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ORIGINAL PAPER

Inguinal hernia repair: A comparison of strengthening the posterior inguinal wall with aponeuroplasty *versus* the Lichtenstein technique (mesh repair). A randomized controlled trial in a low-resource setting

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Summary *Background: Inguinal hernia repair is a frequently performed surgical procedure that generally employs prosthetic mesh. However, alternative techniques, notably the reinforcement of the posterior inguinal wall through aponeuroplasty, have not been sufficiently explored, particularly in resource-constrained environments. This study aims to evaluate and compare the efficacy and outcomes of aponeuroplasty against traditional mesh repair in adult patients with inguinal hernias.*

Methods: A randomized controlled trial was conducted from April 1, 2019, to May 22, 2024, enrolling 200 adult patients diagnosed with inguinal hernias. Participants were randomized into either Group A (Lichtenstein technique with prosthetic mesh repair, n = 96) or Group B (posterior inguinal wall aponeuroplasty, n=104). Patients were monitored for a minimum of two year postoperatively. The aponeuroplasty technique required meticulous dissection of the external oblique and transversus abdominis aponeuroses, ensuring tissue integrity and securing the tissue to the inguinal ligament and muscle arch. Complications, recurrence rates, and other surgical outcomes were systematically analyzed.

Results: Demographic analyses revealed no significant differences between groups. Group B demonstrated significantly shorter operative times (30 ± 9.43 minutes vs. 38 ± 12.55 minutes, p = 0.004) and lower postoperative pain levels (p = 0.031). Over the follow-up period of two years, hydroceles were documented in 9 patients (4.5%), with a notably lower incidence in Group B (1 case, 1.0%) compared to Group A (8 cases, 8.3%, p = 0.030). Recurrence rates were similar in both groups (3 in Group A and 2 in Group B, p = 0.613).

Conclusion: Strengthening the posterior inguinal wall via aponeuroplasty offers superior outcomes compared to prosthetic mesh repair, particularly regarding postoperative pain and operative time. These findings advocate for the consideration of aponeuroplasty as an effective surgical alternative for inguinal hernia repair in low-resource settings. Future studies are warranted to validate these conclusions across diverse and larger populations.

KEY WORDS: *Aponeuroplasty; Hernia; Inguinal; Low-resource settings; Mesh; Prosthetic; Operative time; Pain; Postoperative; Recurrence.*

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INTRODUCTION

Inguinal hernias pose a significant surgical concern, with lifetime prevalence rates of approximately 27% in men and 3% in women. The incidence is particularly high, reaching 1.700 per 100.000 individuals and escalating to 4.000 per 100.000 in those over 45 years of age (1, 2). These hernias can lead to serious complications, such as obstruction and strangulation, contributing to approximately 40.000 fatalities annually (2, 3).

Surgical management of inguinal hernias involves various techniques, including both mesh and non-mesh repairs. While mesh repair is often preferred due to its association with lower recurrence and complication rates, the high costs of mesh can limit accessibility, particularly in resource-constrained settings (2, 4). In specialized centers, experienced surgeons can achieve recurrence rates as low as 2%, whereas less experienced practitioners may report rates as high as 25% (5-8).

Among traditional techniques, the Shouldice method is noted for its recurrence rate of less than 1%, contingent upon the surgeon's expertise, as it reinforces the posterior wall through multi-layered tissue repair (5). The Desarda repair, which employs an undetached strip of the external oblique muscle aponeurosis, shows short-term outcomes comparable to both the Shouldice and Lichtenstein techniques; however, long-term data on its efficacy remain limited (9, 10). Both methods, while effective, demand significant surgical skill.

In contrast, the Lichtenstein technique utilizes mesh for hernia repair and is favored for its ease of application and effectiveness in reducing recurrence rates. Nonetheless, the potential complications associated with mesh have prompted renewed interest in alternative techniques (10, 11). This overview underscores the need for effective management strategies for inguinal hernias, particularly in light of the varying advantages and disadvantages of available surgical approaches. This study aims to identify effective inguinal hernia repair methods that prioritize safety and efficacy while minimizing reliance on imported materials. By utilizing the external oblique and transversus abdominis aponeuroses for posterior wall reconstruction, this prospective randomized clinical trial will compare the established

Lichtenstein technique to our modified Andrews' repair in adult patients in Yemen (5). The anticipated findings may contribute to advancements in surgical practices and improve patient outcomes in inguinal hernia repair.

