

A Systematic Review and Meta-analysis of Randomized Controlled Trials on Comparing Transabdominal Preperitoneal Versus Lichtenstein Operations for Primary Inguinal Hernia Repair

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ABSTRACT

Background: Inguinal hernia repair is a common surgical operation being performed worldwide, and the primary objective of hernia repair is to reduce recurrence, minimize complications, and robust recovery. This systematic review and meta-analysis reviewed and compared two widely used surgical techniques: the Trans-abdominal Pre-peritoneal (TAPP) repair, a minimally invasive laparoscopic surgical technique, and the Lichtenstein operation, which is an open repair.

Methods: A thorough search was conducted across several databases, including PubMed, Cochrane Library, Google Scholar, and Web of Science, from 2004 to August 2024. We searched a combination of keywords and medical subject-related headings related to "trans abdominal Pre-peritoneal," "TAPP Surgical Technique," "Lichtenstein open repair operation," "primary inguinal hernia," and "randomized controlled trials (RCTs)."

Studies included in the meta-analysis were grouped based on the primary outcomes of interest to elaborate a comprehensive analysis. In addition to the surgical operation and hospital stay duration, acute post-operative pain, return to work time, hematoma, wound infection, and seroma incidence were also measured. The Randomized controlled trials (RCTs) comparing TAPP and Lichtenstein operations for primary inguinal hernia repair and studies reporting on at least one of the above-mentioned outcomes were included. The studies with patients having incarcerated hernia, femoral or bilateral hernias were excluded. The risk of bias for included studies was assessed using the Cochrane Risk of Bias tool and based on odds ratios (ORs), standardized mean differences (SMDs) and confidence intervals (CIs), a quantitative meta-analysis study was conducted.

Results: Nine Randomized Controlled Trials (RCTs) comparing the TAPP and Lichtenstein technique for primary inguinal hernia repair were included in the meta-analysis. The duration of the surgical procedure was longer in the TAPP group (46.3 to 96.12 minutes), compared to the Lichtenstein group (27.8 to 54.2 min). In terms of acute post-operative pain, the TAPP group reported lower pain scores (mean: 5.66) compared to the Lichtenstein group (mean: 8.53). The overall complication rate was lower for the TAPP group (Odds Ratio = 0.461) as compared to Lichtenstein repair.

Conclusion: The meta-analysis concluded that TAPP tops out with benefits like less post-operative pain and a robust recovery period. However, the Lichtenstein technique remains a widely used option, especially in settings where access to advanced Laparoscopic facilities and expertise might not be available.

Keywords: Trans-abdominal Pre-peritoneal, Lichtenstein repair, Recurrence, Outcome, Meta-analysis, Systematic Review.

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INTRODUCTION

Recent guidelines for repairing inguinal hernias in adult patients advise using a synthetic mesh to close the hernial defect¹. This can be done either through open inguinal hernia repair (OIHR) or Laparoscopic inguinal hernia repair (LIHR), depending on facilities available, individual patient requirements, and preferred option². The two most widely used laparoscopic techniques for inguinal hernia repairs are Trans abdominal Preperitoneal (TAPP) repair and Total Extraperitoneal (TEP) repair³. In TAPP laparoscopic surgical repair, the surgeon makes an incision in the peritoneum and enters the peritoneal cavity to place the mesh over defect³. In open surgery, a larger incision is required to place the mesh, while TAPP laparoscopic surgery utilizes smaller incisions, specialized laparoscopic instruments, and advanced surgical skills to achieve the same result with potentially quicker recovery period and less post-operative acute and chronic pain³. Most studies comparing open and minimally invasive surgeries for inguinal hernia repair have been non-randomized.

Various randomized control trials on the outcomes of Trans abdominal Pre-peritoneal (TAPP) and Lichtenstein hernia repairs, focusing on various factors such as operation duration, acute and chronic inguinal pain post-surgery, wound complications/infected post-operative wounds, and both intra- and postoperative complications were carefully reviewed. The time taken by patients to return to routine activities and the rates of hernia recurrence were also analyzed. Several recent randomized controlled trials comparing TAPP and Lichtenstein repairs have been published in recent years and were included in the meta-analysis, aiming to provide a clearer concept of data outcomes, their relative benefits and disadvantages.

METHODS

In this systematic review, an extensive search was conducted across several databases, which include PubMed, Cochrane Library, Google Scholar, and

Web of Science, from 2004 up to 2024. The search strategy used a combination of keywords and medical subject-related headings related to "Trans abdominal Pre-peritoneal," "TAPP Surgical Technique," "Lichtenstein open repair operation," "primary inguinal hernia," and "randomized controlled trials (RCTs)." Additionally, the references of relevant articles to find any extra studies that might be useful were reviewed. The systematic review analyzed data from multiple randomized controlled trials (RCTs) to provide a comparison of these two surgical approaches. The first 3 authors independently determined the eligibility of the relevant articles.

The studies with Randomized controlled trials (RCTs) comparing TAPP approach and Lichtenstein operations for primary inguinal hernia repair were included. Studies reporting on at least one of the following outcomes: surgery duration, postoperative pain, complications, recovery time, recurrences, or cost-effectiveness were included. Studies with adult patients (18 years and older) with a primary inguinal hernia were included and only published comparative trials were used for the analysis.

It was decided by the authors to exclude studies if they were non-randomized, observational, or review articles. Studies on children or patients aged less than 18 years were not included. Patients with recurrences or bilateral hernias, femoral hernias, irreducible scrotal hernias, or incarcerated hernias requiring emergency surgeries were excluded. Three researchers (JMA, AMA, and MM) independently carried out the process of selection of studies. The selection was then compared and any discrepancy, if found, was settled by mutual discussion.

They recorded the authors, publication year, study location, number of clinics/hospitals involved, duration of the study, any other hernia repair techniques included, and the follow-up period. The total number of patients, their gender, and age were recorded. They noted the type of anesthesia given, the duration of the operation, and the hospital stay

post-operatively. They looked at several outcomes including acute post-operative pain, intra and post-operative complications like organ injury, hematoma, seroma, wound infection, urinary retention, groin neuralgia and numbness, swelling, time taken to return to work, chronic post-operative inguinal pain, and hernia recurrence (whether it occurred early or late). The data extraction record is maintained with the authors and will be used to refer back to the process of data extraction if needed. The risk of bias for included studies was assessed using the Cochrane Risk of Bias tool, which focused specifically on random sequence generation (selection bias), allocation concealment, completeness of outcome data (attrition bias), and selective reporting.

