Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(4), 334-344 | ISSN:2251-6727

A Comparative Study of Laparoscopic Transabdominal Pre-Peritoneal (Tapp) Repair and Lichtenstein Mesh Repair of Inguinal Hernia

Dr. Aamir khan 1, Dr. Pankaj Kumar 2, Dr. Dharmdev Yadav 3, Dr. Ashutosh Gupta 4

1- Junior resident, Department of General Surgery IIMS&R , Integral University Lucknow,Uttarpradesh.

2- Professor And Head of Department Of General Surgery IIMS&R , Integral University Lucknow,Uttarpradesh.

3- Assistant Professor, Department of General Surgery IIMS&R, Lucknow, Uttarpradesh.

4- Associate Professor, Department Of General Surgery IIMS&R, Lucknow ,Uttarpradesh

Corresponding Author- Dr. Aamir Khan.

(Received: 16 May 2025 Revised: 20 June 2025 Accepted: 02 July 2025)

KEYWORDS

Inguinal hernia, TAPP repair, Lichtenstein repair, postoperative pain, laparoscopic surgery, cost analysis, hernia recurrence

ABSTRACT:

Background: Inguinal hernias represent one of the most frequently encountered surgical pathologies in general surgery practice. The surgical management has evolved from traditional tissue-based repairs to contemporary mesh-reinforced techniques, with both open and minimally invasive approaches available. The established Lichtenstein tension-free mesh repair remains a cornerstone treatment, while laparoscopic Transabdominal Preperitoneal (TAPP) techniques are increasingly adopted for their minimally invasive benefits. This investigation seeks to evaluate TAPP versus Lichtenstein approaches across multiple clinical parameters including surgical duration, post-surgical recovery metrics, adverse events, economic considerations, and hernia recurrence rates.

Methods: We conducted a prospective comparative analysis within the General Surgery Department at IIMSR, Lucknow, spanning 18 months. Sixty patients presenting with uncomplicated inguinal hernias were randomized into equal cohorts: 30 patients received TAPP repair while 30 underwent Lichtenstein mesh repair. We systematically documented surgical duration, post-operative pain assessment via Visual Analog Scale, complication profiles, length of stay, time to ambulation, treatment costs, and 6-month recurrence surveillance. Statistical analysis employed SPSS v26.0 with significance threshold set at $p < 0.05$.

Results: TAPP procedures demonstrated significantly extended operative duration compared to Lichtenstein repairs. Conversely, TAPP patients experienced markedly reduced post-operative pain scores, abbreviated hospitalization periods, and accelerated mobilization timelines relative to the Lichtenstein cohort. Economic analysis revealed substantially higher costs associated with TAPP procedures. Post-surgical complication rates remained statistically equivalent between groups, with zero hernia recurrences documented during 6-month surveillance in both cohorts.

Conclusion: Laparoscopic TAPP repair demonstrates clear advantages in pain reduction, recovery acceleration, and early mobilization, though at the expense of increased operative duration and financial cost. Both surgical modalities prove safe and efficacious with comparable short-term clinical outcomes. Surgical approach selection should incorporate patient-specific factors, surgeon experience, and institutional resource allocation.

INTRODUCTION

Inguinal hernia pathology constitutes among the most prevalent conditions requiring surgical intervention globally, affecting approximately 27% of males and 3% of females during their lifetime [1]. The surgical management of inguinal hernias has undergone substantial transformation through successive decades, progressing from primary tissue approximation

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(4), 334-344 | ISSN:2251-6727

techniques toward mesh-reinforced tension-free reconstructions, and subsequently embracing minimally invasive laparoscopic methodologies. The Lichtenstein mesh repair technique, established during the 1980s, has maintained its position as the reference standard owing to its technical simplicity, consistent reproducibility, minimal recurrence rates, and favorable cost profile [2,3].