Materials and methods

Study design

This randomized clinical trial was conducted between March 2020 and April 2023, involving 204 individuals aged 18 years and older diagnosed with inguinal hernia and referred to the surgical facility at *Al-Nasar Hospital in Ibb, Yemen*. Diagnosis was based on the presence of visible inguinal or inguinoscrotal swelling, a detectable cough impulse, inability to reduce the swelling, and dull, aching pain in the inguinal region. Eligible patients were randomly assigned to one of two surgical repair methods: Lichtenstein mesh repair (Group A) or tension-free aponeuroplasty (Group B). Informed consent was obtained from all participants prior to inclusion. Comprehensive evaluations included patient history, physical examinations, complete blood counts, renal function tests, urine culture and sensitivity assessments, and abdominal ultrasound. Older patients underwent additional diagnostic evaluations as part of their pre-anesthetic workup to identify potential complications.

Anesthesia type – general, local, or spinal – was determined by anesthesiologists with patient approval. Operations were performed by a surgeon with a minimum of 10 years of experience in hernia repair. Postoperative follow-up was maintained for two years by a team of two surgeons, and data were collected systematically.

Inclusion criteria: Patients eligible for inclusion were those aged over 18 years diagnosed with inguinal hernia requiring elective surgical repair.

Exclusion criteria: Exclusion criteria included individuals under 18, pregnant women, patients with scrotal hernias, those unable to provide informed consent due to cognitive limitations, and individuals with a history of prostatectomy, Pfannenstiel incision, or previous preperitoneal or abdominal bladder surgeries. Additionally, patients presenting with obstructed, strangulated, or gangrenous hernias, recurrent inguinal hernias, or intraoperatively identified thin, weak, or divided external oblique aponeurosis were excluded.

Sample size calculation: The sample size was calculated utilizing a 95% confidence interval, 90% power, and a 5% acceptable margin of error based on an 11.1% reported recurrence rate from a previous study by *Elsebae et al.* (12). G Power version 3 software was employed to determine that at least 180 participants (90 per group) were required. Including a projected maximum dropout rate of 10%, a total sample size of 200 participants (100 per group) was established.

Randomization and blinding: A total of 204 eligible participants were randomly assigned to two parallel groups: Group A (100 patients) and Group B (104 patients). The clinic's supervisor, who was trained in block randomization techniques, performed the allocation using a computer-generated non-stratified randomization list with a block size of six, ensuring that physicians, patients, data collectors, and statistical analysts remained blinded to group assignments.

Group A: Lichtenstein mesh-based repair technique

In Group A, the Lichtenstein technique involved making an oblique inguinal incision to expose the inguinal canal and hernia sac. The sac was meticulously dissected, reduced, and excised if necessary. A tailored polypropylene mesh was anchored securely to the surrounding tissues using absorbable sutures or tacks (Figure 1). The inguinal canal was subsequently closed in layers to minimize tension and optimize cosmetic outcomes, followed by standard postoperative care to monitor for complications. The steps of the Lichtenstein mesh-based repair technique were consistent with those outlined in previous reports by *Messias et al.* and adhere to established procedural recommendations (13).

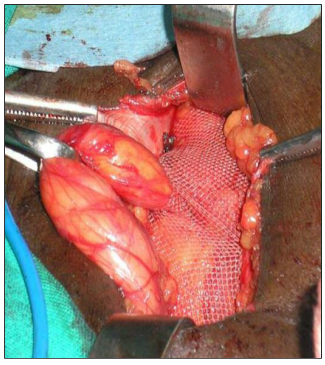


Figure 1.
Intraoperative photo showcasing the mesh and the positioning of the spermatic cord in the Lichtenstein Mesh-Based Repair Technique.

Group B: Authors' operative technique

Access to the hernia sac was achieved via an oblique inguinal incision, allowing for visualization of the external oblique aponeurosis while preserving the thin fascial layer over it. The integrity of the fascia, especially in areas of thinning at the superior portion of the hernia sac, was assessed (Figure 2).