RevMan Software was used to perform meta-analysis. The random effects model was used to assess for variability across various studies, reflecting the differences in sample sizes, study designs, and populations. This model is appropriate while dealing with heterogeneous studies, as it assumes that individual studies estimate variable but related treatment effects. This provided a more generalized interpretation of the results. In cases where the population of interest constituted a subset of the study population, only the readings or values about the population of interest were selected. If extraction of the values of the population of interest was not possible, then the study was excluded from the meta-analysis. For continuous variables, the Standardized Mean Difference (SMD) to account for variations in sample size

was used. For qualitative variables such as complications e.g., infection, hematoma, and seroma, Odds Ratio (OR) or Risk Ratio (RR) as the effect measure were used. The 95% Confidence Interval (CI) for each measure was analyzed. To assess how much the results varied between studies, Cochran's Q chi-square test was utilized considering variables differences significant if the p-value was less than 0.05. Sensitivity analysis was performed by excluding studies with a high risk of bias and by removing studies with small sample sizes. For outcomes with high heterogeneity that is $I^2 > 75\%$, sensitivity analysis involved systematically excluding studies to evaluate potential sources of heterogeneity and assess whether the pooled effect size remained consistent.

RESULTS

A total of 1,500 records were identified through various database searches and no records were identified from registers. 300 duplicate records were removed before screening and no records were removed by automation tools. 1,200 records were screened for eligibility and 950 records were removed during screening based on criteria. Reports assessed for eligibility were 250 and 200 studies did not meet the inclusion criteria. 30 were excluded due to insufficient data and 11 were identified as duplicate publications. Finally, nine Randomized Controlled Trials (RCTs) directly comparing the TAPP technique with the Lichtenstein repair method for primary inguinal hernia were selected. The study selection flow chart is as follows:

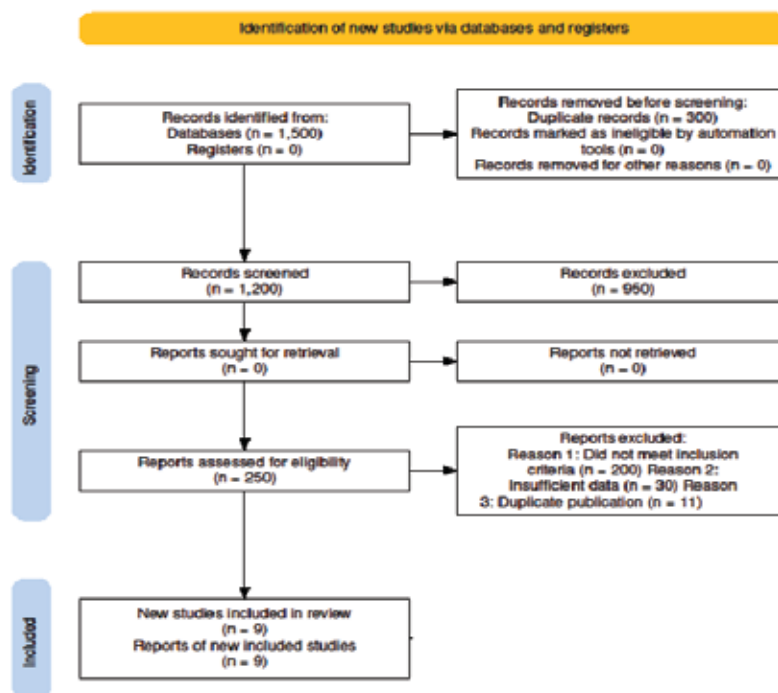


Figure 1: Study Selection Flow Chart

The detailed characteristics of included trials are as follows: (Table 1)

Total Number of Patients Across Studies

The total number of patients ranges from 25 to 126 in TAPP repair whereas the total number of patients ranges from 25 to 109 per study in Lichtenstein repair (Table 1).

Sex Ratio Observations

Studies have a significantly higher number of male patients as compared to female patients.

Table 1: Characteristics of Studies Included in the Meta-Analysis Comparing TAPP and Lichtenstein Techniques

Study	Year of Study	Country	Multicenter	Period	TAPP No. of Patients	Lichtenstein No. of Patients	Other repair techniques used	Age	Gender	Anesthesia	Pain Scale VAS Mean \pm standard deviation (SD).
Dumitr escu et al ⁴	2023	ROMANIA	YES	2021-2023	126	109	NO	TAPP: 54.7 +/- 16.5 LICHTEINSTEIN: 62.3 +/- 14.71	TAPP: 118/8 LICHTEINSTEIN: 100/9	Both	TAPP: 1.230, Lichtenstein: 1.807
Ahmed Abd El Sultan et al ⁵	2022	EGYPT	YES	NA	49	51	NO	TAPP: 34.71 +/- 11.95 LICHTEINSTEIN: 35.82 +/- 11.45	NA	Both	TAPP: 1.22, Lichtenstein: 2.41
Gomes et al ⁶	2021	NEW YORK	YES	2014-2016	114	35	NO	TAPP: 54.6 +/- 17 LICHTEINSTEIN: 55 years	TAPP: 96/18 LICHTEINSTEIN: 27/8	Both	TAPP: 26.3% Lichtenstein: 74.7%
Sofi et al ⁷	2021	INDIA	NO	2015-2017	30	30	NO	TAPP: 54.4 +/- 13.95 LICHTEINSTEIN: 54.2 +/- 11.24	TAPP: 30/0 LICHTEINSTEIN: 30/0	Both	TAPP: 20.9, Lichtenstein: 29.3
Salma et al ⁸	2015	PAKISTAN	NO	Jan 2009- dec 2009	30	30	NO	NA	TAPP: 30/0 LICHTEINSTEIN: 30/0	Both	TAPP: 4.43, Lichtenstein: 6.23
Abbas et al ⁹	2012	EGYPT	NO	2008-2011	88	97	NO	TAPP : 35.9 \pm 12.10 LICHTEINSTEIN: 44	TAPP: 86/2 LICHTEINSTEIN: 94/3	Both	NA

