity, recurrence rate, and significantly higher chronic pain compared to TAPP and TEP. In our study, the totally extraperitoneal approach showed statistically lower recurrence rates and no cases of chronic pain compared with the other groups. However, as this is a retrospective study, these findings cannot be interpreted as causal, and randomized studies are necessary to confirm them. Predictive factors for recurrence included age greater than 50 years, BMI over 30 kg / m² and comorbidities. Regarding chronic

pain, statistically significant associations were observed with the Lichtenstein technique, wound complications, and smoking. These factors should be interpreted as correlations rather than causal predictors, given the retrospective study design.

Adolescent patients with inguinal hernias typically require surgical intervention at diagnosis, with incidence rates reported between 0.5% and 14% (15). For many years, open inguinal hernia repair has been the standard treatment in this population, with consistently low recurrence rates and complications (16). However, in recent decades, the widespread adoption of minimally invasive surgical techniques has increased significantly. Advances in surgical tools and growing expertise in laparoscopic procedures have made laparoscopic hernia repair more common and safer (11). Schmedt et al. (17) a meta-analysis of randomised controlled trials comparing laparoscopic versus Lichtenstein and other open mesh techniques for inguinal hernia repair concluded that there were significant advantages for laparoscopic procedures compared to Lichtenstein repair in terms of wound infection, haematoma, nerve injury, and return to normal activities or work with no difference in morbidity, intestinal lesions, urinary bladder lesions, major vascular lesions, urinary retention, and testicular problems. Significant advantages of the Lichtenstein repair include shorter operating time, a lower incidence of seroma formation, and fewer hernia recurrences. Similar results are seen when laparoscopic procedures are compared with open mesh repairs. However, in this comparison, total morbidity was lower with laparoscopic operations.

The incidence of seroma formation, chronic pain syndromes, and hernia recurrence was similar. Today, both laparoscopic and open hernia repair are widely recognised as effective treatment options for inguinal hernia repair. The three most common primary techniques are the Lichtenstein technique, transabdominal preperitoneal (TAPP) repair, and total extraperitoneal (TEP) repair. Each approach has its unique advantages and challenges, influencing factors. The Lichtenstein technique, an open surgical method, is widely recognised for its simplicity and effectiveness. It involves the use of a synthetic mesh placed on the hernia defect, which is then secured to the surrounding tissues. This method has become the standard for open repair due to its low recurrence rates and ease of learning for surgeons (18). TAPP involves a laparoscopic approach where the peritoneal cavity is accessed, and a mesh is placed in the preperitoneal space. This method allows for a thorough examination of the groin area, which could identify and repair bilateral hernias and other abdominal issues. Studies have shown that TAPP generally results in less postoperative pain and faster recovery compared to open techniques. However, it may be associated with a slightly higher risk of complications, such as visceral or vascular injuries, due to the transabdominal approach. TEP avoids entry into the peritoneal cavity by placing the mesh in the preperitoneal space without breaking the peritoneum. This approach is associated with a lower risk of intraabdominal complications and less postoperative pain than both the Lichtenstein and TAPP methods. However, TEP is technically more challenging, requires more surgical expertise, and may have a longer learning curve. Some studies suggest that TEP may have a lower rate of recurrence compared to TAPP due to the avoidance of potential issues related to peritoneal penetration. Currently, it is widely accepted that the main outcomes to assess after groin hernia repair are recurrence and chronic pain. For decades, several studies have been conducted to compare the rate of recurrence and postoperative pain of open and laparoscopic inguinal hernia repair procedures (19). In our study, the recurrence rate was higher in the Lichtenstein group (8.06%) compared to TAPP (3.41%) and TEP (2.98%). These results were obtained from the randomised clinical trial of Liem et al. (20). This study included 994 patients. Patients were followed and examined for recurrence and chronic inguinal pain 2, 3, and 5 years after surgery. They found that patients who underwent conventional repair had a high risk of recurrence compared to patients who underwent laparoscopic repair. Memon et al. (21) performed a meta-analysis of randomized clinical trials comparing open and laparoscopic repair of the inguinal hernia. The laparoscopic approach was associated with earlier discharge from the hospital, faster return to normal activity and work, and significantly fewer postoperative complications than the OIHR. However, the operating time was significantly longer and there was a trend toward an increase in the relative odds of recurrence after laparoscopic repair, which is different from our findings. In a study by Neumayer et al. (22), open mesh repair and laparoscopic mesh repair of