The progressive refinement of surgical instrumentation and technological capabilities has facilitated the widespread adoption of laparoscopic repair methodologies, with Transabdominal Preperitoneal (TAPP) repair emerging as a particularly favored approach. TAPP repair methodology provides numerous theoretical advantages compared to conventional open surgical techniques, encompassing diminished post-operative discomfort, expedited restoration of functional capacity, superior aesthetic outcomes, and reduced incidence of wound-associated complications [4,5]. Nevertheless, legitimate concerns persist regarding the extended operative requirements, increased technical complexity demanding specialized training, elevated procedural costs, and mandatory general anesthesia requirements inherent to laparoscopic approaches [6,7].

Numerous research investigations have endeavored to establish comparative outcome data between open and laparoscopic methodologies. Several randomized controlled trials and systematic meta-analyses have documented reduced chronic pain incidence and accelerated recovery patterns with laparoscopic repair, while alternative studies have emphasized the increased operative duration and economic burden [8–11]. The selection between these surgical approaches frequently depends upon surgeon expertise levels, patient selection criteria, available institutional resources, and established clinical protocols.

While extensive international literature exists, comparative outcome data from regional medical centers within India remains limited, particularly studies employing rigorous prospective methodologies and standardized surgical protocols. Consequently, this prospective comparative investigation was initiated at a tertiary care facility in Northern India to systematically evaluate and compare clinical outcomes between laparoscopic TAPP repair and Lichtenstein mesh repair in patients presenting with uncomplicated inguinal hernias. The study emphasizes critical clinical parameters including operative duration, post-operative pain assessment, hospitalization length, complication incidence, mobilization timeframes, treatment economics, and short-term recurrence patterns to support evidence-based surgical decision-making in routine clinical practice.

MATERIALS AND METHODS

Study Design and Setting

This prospective comparative investigation was executed within the General Surgery Department at the Integral Institute of Medical Sciences and Research (IIMSR), Lucknow. The study period encompassed 18 months following Institutional Ethical Committee approval.

Sample Size

Sixty patients diagnosed with uncomplicated inguinal hernia were recruited for study participation. Sample size calculation was performed utilizing an anticipated effect size (δ) of 0.75 through standard statistical methodology and established guidelines. Patient allocation was equally distributed between two treatment groups:

- **Group 1 (TAPP Repair)** – 30 patients received Transabdominal Preperitoneal (TAPP) laparoscopic repair
- **Group 2 (Lichtenstein Repair)** – 30 patients received conventional Lichtenstein mesh repair

Inclusion Criteria

- Patients within 12-80 years age range
- Confirmed diagnosis of uncomplicated direct or indirect inguinal hernia

Exclusion Criteria

- Patients presenting with complicated or recurrent hernia pathology

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(4), 334-344 | ISSN:2251-6727

- Previous lower abdominal surgical history
- American Society of Anesthesiologists (ASA) physical status exceeding Grade 3
- Patients declining informed consent participation

Methodology

All study participants underwent comprehensive clinical assessment incorporating detailed medical history, systematic physical examination, and appropriate diagnostic investigations. Specialized diagnostic maneuvers including finger invagination testing and ring occlusion testing were utilized for diagnostic confirmation. Alternative diagnoses including non-hernial inguinal masses, strangulated hernias, and incarcerated hernias were systematically excluded.

Written informed consent was secured from each participant following comprehensive explanation of study objectives and surgical procedures. Patients were subsequently randomized into treatment groups: Group 1 received laparoscopic TAPP repair while Group 2 underwent open Lichtenstein repair.

Pre-operative preparation included universal catheterization. Post-operative management incorporated scrotal support for all patients. Pain assessment utilized the Visual Analog Scale (VAS), a validated subjective pain measurement tool ranging from 0 (complete pain absence) to 10 (maximum imaginable pain). VAS documentation occurred at predetermined intervals: 6 hours, 12 hours, 24 hours, 1 week, 1 month, and 6 months post-operatively.

Parameters Observed

The following clinical parameters underwent evaluation and inter-group comparison:

- Surgical procedure duration
- Post-operative pain assessment (VAS scores) at specified time intervals
- Post-operative complication occurrence
- Return to normal daily activities timeframe
- Hernia recurrence during follow-up surveillance
- Economic analysis of each procedural approach

Statistical Analysis

Data compilation utilized Microsoft Excel with analysis performed using SPSS version 26.0 (SPSS Inc., Chicago, IL, USA). Continuous variables received expression as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages. Inter-group mean comparisons employed Student's t-test methodology. Correlation analysis utilized Spearman's correlation coefficient.