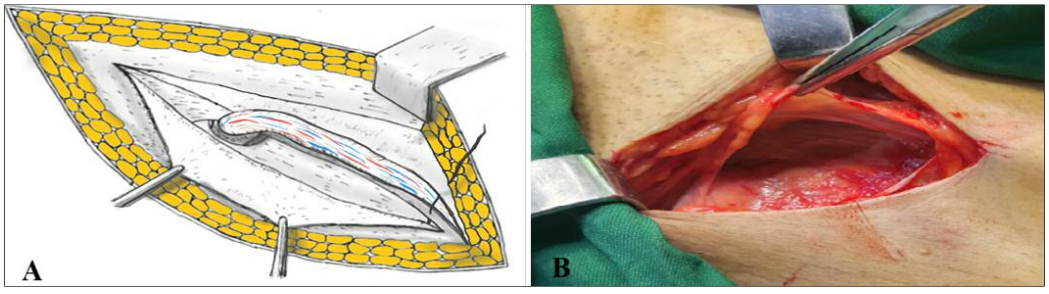


Figure 2.
(A) Schematic representation of the inguinal hernia incision process, highlighting sac identification and peritoneum closure. (B) Intraoperative photograph illustrating the same process.

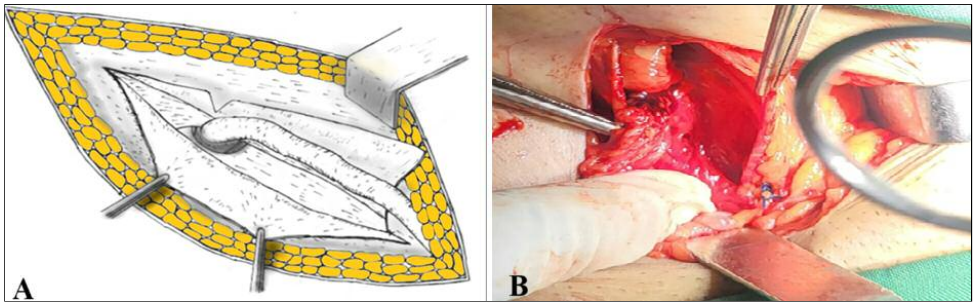
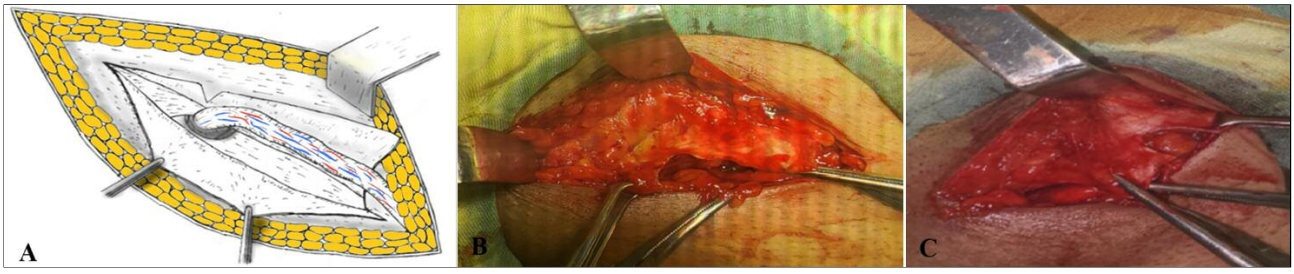


Figure 3.
(A) Diagram showing a suture connecting the lateral rectus sheath to the inguinal ligament, forming a new external ring.
(B) Operative image depicting the executed suture placement.

Meticulous dissection of the external oblique and transversus abdominis aponeuroses was performed, ensuring the preservation of tissue integrity while anchoring the tissue to the inguinal ligament and muscle arch. An incision along the upper crux of the superficial ring was made, preserving the thinned portion in the lower leaflet and obtaining a robust upper strip suitable for repair with interrupted sutures (Figure 3). The medial leaflet of the external oblique aponeurosis was sutured to the inguinal ligament from the pubic tubercle to the abdominal ring using 1/0 Vicryl interrupted sutures. The initial sutures anchored in the anterior rectus sheath at the junction with the external oblique, while the last suture was placed to narrow the abdominal ring without compressing the spermatic cord (Figure 4). Lateral suturing was facilitated by retracting the cord structures with the index finger. A splitting incision was created in the sutured medial leaflet to detach a strip matching the gap between the muscle arch and the inguinal ligament, extending from the pubic symphysis to 1-2 cm beyond the abdominal ring (Figure 5). The upper edge of this strip was then secured to the internal oblique or conjoined muscle using 1/0 Vicryl interrupted sutures, minimizing tension on the suture lines, although this was not paramount for success (Figure 6). This configuration

Figure 4.
(A) Drawing of the dissection of the external oblique aponeurosis along the rectus sheath, reaching a height corresponding to the spermatic cord diameter.
(B and C) Operative photograph demonstrating the dissection in progress.