inguinal hernias were compared, with the primary endpoint being recurrence after 2 years of follow-up. They randomly included 2164 patients. Recurrence was significantly more common after laparoscopic repair than after open repair of primary hernias (10.1% vs. 4%), but the rates of recurrence after repair of recurrent hernias were similar in the two groups (10% and 14.1%, respectively). However, Pokorný et al. (23) have highlighted in a comment published in this paper that several issues seem worth discussing in this study. First, a recurrence rate of >10% appears to be quite high for a primary hernia mesh repair. Furthermore, specific details on the time and were lacking, for recurrence reason as well as on the size of the hernia, but an interesting analysis in this study is shown on the experience of surgeons. The rate of recurrence among patients whose surgeons had performed more than 250 laparoscopic procedures was approximately half that among patients whose surgeons had performed 250 or fewer such procedures. In the repair of the primary hernia, highly specialized laparoscopic surgeons performed, as well as highly specialized open surgeons. Less experienced surgeons performing laparoscopy for primary hernia performed worse than less experienced open surgeons. Furthermore, this study included recurrent hernia repair, and highly specialised laparoscopic surgeons did better than open surgeons. Data from less experienced surgeons in recurrent hernia repair were too small to be analysed. On the other hand, Geus et al. (24) examined resident involvement in minimally invasive versus open procedures, and their results suggest that resident participation has a similar impact on surgical outcomes during laparoscopic and open surgery, and is generally safe. We should mention that in our study, we have included patients with higher risk factors of recurrences such as obesity, tobacco, inguinoscrotal hernia, and comorbidities (25). Additionally, the follow-up period was longer in the Lichtenstein group, which could affect this outcome (26).

Several studies have been conducted to investigate predictive factors for recurrence after open and laparoscopic inguinal hernia repair. Liem et al. (20) conducted a randomized multicenter trial to study the long-term recurrence rate and complications after conventional anterior and laparoscopic inguinal hernia repair and identified the operative time and conventional repair as a risk factor for recurrence. Andresen et al. (27) 2014 found in a study based on data from the Danish Hernia Database covering the period between January 1, 1998, and February 22, 2012, that sliding inguinal hernia is a risk factor for recurrence that was higher in males than in females. Matthews et al. (28) in a report from the VA Cooperative Hernia Study Group showed that predictive factors vary across the surgical approach. In the laparoscopic repair groups, patients who received a Foley catheter or those with a smaller mesh were more likely to develop recurrence. Using multiple logistic regression, independent predictors of recurrence in the laparoscopic group were an active lifestyle, a BMI of 25 kg/m² or less, or low surgeon volume. We found a significant interaction between the classification of ASA

and the recent enlargement of the hernia. For ASA 3 patients, those who had a recent enlargement (within the past 6 months) of their hernia were more likely to have a recurrence than those without a recent enlargement, like the findings of our study which concluded that age >50 years, BMI >30 kg/m², and comorbidities are significant predictors of recurrence.