Statistical significance was established at p-value < 0.05, with $p < 0.01$ and $p < 0.001$ interpreted as highly significant and very highly significant, respectively.

RESULTS AND OBSERVATIONS;

Table-1: Age distribution of the enrolled patients among the groups.

AGE	LAP TAPP REPAIR		LICHTENSTEIN REPAIR		P-VALUE
	N	%	N	%	
10-19	3	10.00%	4	13.33%	
20-29	2	6.67%	3	10.00%	

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(4), 334-344 | ISSN:2251-6727

30-39	**3**	**10.00%**	**2**	**6.67%**	
40-49	**3**	**10.00%**	**9**	**30.00%**	
50-59	**8**	**26.67%**	**5**	**16.67%**	**X=5.135 p=0.5266**
60-69	**6**	**20.00%**	**4**	**13.33%**	
70-80	**5**	**16.67%**	**3**	**10.00%**	
Grand Total	**30**	**100.00%**	**30**	**100.00%**	

In the laparoscopic TAPP group, the highest proportion of patients was in the 50–59 years age group (26.67%, n=8), followed by 60–69 years (20.00%, n=6) and 70–80 years (16.67%, n=5). Conversely, in the Lichtenstein group, the 40–49 years age group had the highest proportion (30.00%, n=9), followed by 50–59 years (16.67%, n=5) and 20–29 years (10.00%, n=3). Although slight differences in age distribution exist between the two groups, the chi-square test result (X^2 = 5.135, p = 0.5266) indicates no statistically significant difference in age distribution between the two surgical groups.

Table-2: Gender distribution of the enrolled patients among the groups.

GENDER	**LAP TAPP REPAIR**		**LICHTENSTEIN REPAIR**		**P-VALUE**
	N	**%**	**N**	**%**	
Female	**1**	**3.33%**	**0**	**0.00%**	
Male	**29**	**96.67%**	**30**	**100.00%**	**X=1.017 p=0.3132**
Grand Total	**30**	**100.00%**	**30**	**100.00%**	

In the TAPP group, 29 out of 30 patients (96.67%) were male and 1 (3.33%) was female, whereas in the Lichtenstein group, all 30 patients (100%) were male. The difference in gender distribution between the two groups is not statistically significant, as indicated by the chi-square value of 1.017 and a p-value of 0.3132.

Table-3: Diagnosis of the enrolled patients among the groups.

DIAGNOSIS	**LAP TAPP REPAIR**		**LICHTENSTEIN REPAIR**		**P-VALUE**
	N	**%**	**N**	**%**	

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(4), 334-344 | ISSN:2251-6727

B/L DIRECT HERNIA	**0**	**0.00%**	**2**	**6.67%**	
LT DIRECT HERNIA	**3**	**10.00%**	**1**	**3.33%**	
LT INDIRECT HERNIA	**6**	**20.00%**	**9**	**30.00%**	**X=4.705**
RT DIRECT HERNIA	**1**	**3.33%**	**0**	**0.00%**	**p=0.3189**
RT INDIRECT HERNIA	**20**	**66.67%**	**18**	**60.00%**	
Grand Total	**30**	**100.00%**	**30**	**100.00%**	

Table-4: Post-operative of the enrolled patients among the groups.