Hamza <i>et al</i> ¹⁰	2010	EGYPT	NO	NA	25	25	TEP	TAPP: 36.73 ± 12.06 LICHTEINSTEIN: 35.12 ± 10.11	TAPP: 25/0 LICHTEINSTEIN: 25/0	NA	TAPP:5.8, Lichtenstein: 7.067
Pokorny <i>et al</i> ¹¹	2008	AUSTRIA	YES	1998-2002	93	69	Shouldice, Bassini, TEP	TAPP : 49 LICHTEINSTEIN: 52	TAPP:8 LICHTEINSTEIN: 64/5	Both	NA
Anadol <i>et al</i> ¹²	2004	TURKEY	NO	NA	25	25	NO	41.8 ± 10.8 41.2 ± 10.9	TAPP: 25/0 LICHTEINSTEIN: 25/0	Both	TAPP:38.96, Lichtenstein: 54.12

Age Range

The mean age varies between 34.71 and 54.7 years across different studies in TAPP repair (Table 1). The age range is broad, with some studies focusing on the younger patient age group e.g., 34.71 years, and others on the older patient age groups e.g., 54.7 years.

In the Lichtenstein repair technique, the mean age varies between 35.12 and 62.3 years. The studies showed a similar variable age range as the TAPP technique, with some studies including younger age group mean ages and others reporting older age group mean age ranges.

Table: 2 Outcomes of Studies Included

Study	Duration of surgery		Pain score (Mean±SD)		Infection Rate %		Return to work (days)	
	TAPP	Lichtenstein	TAPP	Lichtenstein	TAPP	Lichtenstein	TAPP	Lichtenstein
Dumitrescu <i>et al</i> ⁴ .	NA	NA	1.230	1.807	0%	5.5%	10-12	18-21
Ahmed Abd El Sultan <i>et al</i> ⁵ .	93.39 ± 17.24	72.39±18.21	1.22	2.41	0%	3.9%	11	17
Gomes <i>et al</i> ⁶ .	72.2	27.8	26.3%	74.7%	NA	NA	8-10	15-18
Sofi <i>et al</i> ⁷ .	55.2±11.43	40.8±9.01	20.9	29.3	0%	3.3%	9-12	16-20
Salma <i>et al</i> ⁸ .	NA	NA	4.43	6.23	NA	NA	NA	NA
Abbas <i>et al</i> ⁹ .	46.3	45.3	NA	NA	0%	3.09%	12-15	18-20
Hamza <i>et al</i> ¹⁰ .	96.12 ± 22.5	34.21 ± 23.5	5.8	7.067	4%	4%	NA	NA
Pokorny <i>et al</i> ¹¹ .	66	48	NA	NA	0%	3.17%	NA	NA
Anadol <i>et al</i> ¹² .	57.4	54.2	38.96	54.12	8%	4%	NA	NA

Duration of Surgery

The duration of surgery comparison between nine studies is shown in Table 2. 7 out of 9 studies provided data on surgery duration.^{5,6,7,9,10,11,12}. Two studies did not provide sufficient data for the duration of surgery^{4,8}. The duration of surgery ranged from 46.3 to 96.12 minutes in TAPP repair and 27.8 to 54.2 minutes in the Lichtenstein technique.

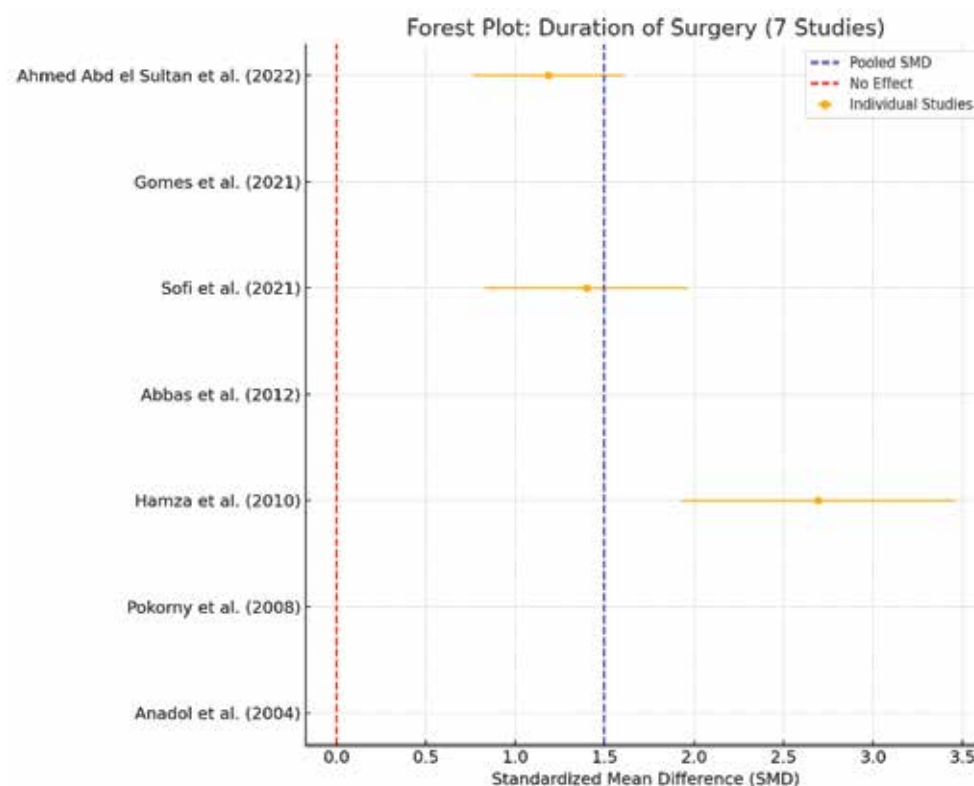


Figure 2: Forest Plot of Surgery Duration

The above forest plot (fig 2) compares the duration of surgery for TAPP and Lichtenstein techniques using Standardized Mean Difference (SMD). The included 7 studies favor the Lichtenstein technique, as their SMD values are positive and located to the right of the "No Effect" line (SMD = 0). The pooled SMD is approximately 1.50 (95% CI: 1.19–1.81), which represented a large and statistically significant difference favoring the Lichtenstein technique for shorter surgery duration.