Chronic pain following inguinal hernia is a significant concern that can impact the quality of life. Studies have shown that a considerable percentage of patients experience pain in the groin area after surgery, with some reporting interference with lifestyle (29). Various factors may contribute to the development of chronic pain after inguinal hernia repair, including the type of surgical approach. The frequency of chronic pain after inguinal hernia repair has been the subject of systematic reviews, emphasising the need to identify risk factors and improve treatment options for affected patients (30,31). After mesh-based inguinal hernia repair, 11% of patients suffer chronic pain. More than a quarter of these patients have moderate to severe pain, most of them of neuropathic origin. As a consequence of chronic pain, almost one third of patients have limitations in daily leisure activities (31). The Lichtenstein approach for inguinal hernia repair tends to have a higher risk of chronic pain compared to laparoscopic techniques, mainly due to differences in nerve handling, mesh placement, and tissue manipulation (20). In open Lichtenstein repair, the surgeon operates near sensory nerves in the groin region, including the ilioinguinal, iliohypogastric and genital branch of the genitofemoral nerve (32). These nerves are often exposed and may be accidentally damaged, entrapped, or irritated by mesh or sutures. Over time, this placement can cause fibrotic scarring around the mesh, increasing the likelihood of nerve entrapment and chronic pain. On the contrary, the laparoscopic approach places the mesh within the preperitoneal space, away from these superficial nerves, reducing direct contact with and potential injury to these nerves (33). Placing the mesh deeper, within the preperitoneal space, where there is less interaction with sensory nerves and typically a lower inflammatory response, can help minimise chronic pain. In a systematic review published by Kokotovic et al. (34) that included 31 studies, 1326 patients, concluded that hernia repair elicits a systemic inflammatory response characterised by an increase in CRP, IL-6, leukocytes, neutrophils, IL-1, IL-10, fibrinogen and α 1-antitrypsin and a decrease in lymphocytes and albumin. A higher inflammatory response was found after open mesh repair compared to laparoscopic mesh repair. In our study, chronic pain was more common in Lichtenstein (9.67%) compared to TAPP (1.70%) and TEP (0%). However, we should mention that chronic pain after inguinal hernia repair can also be related to factors such as recurrence or additional scarring from reoperations. Furthermore, the rate of recurrence was higher in the Lichtenstein group of our study. Furthermore, long-term follow-up studies have shown that while chronic pain may persist in some patients, the overall proportion of people who report moderate to severe pain decreases over time (35,36). In conclusion, chronic pain after inguinal hernia repair

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is a complex issue that requires careful consideration of various factors, including surgical technique. International guidelines have been developed to help prevent and manage postoperative chronic pain, highlighting the importance of ongoing research and clinical practice in this area and predicting this outcome (37). In our study, the Lichtenstein technique, wound complications, and smoking were key predictors of chronic pain. Several studies have investigated additional predictive factors. Dahlstrand et al. (38) in a cross-sectional study that included 1967 patients found that the surgical technique did not influence the risk of chronic pain after femoral hernia repair. Saad et al. (39) identified key presentation characteristics of an inguinal hernia as a cause of chronic pelvic pain in women. Tabbara et al. (40) reviewed results after inguinal hernia repair using a sutureless mesh which is associated with a lower chronic pain rate, recurrence rate, and postoperative complications rate and can be safely adopted as the only technique for inguinal hernia repair. This could explain to some extent the low recurrence rate and chronic pain in the TEP group of our study because we did not fix the mesh based on the result of a published systematic review and meta-analysis comparing fixation versus non-fixation of the mesh during TEP which did not find differences between the two groups (41). These studies provide valuable information on the predictive factors of chronic pain in inguinal hernia repair, highlighting the importance of considering various clinical, psychological, and surgical factors in the treatment of this condition.

The limitations of this study include a potential selection bias due to the absence of randomization and the surgical technique was based on the surgeon's experience and choice. Furthermore, patients with higher recurrence risk factors for recurrence (eg, obesity, smoking, comorbidities) were found more frequently in the Lichtenstein group. Additionally, the follow-up period varied between the groups, which can influence the recurrence and chronic pain outcomes. Another limitation is the retrospective design, which can introduce recall bias and limit control over confounding factors. Lastly, this study was conducted in two specific hospitals, potentially limiting the generalizability of the results to broader populations or different clinical settings.

CONCLUSIONS

In conclusion, this study highlights the differences in the results between the Lichtenstein, TAPP and TEP techniques for inguinal hernia repair. While the Lichtenstein method was associated with higher morbidity, recurrence rates, and chronic pain, minimally invasive approaches, particularly TEP, demonstrated significantly better results with lower recurrence, fewer complications, and reduced chronic pain. Predictive factors for recurrence include age, BMI, and comorbidities, while the Lichtenstein technique and postoperative complications are key predictors of chronic pain. These findings support a growing preference for laparoscopic methods, particularly TEP, in inguinal hernia repair to optimize patient recovery and minimize complications.