POST OPERATIVE STAY	**LAP TAPP REPAIR**		**LICHTENSTEIN REPAIR**		**P-VALUE**
	N	**%**	**N**	**%**	
1-3	**28**	**43.33%**	**24**	**0.00%**	
4-7	**2**	**3.33%**	**6**	**10.00%**	**X=2.308 p=0.1287**
Grand Total	**30**	**100.00%**	**30**	**100.00%**	
Mean±SD	**1.87±0.99**		**2.733±1.21**		**t=3.013 p=0.0038***

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(4), 334-344 | ISSN:2251-6727

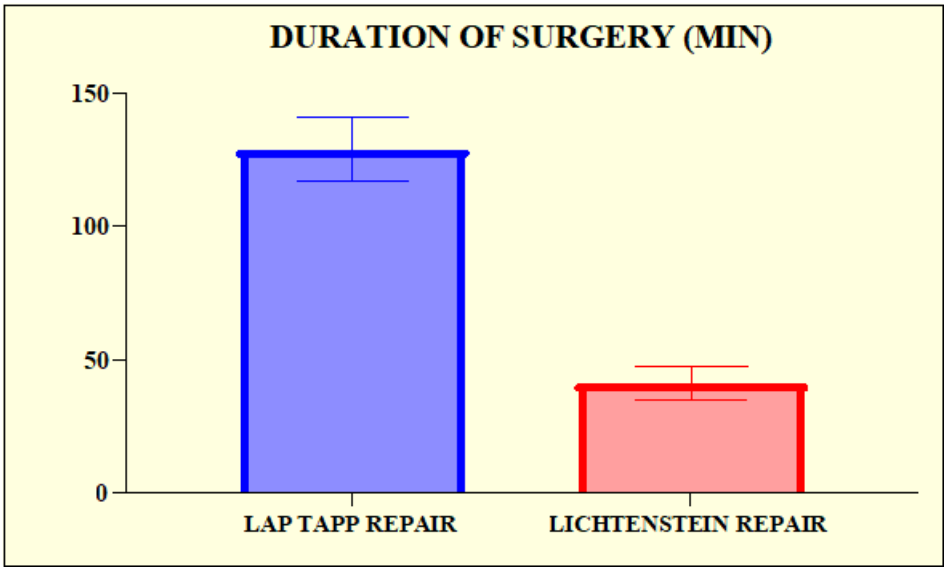

Figure-1: Graphical representation of the Duration of surgery of the enrolled patients among the groups.

Table-5: Post operative complication of the enrolled patients among the groups.

POST OPERATIVE COMPLICATION S	LAP TAPP REPAIR		LICHTENSTEIN REPAIR		P- VALUE
	N	%	N	%	
Hematoma	1	3.33%	1	3.33%	X=0.000 p>0.9999
Inflammation	1	3.33%	2	6.67%	X=0.3509 p=0.5536
Seroma	2	6.67%	6	20.00%	X=2.308 p=0.1287

Post-operative complications between laparoscopic TAPP and Lichtenstein repair show generally low complication rates in both groups. Hematoma occurred in 1 patient (3.33%) in each group, with no statistical difference (χ^2 = 0.000, p > 0.9999). Inflammation was slightly more common in the Lichtenstein group (6.67%, n=2) compared to the TAPP group (3.33%, n=1), but this difference was not significant (χ^2 = 0.3509, p = 0.5536). Seroma formation was observed more frequently in the Lichtenstein group (20.00%, n=6) than in the TAPP group (6.67%, n=2), though this difference also did not reach statistical significance (χ^2 = 2.308, p = 0.1287). Overall, no statistically significant differences were noted in post-operative complications between the two techniques.

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(4), 334-344 | ISSN:2251-6727

Table-6: Post operative pain of the enrolled patients among the groups.

POST OPERATIV E PAIN	LAP TAPP REPAIR		LICHTENSTEIN REPAIR		P-VALUE
	N	%	N	%	
Mild (1-3)	23	76.67%	18	60.00%	X=1.926 p=0.1652
Moderate (4-7)	7	23.33%	12	40.00%	
Mean±SD	2.73±1.23		3.46±1.38		t=2.163 p=0.0347*

Post-operative pain assessment revealed that mild pain (score 1–3) was more common in the laparoscopic TAPP group (76.67%, n=23) compared to the Lichtenstein group (60.00%, n=18), while moderate pain (score 4–7) was reported more frequently in the Lichtenstein group (40.00%, n=12) than in the TAPP group (23.33%, n=7). Although the categorical distribution of pain did not reach statistical significance (χ^2 = 1.926, p = 0.1652), the mean pain score was significantly lower in the TAPP group (2.73 ± 1.23) compared to the Lichtenstein group (3.46 ± 1.38), with a t-value of 2.163 and a p-value of 0.0347, indicating that patients who underwent laparoscopic repair experienced significantly less post-operative pain.