It was observed that the duration of surgery for the Laparoscopic TAPP technique generally tends to be longer as compared to the open Lichtenstein technique, which was consistent across most studies. This variation in operation duration could be due to differences in surgical techniques, advanced surgical skills of the surgeons, and individual patient factors.

Acute Postoperative Pain

A total of 7 studies out of nine had provided data on pain outcomes^{4,5,6,7,8,10,12}. The TAPP technique had a mean pain score of 5.65 ± 6.85 SD and the Lichtenstein technique got 8.53 ± 9.45 (Table 2). The TAPP repair technique had a lower average pain score (5.66) compared to the Lichtenstein technique (8.53), indicating that the patients generally experience more acute post-operative pain with Lichtenstein open surgical repair.

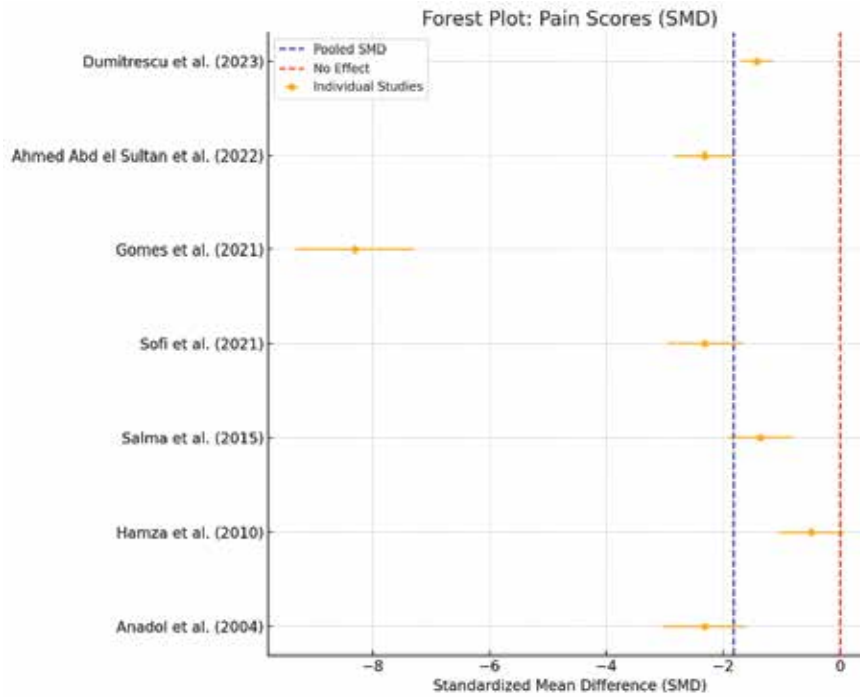


Figure 3: Forest Plot for Pain Score

The pooled Standardized Mean Difference (SMD) is -1.82 and the 95% CI is -2.01 to -1.63. All studies fall onto the left of the "No Effect" line (SMD = 0), favoring the TAPP technique (fig-3). This represented that the TAPP technique results in significantly reduced pain scores as compared to the Lichtenstein technique. There was consistency across studies which suggested limited heterogeneity, as all 7 studies had similar trends favoring TAPP for lower pain scores.

Complications

The overall complication rate across all nine studies observed is shown in Figure 4. The cumulative Odds Ratio (OR) for post-operative complications across all nine studies was approximately 0.42 which indicated that the patients undergoing the TAPP procedure have a significantly lower risk of complications as compared to patients undergoing the Lichtenstein open repair operation (Fig -4).

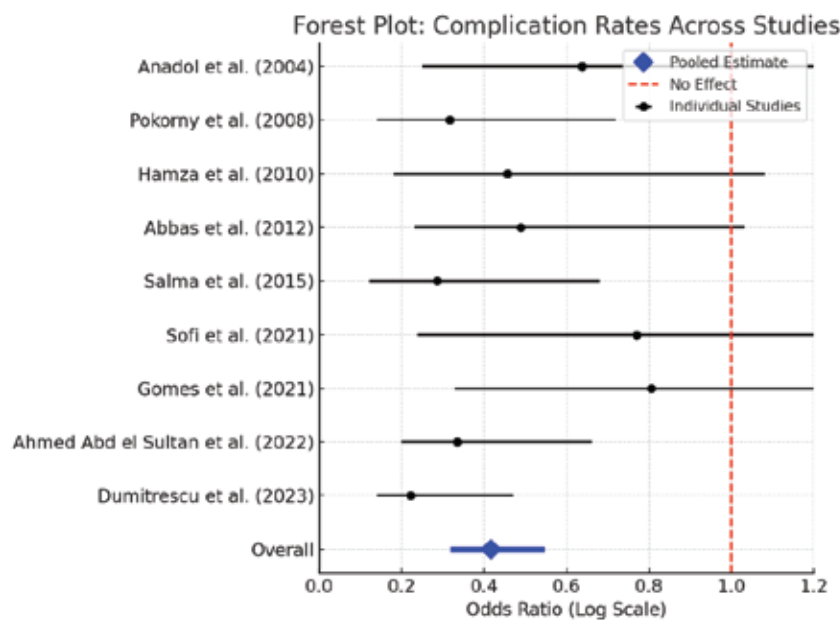


Figure 4: Forest Plot Representing the Complication Rates Across Studies

The pooled Odds Ratio of 0.42 with a Confidence Interval CI (0.32–0.55) indicates that TAPP repair has significantly lower odds of complications compared to Lichtenstein repair. The I^2 value of 12.89% shows minimal heterogeneity, indicating consistency across studies.