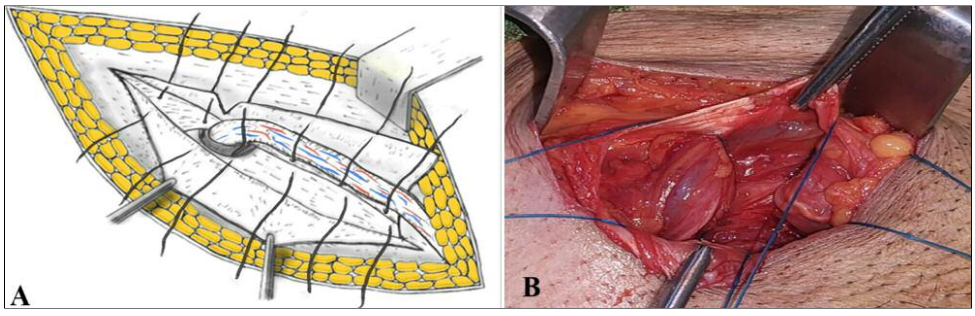


Figure 5.
(A) Illustration of provisional sutures linking the medial external oblique aponeurosis to the transversalis fascia at the lower edge of the internal oblique and transversus abdominis muscles.
(B) Intraoperative photo showing suturing technique.

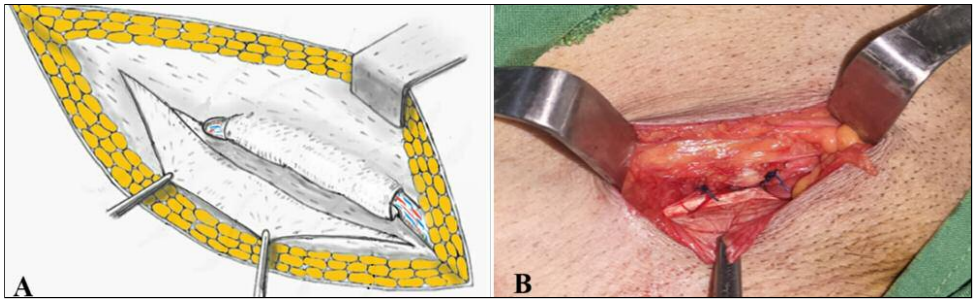
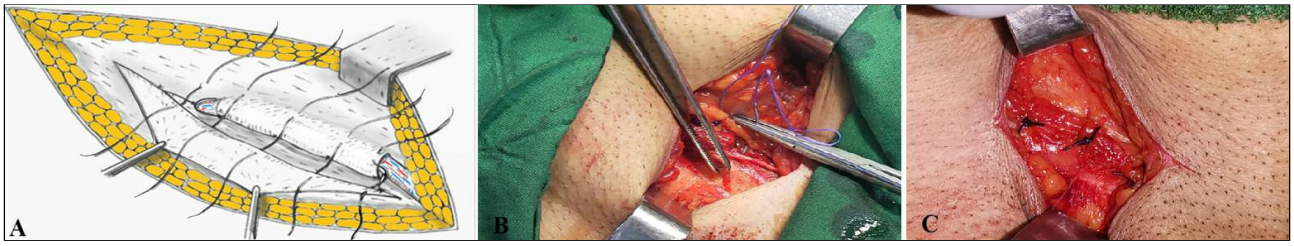


Figure 6.
(A) Schematic depicting the dissection of the external oblique aponeurosis to a height equal to the spermatic cord diameter, aligned with the external inguinal ring.
(B) Operative image illustrating the completed dissection.