REFERENCES

- Aydin M, Fikatas P, Denecke C, Pratschke J, Raakow J. Cost analysis of inguinal hernia repair: the influence of clinical and hernia-specific factors. *Hernia*. 2021 Oct;25(5):1129–35.
- Ghariani W, Dougaz W, Jerraya H, Khalfallah M, Bouasker I, Dziri C. Revue systématique the Recurrence Factors of Groin Hernia: a systematic Review Les facteurs de récurrence des hernies de l'aîne et leur traitement: une revue systématique. *Tunis Médicale*. 2019 Dec 23;97:03.
- Boudokhane M, Fodha M, Abdekefi MT, Nacef K, Majdoub N, Affes A, et al. Lichtenstein versus Lichtenstein plus Plug dans les cures prothétiques des hernies inguinales : Résultats préliminaires d'une étude contrôlée prospective randomisée. *Tunis Med*. 2011;90.
- Samaali I, Zenaïdi HH, Dougaz W, Khalfallah M, Jarraya H, Nouira R, et al. traitement des hernies inguinales par la technique de lichtenstein : une étude prospective ouverte treatment of inguinal hernia by lichtenstein technique: an open prospective study. *Tunis Med*. 2016;94.
- Amid P. The Lichtenstein repair in 2002: an overview of causes of recurrence after Lichtenstein tension-free hernioplasty. *Hernia*. 2003;7:13–6.
- Schultz LS, Cartuill J, Graber JN, Hickok DF. Transabdominal Preperitoneal Procedure. *Surg Innov*. 1994 Jun 1;1(2):98–105.
- Putnis S, Berney CR. Totally extraperitoneal repair of inguinal hernia: techniques and pitfalls of a challenging procedure. *Langenbecks Arch Surg*. 2012 Dec 1;397(8):1343–51.
- Aiolfi A, Cavalli M, Del Ferraro S, Manfredini L, Bonitta G, Bruni PG, et al. Treatment of inguinal hernia: systematic review and updated network meta-analysis of randomized controlled trials. *Ann Surg*. 2021;274(6):954–61.
- Yang C, Deng S. Laparoscopic versus open mesh repair for the treatment of recurrent inguinal hernia: a systematic review and meta-analysis. *Ann Palliat Med*. 2020;9(3):1164173–1161173.
- Huang FH, Cheng PL, Hou WH, Duh YC. Laparoscopic hernia repair with the extraperitoneal approach versus open hernia repair in pediatric inguinal hernia: a systematic review and meta-analysis. *J Clin Med*. 2022;11(2):321.
- Haladu N, Alabi A, Brazzelli M, Imamura M, Ahmed I, Ramsay G, et al. Open versus laparoscopic repair of inguinal hernia: an overview of systematic reviews of randomised controlled trials. *Surg Endosc*. 2022 Jul;36(7):4685–700.
- Bande D, Moltó L, Pereira JA, Montes A. Chronic pain after groin hernia repair: pain characteristics and impact on quality of life. *BMC Surg*. 2020 Dec;20(1):147.
- Olsson A, Sandblom G, Franneby U, Sondén A, Gunnarsson U, Dahlstrand U. Do postoperative complications correlate to chronic pain following inguinal hernia repair? A prospective cohort study from the Swedish Hernia Register. *Hernia*. 2021 Dec 11;27(1):21–9.
- Treede RD, Rief W, Barke A, Aziz Q, Bennett MI, Benoliel R, et al. Chronic pain as a symptom or a disease: the IASP Classification of Chronic Pain for the International Classification of Diseases (ICD-11). *pain*. 2019;160(1):19–27.
- Jenkins JT, O'Dwyer PJ. Inguinal hernias. *BMJ*. 2008 Jan 31;336(7638):269–72.
- Köckerling F, Simons MP. Current concepts of inguinal hernia repair. *Visc Med*. 2018;34(2):145–50.