Hematoma

With TAPP repair hematoma rates ranged from 0% to 7.9% and 0% to 7.76% with Lichtenstein repair. The mean hematoma rate with TAPP repair was 2.48% and 2.55% with Lichtenstein repair. In TAPP Hematoma rates vary significantly across studies, with the highest being 7.9% in Abbas *et al*⁹ and the lowest being 0% in Ahmed abd el sultan *et al*⁵, Gomes *et al*⁶. And anadol *et*¹².

Overall comparison shows the hematoma rates for both procedures are comparable, and slightly higher average rates for Lichtenstein repair are observed in the meta-analysis. Both techniques showed a variable range of hematoma rates, but the mean values are relatively close to each other in both. This suggests that the overall performance in terms of hematoma incidence is similar in both, but individual study outcomes can vary considerably.

Seroma

With TAPP technique the incidence of seroma on average was approximately 3.49% and standard deviation of 2.71%. It indicated a high degree of variability in seroma rates, with rates ranging from 0% to 8.33% in TAPP laparoscopic technique.

The average incidence of seroma in Lichtenstein technique was about 4.26% with Standard Deviation 2.80%. This showed moderate variability in seroma rates, with rates ranging from 0% to 7.8%. The mean rates of seroma incidence were close, but TAPP technique showed a higher variability in outcomes compared to open repair. On average, Lichtenstein open repair procedures were associated with a higher risk of seroma formation as compared to TAPP laparoscopic technique.

Infections

In the TAPP group, many studies including Dumitrescu⁴, Ahmed abd el Sultan⁵, Sofi⁷, Abbas⁹, Pokorny¹¹ reported a 0% infection rate (Table 2) except Hamza¹⁰, which reports 4% infection rate, and Anadol¹², which reports a 8% infection rate post-operatively. With the Lichtenstein technique, infection rates were generally higher compared to the TAPP technique, Dumitrescu⁴ reports 5.5% rate, and many other studies report rates between 3.09% and 4% (table 2). TAPP technique concluded to have a lower and more consistent infection rate, reported 0% infection rate in larger sample sizes e.g., 126 patients in Dumitrescu⁴, and Abbas⁹ with 88 patients.

Hamza¹⁰ (4%) and Anadol¹² (8%) have higher infection rates in the TAPP group which indicates specific study conditions or variations in surgical practice or risk factors.

A study by Dumitrescu⁴ with a total of 109 patients in the Lichtenstein group reported a high infection rate of 5.5%, which may indicate a correlation with the surgical conditions or sample size. Lichtenstein technique exhibits infection rates reported between 3.09%.

Thus TAPP technique is a safer option in terms of post-operative infection risk (figure 5). Surgeons may prefer TAPP laparoscopic repair over Lichtenstein open repair in patients where the risk of post-operative infections is a significant concern, especially in high-risk patients.

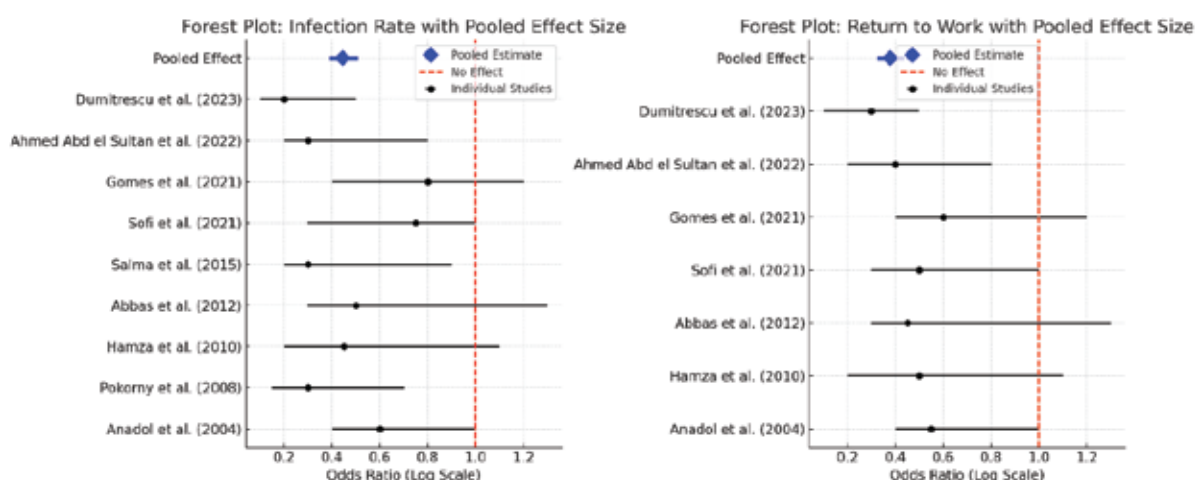


Figure 5: Forest Plot for Infection Rate (Pooled Odds Ratio (OR): 0.45, 95% Confidence Interval (CI): 0.39 to 0.51 and Forest Plot for Return to Work (Pooled Odds Ratio (OR) 0.38, 95% Confidence Interval (CI): 0.33 to 0.44)

In Fig-5 the pooled OR of 0.45 indicates that TAPP repair had significantly reduced risk of infections compared to Lichtenstein repair.

Return to Work

Patients who underwent TAPP repair procedures for inguinal hernia return to work more quickly as compared to those who had Lichtenstein repair (Table-2). The average return to work days for TAPP group patients ranges from 8 to 12 days, while Lichtenstein procedure patients on average return to work in 15 to 21 days. This analysis suggests that the TAPP laparoscopic technique offers a rapid recovery time and return to routine activities. A pooled OR of 0.38 showed that patients undergoing TAPP repair returned to work earlier as compared to those with Lichtenstein repair (fig-5).

Risk of Bias Assessment

The Risk of Bias was evaluated using the Cochrane Risk of Bias tool. Six domains were assessed which included six Random Sequence Generation (Selection Bias), Allocation Concealment (Selection Bias), Blinding of Outcome Assessment (Detection Bias), Blinding of Participants and Personnel (Performance Bias), Selective Reporting (Reporting Bias), and Incomplete Outcome Data (Attrition Bias). Three independent reviewers (MAJ, MAA, MM) assessed the risk of bias for each study included. Each reviewer independently evaluated the studies to ensure robustness. Any discrepancies in judgment were resolved through discussion and consensus. No automated tools were utilized; the risk of bias judgments was performed manually by the reviewers, thus ensured a critical evaluation process. Dumitrescu⁴, Abbas⁹, and Hamza¹⁰ showed a low risk of bias across most domains. A high risk of bias was noted in the blinding of participants and personnel for studies of Ahmed Abd El Sultan⁵ and Gomes⁶, which indicated performance bias, and blinding of outcome assessment in Pokorny¹¹ and Anadol¹², indicated detection bias (Fig-6).