Figure 7.
(A) Diagram outlining suture application from the medial side, with layers tied from lateral to medial.
(B and C) Intraoperative photo showcasing the positioning of the spermatic cord beneath the external oblique aponeurosis.



positioned the external oblique strip posterior to the spermatic cord, reconstructing the posterior wall of the inguinal canal. Following the repositioning of the spermatic cord, the lateral leaflet of the external oblique was sutured to the newly formed medial leaflet anterior to the cord, ensuring an adequate closure (Figure 7).
Undermining the surfaces of the medial leaflet enhanced its approximation to the lateral leaflet. The procedure concluded with the standard closure of the superficial fascia and skin.
Postoperative care: Postoperative care for patients involved administering a prophylactic single oral dose of 500 mg ciprofloxacin daily for five days following surgery. For high-risk patients, low molecular weight heparin was administered the night before surgery to prevent deep venous thrombosis, continuing throughout hospitalization. Early mobilization was encouraged approximately six hours post-surgery. Pain management postoperatively included *nonsteroidal anti-inflammatory drugs* (NSAIDs) or pethidine as required. Closed suction drainage, if utilized, was removed on the day of discharge. The postoperative course for each patient was closely monitored, and outpatient follow-up visits were meticulously documented.
Main outcomes: The primary outcomes included operative time, postoperative pain levels, surgical complications, and length of hospital stay. Secondary outcomes evaluated hernia recurrence between the two surgical techniques: *tension-free aponeuroplasty* (TFA, Group B) and *Lichtenstein mesh* repair (LM, Group A).
Gathered data: The collected data included patient and hernia characteristics such as age, gender, laterality of hernia, duration of hernia prior to the operation, smoking status, obesity (BMI > 30 kg/m²), history of anemia, diabetes, benign prostatic hyperplasia, and hernia classification (small, medium, large). Operative and postoperative characteristics included operative time, length of hospital stay, postoperative complications, incidence of postoperative hydrocele, need for pethidine, and recurrence rates. Postoperative complications were categorized into types, including cord edema, wound seroma, hematoma, chronic pain, testicular pain, *urinary tract infection* (UTI), and hypoesthesia.
Statistical analysis: Quantitative data were summarized as means and standard deviations, while qualitative variables were expressed as frequencies and percentages. The normality of the data was assessed using the Smirnov-Kolmogorov test. To compare quantitative variables, either the independent-samples t-test or Mann-Whitney U test was utilized, depending on data distribution. Qualitative variables were analyzed using the chi-square test or Fisher's exact test as appropriate. Regression analysis was performed to evaluate predictive factors related to outcomes in the LM group, with *odds ratios* (OR) and 95% *confidence intervals* (CI) calculated for significant predictors. A p-value of less than 0.05 was considered statistically significant. Statistical analyses were conducted using SPSS version 22 software (*IBM Corp., Armonk, NY, USA*).
Ethical Approval: Approval for the study protocol and all related procedures was granted by the *Institutional Ethics Committee of Ibb University* (*ID number IBBUNI.AC.YEM. 2022.49*), in accordance with the Declaration of Helsinki. The study protocol was established on June 1, 2020, and registered with the *University Hospital Medical Information Network Clinical Trials Registry* (UMIN-CTR) in Japan under number R000057639 (see: *https://center6.umin.ac.jp/cgi-open-bin/ctr_e/ctr_view.cgi? recptno=R000057639*).

Results

Summary of aponeurosis used in the technique

In this tension-free inguinal hernia repair technique, the aponeuroses of the external oblique and transversus abdominis muscles played crucial roles. The external oblique aponeurosis was incised to allow proper placement of the spermatic cord and to prevent obstruction during the formation of the inguinal canal. Similarly, the transversus abdominis aponeurosis was incised to facilitate the reconstruction of the posterior wall of the inguinal canal.
This utilization of aponeurosis enabled the placement of sutures that reinforced the structural integrity of the inguinal canal while minimizing the risk of postoperative complications.