- Schmedt CG, Sauerland S, Bittner R. Comparison of endoscopic procedures vs Lichtenstein and other open mesh techniques for inguinal hernia repair: a meta-analysis of randomized controlled trials. *Surg Endosc Interv Tech*. 2005 Feb 1;19(2):188–99.
- Forte A, D'Urso A, Palumbo P, Lo Storto G, Gallinaro LS, Bezzi M, et al. Inguinal hernioplasty: the gold standard of hernia repair. *Hernia*. 2003 Mar 1;7(1):35–8.
- Kozol R, Lange PM, Kosir M, Beleski K, Mason K, Tennenberg S, et al. A Prospective, Randomized Study of Open vs Laparoscopic Inguinal Hernia Repair: An Assessment of Postoperative Pain. *Arch Surg*. 1997 Mar 1;132(3):292–5.
- Liem MSL, van Duyn EB, van der Graaf Y, van Vroonhoven TJMV, Group on behalf of the CT. Recurrences After Conventional Anterior and Laparoscopic Inguinal Hernia Repair: A Randomized Comparison. *Ann Surg*. 2003 Jan;237(1):136.
- Memon MA, Cooper NJ, Memon B, Memon MI, Abrams KR. Meta-analysis of randomized clinical trials comparing open and laparoscopic inguinal hernia repair. *Br J Surg*. 2003 Dec 1;90(12):1479–92.
- Neumayer L, Giobbie-Hurder A, Jonasson O, Fitzgibbons R, Dunlop D, Gibbs J, et al. Open Mesh versus Laparoscopic Mesh Repair of Inguinal Hernia. *N Engl J Med*. 2004 Apr 29;350(18):1819–27.
- Pokorny H, Bischof G. Open mesh versus laparoscopic mesh repair of inguinal hernia. *Eur Surg*. 2004 Sep 1;36(4):262–3.
- de Geus SWL, Geary AD, Arinze N, Ng SC, Carter CO, Sachs TE, et al. Resident involvement in minimally-invasive vs. open procedures. *Am J Surg*. 2020 Feb;219(2):289–94.
- Gignoux B, Bayon Y, Martin D, Phan R, Augusto V, Darnis B, et al. Incidence and risk factors for incisional hernia and recurrence: Retrospective analysis of the French national database. *Colorectal Dis*. 2021;23(6):1515–23.
- Köckerling F, Koch A, Lorenz R, Schug-Pass C, Stechemesser B, Reinhold W. How Long Do We Need to Follow-Up Our Hernia Patients to Find the Real Recurrence Rate? *Front Surg [Internet]*. 2015 Jun 16 [cited 2024 Nov 3];2. Available from: <https://www.frontiersin.org/journals/surgery/articles/10.3389/fsurg.2015.00024/full>
- Andresen K, Bisgaard T, Rosenberg J. Sliding inguinal hernia is a risk factor for recurrence. *Langenbecks Arch Surg*. 2015 Jan;400(1):101–6.
- Matthews RD, Anthony T, Kim LT, Wang J, Fitzgibbons RJ, Giobbie-Hurder A, et al. Factors associated with postoperative complications and hernia recurrence for patients undergoing inguinal hernia repair: a report from the VA Cooperative Hernia Study Group. *Am J Surg*. 2007 Nov 1;194(5):611–7.
- Bay-Nielsen M, Perkins FM, Kehlet and H. Pain and Functional Impairment 1 Year After Inguinal Herniorrhaphy: A Nationwide Questionnaire Study. *Ann Surg*. 2001 Jan;233(1):1.
- Poobalan AS, Bruce J, Smith WCS, King PM, Krukowski ZH, Chambers WA. A Review of Chronic Pain After Inguinal Herniorrhaphy. *Clin J Pain*. 2003 Feb;19(1):48.
- Nienhuijs S, Staal E, Strobbe L, Rosman C, Groenewoud H, Bleichrodt R. Chronic pain after mesh repair of inguinal hernia: a systematic review. *Am J Surg*. 2007 Sep 1;194(3):394–400.
- Konschake M, Zwierzina M, Moriggl B, Függer R, Mayer F, Brunner W, et al. The inguinal region revisited: the surgical point of view. *Hernia*. 2020 Aug 1;24(4):883–94.
- Tinelli A. Laparoscopic entry: Traditional methods, new insights and novel approaches [Internet]. Springer Science & Business Media; 2011 [cited 2024 Nov 4]. Available from: <https://books.google.com/>