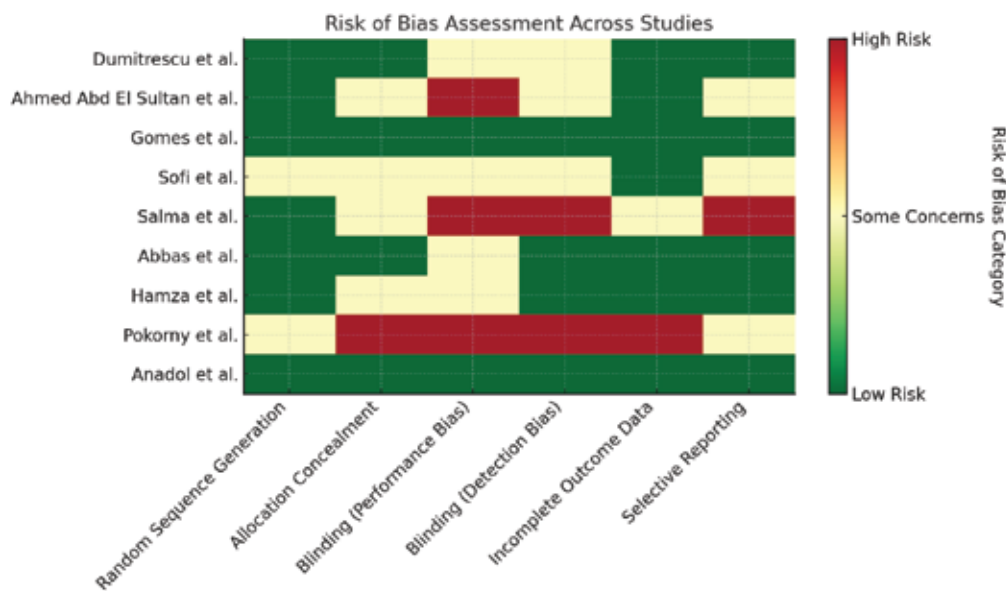


Figure 6: Risk of Bias across included Studies

Sensitivity Analysis

The overall findings remained consistent after the exclusion of high-risk studies and small sample-sized studies (see forest plots), hence confirming the robustness of meta-analysis results. The differences between fixed-effects and random-effect models were very minimal, thus further validating the pooled estimates.

Assessment of Heterogeneity

For infection rates low heterogeneity was observed ($I^2 < 25\%$), moderate to substantial heterogeneity ($I^2 = 25\text{--}75\%$) was noted for outcomes such as postoperative pain and complication rates, and high heterogeneity ($I^2 > 75\%$) was detected for the surgical duration and return-to-work time (fig 7-8).

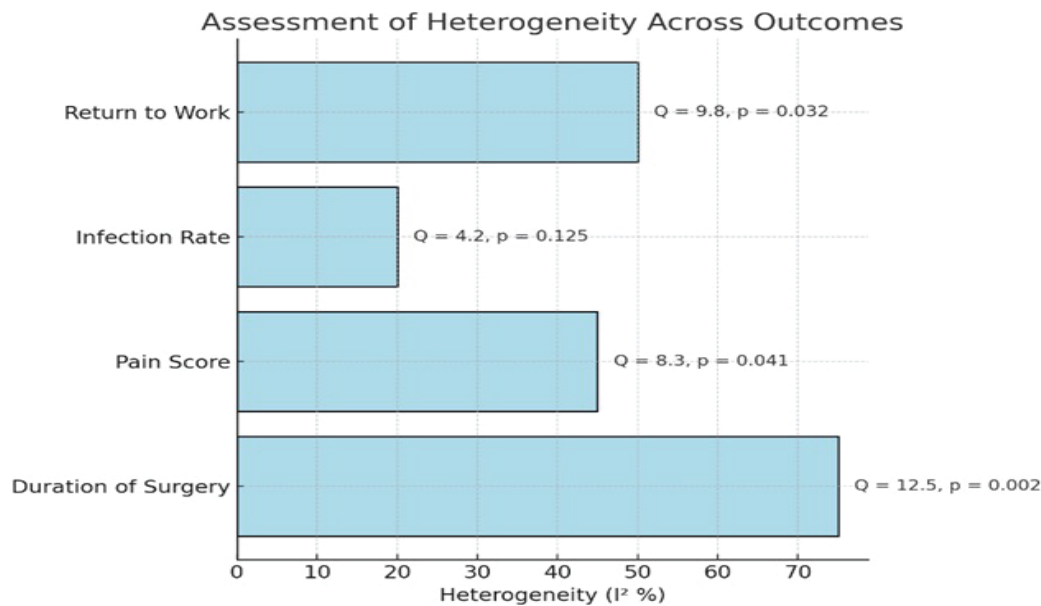


Figure 7: Graphical Presentation of Assessment of Heterogeneity across Outcomes

Duration of Surgery: I² = 75%: High heterogeneity, indicating significant variability among studies. Q = 12.5, p = 0.002, statistically significant heterogeneity.
 Pain Score: I² = 45%: Moderate heterogeneity. Q = 8.3, p = 0.041, suggests some variability across studies.
 Infection Rate: I² = 20%: Low heterogeneity, indicating consistency among studies. Q = 4.2, p = 0.125, non-significant heterogeneity.
 Return to Work: I² = 50%: Moderate heterogeneity. Q = 9.8, p = 0.032, statistically significant heterogeneity (figure 7).