Table-7: Cost and Oral Feed of the enrolled patients among the groups.

	LAP TAPP REPAIR		LICHTENSTEIN REPAIR		P- VALUE
	MEAN	SD	MEAN	SD	
COST (₹)	10632.77	2300.67	5450.17	611.43	t=11.92 p<0.0001 *

The mean cost of surgery was significantly higher in the TAPP group (₹10632.77 ± 2300.67) compared to the Lichtenstein group (₹5450.17 ± 611.43), with a t-value of 11.92 and a p-value < 0.0001, indicating a highly significant cost difference favoring the open repair.

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(4), 334-344 | ISSN:2251-6727

Table-8: Mobilization time of the enrolled patients among the groups.

MOBILISATION TIME IN (HOURS)	LAP TAPP REPAIR		LICHTENSTEIN REPAIR		P-VALUE
	N	%	N	%	
8-9	14	46.67%	0	0.00%	X=33.97 p<0.0001 *
10-11	14	46.67%	7	23.33%	
12-14	2	6.67%	23	76.67%	
Mean±SD	9.76±1.02		12.06±0.82		t=9.626 p<0.0001 *

The comparison of mobilization time post-surgery demonstrates a significantly faster recovery in the laparoscopic TAPP repair group. Most TAPP patients (93.34%, n=28) were mobilized within 8–11 hours, with 46.67% (n=14) mobilized as early as 8–9 hours. In contrast, 76.67% (n=23) of patients in the Lichtenstein group were mobilized between 12–14 hours, and none mobilized before 10 hours. The difference in distribution was highly statistically significant (χ^2 = 33.97, $p < 0.0001$). The mean mobilization time was also significantly shorter in the TAPP group (9.76 ± 1.02 hours) compared to the Lichtenstein group (12.06 ± 0.82 hours), confirmed by a t-value of 9.626 and a p-value < 0.000.

Table-9: Reoccurrence in 6 months of the enrolled patients among the groups.

REOCCURRENCE IN 6 MONTHS	LAP TAPP REPAIR		LICHTENSTEIN REPAIR		P-VALUE
	N	%	N	%	
Yes	0	0.00%	0	0.00%	--
No	30	100.00%	30	100.00%	

At the 6-month follow-up, no cases of hernia recurrence were observed in either the laparoscopic TAPP repair group or the Lichtenstein repair group. All patients—100% (n=30) in each group—remained recurrence-free, indicating excellent short-term surgical outcomes for both techniques.

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(4), 334-344 | ISSN:2251-6727

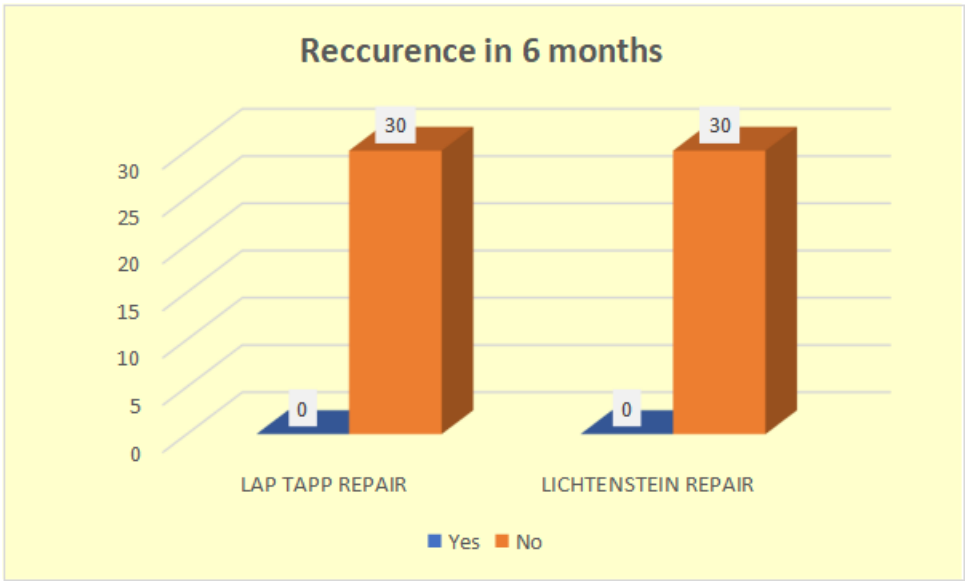

Figure 2: Graphical representation of the recurrence in 6 months of the enrolled patients among the groups