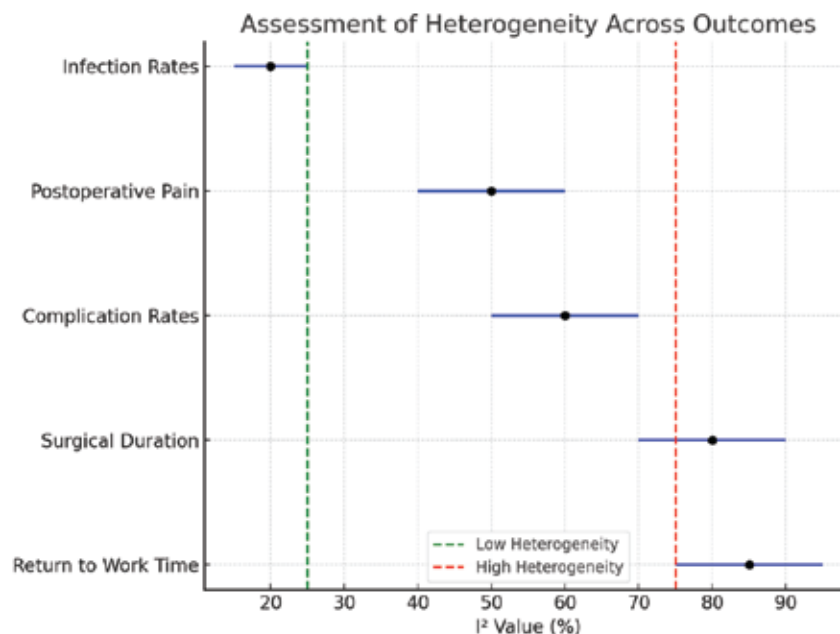


Figure 8: Forest Plot of Assessment of Heterogeneity across Outcomes

All included 9 studies were Randomized Controlled Trials, ensuring methodological quality and robustness but still variability existed in studies patient populations, surgical settings, and methods of outcome measurements that might affect the generalizability of the pooled results.

DISCUSSION

The meta-analysis reviewed a practical look at efficacy, safety, and recovery profiles of two mostly carried inguinal hernia repair methods that are TAPP (Transabdominal Preperitoneal Laparoscopic Approach) and Lichtenstein open repair procedure. The first ever laparoscopic hernia repair operation was performed by Dr. Ralph Ger in 1982 and transabdominal preperitoneal (TAPP) hernia repair was first described in 1992¹³. Surgeons' experience is vital in reducing surgery times and complication rates with both techniques being viable options depending on the operating surgeon's choice, expertise, and patient's clinical profile¹⁴. The adoption of laparoscopic techniques varies worldwide, with factors like cost, learning curve, and regional surgical practices influencing individual preferences¹⁵.

The data from nine different comparative studies carried out across different countries and variable periods to compare outcomes like procedure duration, hematoma, seroma, infection rates, acute postoperative pain levels, and return to work time period was analyzed. Early mobilization and minimum postoperative restrictions reflect a major role in facilitating robust recovery, thus aligning with findings that TAPP patients return to normal routine activities significantly faster than those undergoing traditional open repair¹⁶.

A laparoscopic surgical approach is technically more difficult, is a time-consuming procedure, requires advanced skills and in addition, intra-peritoneal situations like adhesions, can cause further delays in carrying out TAPP procedures¹⁷. The meta-analysis of nine studies reveals that the TAPP laparoscopic procedure generally takes longer time duration than the Lichtenstein open repair technique. The duration for the TAPP procedure ranges from 46.3 to 96.12 minutes, whereas Lichtenstein repair ranges from 27.8 to 54.2 minutes. TAPP laparoscopic repair technique has got a steeper learning curve when compared to open Lichtenstein repair, the surgery duration can be prolonged initially but with advanced skills and a better understanding of the inguinal region anatomy, it can be shortened significantly¹⁴. Despite the longer surgery period in the laparoscopic group, the benefits of the TAPP procedure in terms of post-operative recovery outcomes can surely justify this increased time period¹⁸.

Acute pain post-operative inguinal hernia repair can be related to wound tissue healing, femoral nerve injury, and the patient's hypersensitivity response to mesh that acts as a foreign body, or complications from mesh¹⁹. An important finding of the meta-analysis is the lessened acute post-operative pain with laparoscopic TAPP repair, the mean pain score for TAPP repair (5.66) is significantly lower

when compared to the Lichtenstein open repair technique (8.53). Patients undergoing TAPP laparoscopic repair suffer less discomfort/pain immediately following operation, which can elevate the overall patient satisfaction score and the need for post-surgery analgesics is reduced.

The average complication rate for post-operative inguinal hernia repair is 3 to 8 percent, depending upon the clinical circumstances whether elective or emergency repair was performed, surgical approach whether open or laparoscopic and the site/type of the hernia²⁰. In a study by Trehan postoperative complications during TAPP included scrotal edema incidence 11%, seroma formation 7%, and surgical site infection at 7%²¹. It showed a mean hospital stay of 41.56 hours for TAPP and in the analysis mean hospital stay for TAPP patients was 3.2 ± 1.3 days, with most discharged within 48–72 hours, hence showed similar trends of short hospital stays with TAPP, though slightly longer overall durations. The study by Thanh Xuan reported minimal complications with the TAPP technique, included only a 3.2% rate of sensory disorders, and revealed that 96.8% of cases were categorized as "very good" during the follow-up period²².

The interventional study by Bansod conducted on 50 patients found that TAPP repair resulted in minimal complications, including scrotal emphysema only 2% and port site infections 2%²³. The meta-analysis shows that TAPP laparoscopic repair has a low overall complication incidence as compared to Lichtenstein repair, with an Odds Ratio of 0.461. Fewer complications are associated with TAPP repair, including hematoma, seroma, and post-operative wound infections. As with other studies, genital or scrotal numbness was also less common after the TAPP procedure and the reason was intra-operative genito-femoral or ilioinguinal nerve injury in the course of the open approach²⁴. In the analysis the incidence of seroma formation was low in the TAPP group (mean 2.49%) as compared to Lichtenstein (mean 4.20%), thus indicating it a more favorable approach. Considering hematoma the rates were comparable between Lichtenstein (mean 2.55%) and TAPP group (mean 2.48%). The variation in TAPP laparoscopic group rates enhances the need for adopting careful surgical technique, surgical skills, and careful patient selection. TAPP has proven to be a minimally invasive technique in reducing post-operative infection risks in the meta-analysis due to its lower infection rate of 0% as compared to the Lichtenstein group 3.09% to 5.5%.

In the meta-analysis, TAPP repair demonstrated low postoperative pain and reduced complications which aligns with the findings of Touzi²⁵, who also reported faster recovery and reduced pain VAS scores, however, contrary to their findings of

prolonged operative times for laparoscopic repair, the results indicate no significant difference in operative duration which reflects advancements in surgical expertise and standardization of technique. A study by Ghimire also reported lower complications with TAPP (10%) when compared to Lichtenstein (25%), including fewer hematomas and infections²⁶. International Guidelines for Groin Hernia Management emphasized that post-operatively patients should be encouraged to return to their routine activities sooner²⁷. There is no evidence which emphasizes restrictive recommendations post inguinal hernia surgery²⁷. There was even no association between early return to work with higher rates of hernia recurrences²⁷. The average return to routine work in the analysis for TAPP group patients ranged from 8 to 12 days, compared to 15 to 21 days for Lichtenstein patients. Early return is beneficial for patients in reducing the overall impact on their work and daily life. A study by Jamil reported a faster return to work for TAPP patients in 10.47 ± 3.59 days versus Lichtenstein patients took 13.20 ± 4.75 days, hence reinforcing the recovery benefits of TAPP already highlighted in the meta-analysis²⁸.

A systematic review conducted by Usmani reported that TAPP was found superior to open repair in terms of duration of postoperative hospital stay, pain scores on the VAS scale on postoperative days 1 and 7, and complications, whereas Open repair appeared superior only in terms of operative time²⁹. Meta-analysis by Chávez Peón Pérez³⁰ evaluated inguinal hernia repair with TAPP versus Lichtenstein techniques and suggested that the laparoscopic approach resulted in reduced complications related to infection and chronic pain however the meta-analysis provided a more comprehensive comparison by including parameters such as operative time, return to work, and complications like hematoma and seroma rates, hence offered a broader evaluation. A study by Nair³¹ reported fewer infection rates in the TAPP group, thus suggesting that laparoscopic techniques had better infection control due to minimal invasiveness. Similarly, the analysis showed TAPP's procedure infection rates i.e., 0% in most studies vs. 3.09% to 5.5% for Lichtenstein.

A meta-analysis by Lillo-Albert³² also reported that chronic inguinal pain was significantly lessened in laparo-endoscopic repair techniques compared to Lichtenstein repair. Wu³³ observed in his meta-analysis that pain scores were consistently lower for TAPP on postoperative days 1, 7, and beyond and thus underscores the sustained pain reduction advantages of TAPP over Lichtenstein repair.

The results of a study by Shankar Gururaj Kollampare³⁴ also align with the observations of the analysis by demonstrating that TAPP repair was associated

with significantly reduced postoperative pain VAS scores, faster mobilization on POD1 for TAPP vs. POD2/3 for Lichtenstein, and earlier return to work that is POD5 for TAPP vs. POD10–15 for Lichtenstein. The retrospective study by Salibašić³⁵ reported that patients undergoing TAPP had shorter hospital stays and better recovery as compared to those treated with the Lichtenstein technique and these findings aligned with the study's observation that the TAPP Laparoscopic approach was associated with better recovery metrics. In another study by Mehmood³⁶, an important key benefit was observed in TAPP repair which was its ability to detect and repair contralateral hernias during the same procedure, which was not possible with the open repairs and it highlighted the advantage of the laparoscopic technique, particularly in cases of bilateral inguinal hernias or asymptomatic contralateral defects.

Zargar's study also supports the meta-analysis findings on superiority of TAPP over open repair, including reduced complication rates, quicker recovery period, and reduced pain³⁷. However, it also provides insights into bilateral hernia repair and cost considerations which were not deeply viewed in the analysis. Rather³⁸ in his study highlighted superior cosmetic outcomes for TAPP repair due to small port-site scars of 0.5–2 cm as compared to larger scars of 6–8 cm associated with the Lichtenstein technique.

Although the TAPP technique seems fruitful in terms of cost-effectiveness due to lower complication rates and faster recovery, despite the high costs associated with laparoscopic equipment and specialized laparoscopic skills training. The study by Hidalgo³⁹ reported higher operative time and hospital stay expenditure with TAPP however its capability to access both inguinal regions and reduce long-term complications may justify its use in complex cases. But still, in resource-limited settings like in Pakistan where advanced surgical laparoscopic facilities are not freely available, Lichtenstein repair is a simpler and preferred option. Assakran⁴⁰ reported that the overall cost of hernia procedure was significantly affected by the choice of surgical technique applied and the presence of comorbidities, with laparoscopic approaches generally associated with higher initial costs but improved long-term outcomes.

Further studies should be carried out to find out long-term post-operative outcomes, such as hernia recurrence rate and patients' quality of life, in order to evaluate a more comprehensive analysis of these surgical techniques.

CONCLUSION

Our meta-analysis revealed that TAPP repair offers significant advantages over Lichtenstein for having

lower postoperative pain scores, reduced complication rates, and faster return to work and daily activities. However, the TAPP technique is associated with prolonged operative duration and requires advanced surgical expertise and facilities, which may limit its widespread application, particularly in resource-limited settings.

LIST OF ABBREVIATIONS

TAPP: Transabdominal Preperitoneal
RCTs: Randomised Controlled Trials
CI: Confidence Interval
SMD: Standardised Mean Difference
VAS: Visual Analogue Scale
LIHR: Laparoscopic Inguinal Hernia Repair
OIHR: Open Inguinal Hernia Repair
OR: Odds Ratio
TEP: Total Extraperitoneal

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CONFLICT OF INTEREST

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AUTHORS' CONTRIBUTION

MAJ: wrote study design, **MAA:** worked on the drafting of the manuscript, **MM:** conducted data analysis and results write up, **WMC:** worked on data collection & write up of methodology, **AF:** did literature review and drafting, and **MMG:** did proofreading & final approval.

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