DISCUSSION

Surgical repair of inguinal hernias constitutes a cornerstone procedure in general surgery, with ongoing clinical discourse regarding the optimal approach between traditional open techniques and contemporary laparoscopic methodologies as technological advancement and clinical evidence continue to evolve. This prospective comparative analysis sought to systematically assess two widely utilized surgical approaches—laparoscopic TAPP repair and open Lichtenstein mesh repair—across multiple clinical and outcome metrics.

Demographics

Patient age and gender distribution within our investigation demonstrated statistical equivalence between treatment cohorts, establishing well-balanced groups essential for valid outcome comparisons. Comparable demographic findings have been documented in numerous previous investigations, including those conducted by Jamil et al. (2020) [1], Yang et al. (2018) [2], and Karim et al. (2019) [3], all demonstrating baseline demographic consistency between TAPP and open repair populations. This demographic uniformity ensures that observed outcome differences are directly attributable to surgical technique variations rather than patient population disparities.

Operative Time

Our investigation documented significantly extended operative duration for TAPP repair (129.00 ± 12.27 minutes) relative to Lichtenstein repair (41.17 ± 6.41 minutes), findings that align with established literature precedent. Vinay et al. (2018) [4], Elmessiry et al. (2020) [5], and Rayamajhi et al. (2022) [6] similarly documented prolonged operative intervals for TAPP procedures, attributing this temporal extension to laparoscopic equipment preparation, preperitoneal anatomical dissection requirements, and mesh fixation protocols. While TAPP methodology necessitates a specialized learning trajectory, investigations such as Yang et al. (2018) [2] indicate that operative duration decreases substantially with accumulated surgical experience.

Postoperative Pain

Markedly reduced postoperative pain scores were documented within the TAPP cohort (VAS 2.73 ± 1.23) compared to the Lichtenstein group (VAS 3.46 ± 1.38; $p = 0.0347$). These findings corroborate evidence from numerous comparative investigations favoring laparoscopic repair for pain reduction, including studies by Jamil et al. (2020) [1], Dumitrescu et al. (2023) [7], and Scheuermann et al. (2017) [8]. Minimally invasive surgical approaches minimize tissue trauma and neural

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(4), 334-344 | ISSN:2251-6727

irritation, resulting in enhanced early postoperative patient comfort.

Hospital Stay

Our results revealed abbreviated hospitalization duration within the TAPP group (1.87 ± 0.99 days) compared to the Lichtenstein cohort (2.73 ± 1.21 days; $p = 0.0038$), consistent with findings reported by Jamil et al. [1] and Elmessiry et al. [5], who similarly identified expedited discharge as a distinctive TAPP advantage. Sofi et al. (2021) [9] and Bhondve et al. (2025) [10] substantiated these observations, identifying reduced postoperative discomfort and complications as primary factors enabling early hospital discharge.

Mobilization Time

Expedited mobilization represents a critical factor in optimizing patient recovery trajectories. Mean mobilization duration was significantly abbreviated within the TAPP group (9.76 ± 1.02 hours) compared to the Lichtenstein cohort (12.06 ± 0.82 hours; $p < 0.0001$). Similar conclusions were established by Sofi et al. [9] and Rayamajhi et al. [6], who emphasized that minimally invasive techniques enable accelerated return to functional activity, thereby reducing postoperative complications including thromboembolic events.

Postoperative Complications

Although complications including seroma and hematoma formation occurred across both treatment groups, no statistically significant inter-group differences were observed. These findings align with reports from Ragheb et al. (2020) [11] and Takayama et al. (2020) [12], who documented equivalent complication profiles. Yang et al. (2018) [2] similarly established that while minor complications may demonstrate variation, serious adverse outcomes remain rare and comparable between techniques when appropriate surgical protocols are maintained.

Cost

TAPP repair demonstrated significantly elevated costs (₹10632.77 ± 2300.67) compared to Lichtenstein repair (₹5450.17 ± 611.43), with $p < 0.0001$. This financial differential was anticipated given requirements for specialized laparoscopic instrumentation, general anesthesia administration, and mesh fixation devices. Comparable cost disparities were documented in investigations by Vinay et al. [4], Dumitrescu et al. [7], and Elmessiry et al. [5]. However, as emphasized by Takayama et al. [12], these elevated initial expenditures may be counterbalanced by accelerated recovery, reduced chronic pain incidence, and expedited return to occupational activities.

Recurrence

Critically, no hernia recurrence was documented within either treatment group during the 6-month follow-up surveillance period, confirming short-term effectiveness of both surgical approaches. Similar observations were reported by Yang et al. [2], Lydeking et al. (2021) [13], and Elmessiry et al. [5], indicating that when executed with appropriate technique, both TAPP and Lichtenstein repairs demonstrate durable clinical outcomes.

CONCLUSION

This investigation establishes that laparoscopic TAPP repair, while requiring extended operative duration and increased financial investment, produces significantly reduced postoperative pain, abbreviated hospitalization periods, and accelerated mobilization compared to open Lichtenstein repair. Both surgical techniques demonstrated absence of recurrence at 6-month follow-up and exhibited comparable complication profiles, confirming their safety and clinical efficacy. The selection between these approaches should be individualized, incorporating patient clinical status, hernia characteristics, and available surgical expertise.

ACKNOWLEDGMENT

We are grateful to all the patients who participated in the research for their cooperation and trust. Special thanks to the medical and technical staff for their assistance in data collection and patient care. MCN: IU/R&D/2025-MCN0003757

REFERENCES

1. Jamil M, Khan A, et al. Comparison of outcomes of laparoscopic transabdominal preperitoneal and Lichtenstein mesh repair. *Pak J Med Sci*. 2020;36(3):512–516.
2. Yang B, et al. A comparison of laparoscopic vs open inguinal hernia repair. *BMC Surg*. 2018;18(1):70.

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(4), 334-344 | ISSN:2251-6727

3. Karim T, et al. TAPP vs Lichtenstein: comparative outcomes. *Int Surg J*. 2019;6(5):1470–1474.
4. Vinay G, et al. Comparative study of laparoscopic and open inguinal hernia repair. *J Clin Diagn Res*. 2018;12(3):PC01–PC04.
5. Elmessiry MM, et al. Laparoscopic versus open repair in bilateral hernia. *Surg Laparosc Endosc Percutan Tech*. 2020;30(3):185–190.
6. Rayamajhi S, et al. TAPP vs Lichtenstein: a comparative study. *Nepal Med Coll J*. 2022;24(2):137–141.
7. Dumitrescu V, et al. Pain and recovery in laparoscopic vs open hernia repair. *Ann Ital Chir*. 2023;94:209–216.
8. Scheuermann U, et al. Chronic pain after hernia repair: meta-analysis. *World J Surg*. 2017;41(11):2651–2661.
9. Sofi RA, et al. Laparoscopic TAPP vs open hernioplasty. *Int Surg J*. 2021;8(5):1478–1482.
10. Bhondve S, et al. Prospective comparison of TAPP and Lichtenstein repair. *J Clin Biomed Sci*. 2025;15(1):22–29.
11. Ragheb AR, et al. Outcome analysis in laparoscopic vs open repair. *Egypt J Surg*. 2020;39(1):43–48.
12. Takayama Y, et al. Laparoscopic vs mesh plug hernia repair. *Asian J Endosc Surg*. 2020;13(1):42–47.
13. Lydeking L, et al. Long-term outcomes in inguinal hernia repair. *Ann Surg*. 2021;274(6):e1009–e1016.