Summary of reinforcement technique used

The reinforcement technique involved a series of sutures connecting the aponeurosis of the external oblique muscle to the inguinal ligament, thereby stabilizing the posterior wall of the inguinal canal. Key components included:
1. *Divergent Suturing*: An initial divergent suture connected the medial segment of the external oblique aponeurosis with the transversalis fascia at the lower edge of the internal oblique and transversus abdominis muscles, allowing for even distribution of tension.
2. *Sequential Suturing*: Sutures were applied from the medial to the lateral side, incorporating the lateral edge of the rectus abdominis sheath as necessary, ensuring effective

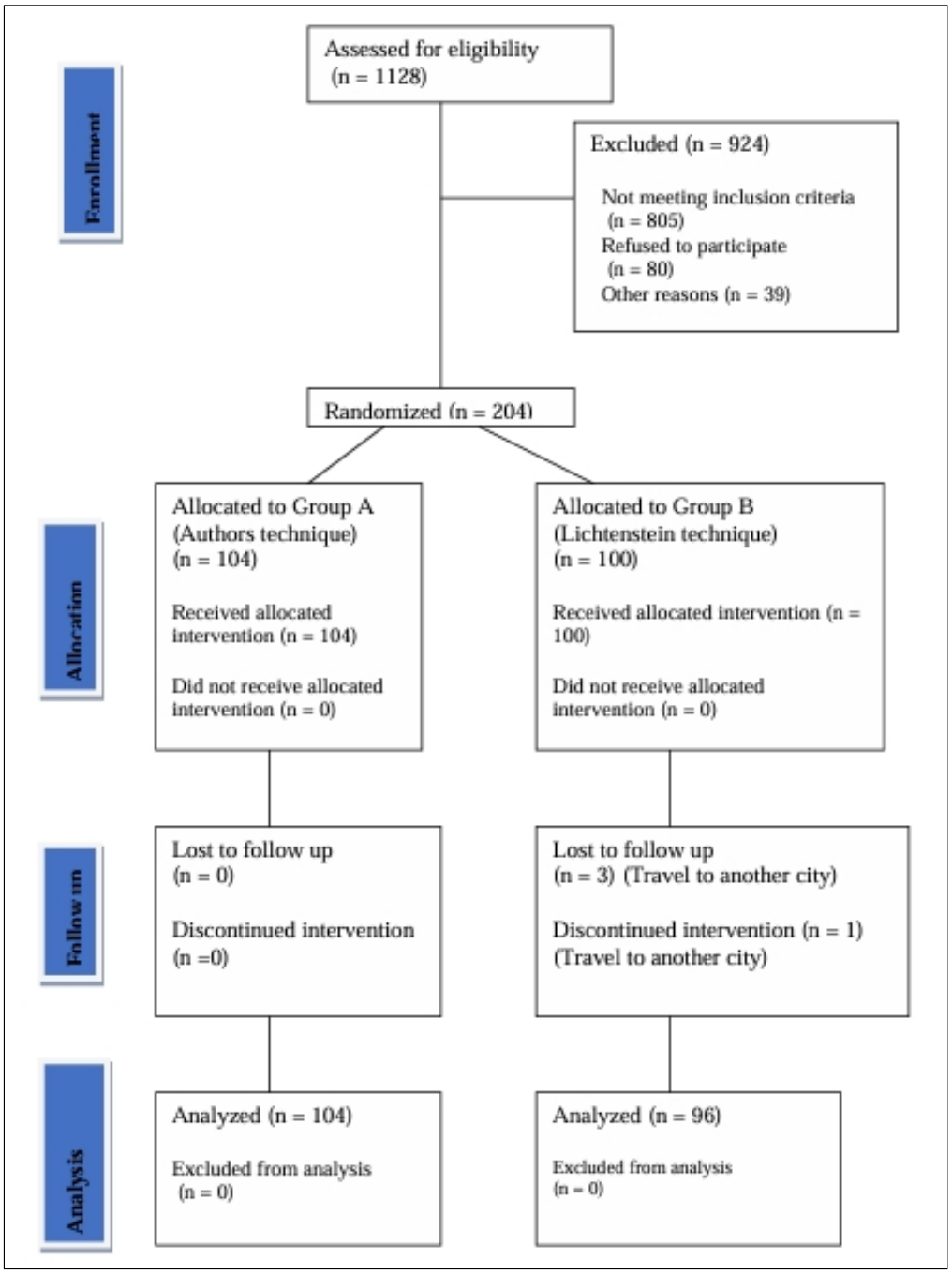


Figure 8.
Flow diagram illustrating the progression through the phases of a randomized trial, including enrollment, intervention allocation, follow-up, and data analysis (i.e., phases of the study).

reinforcement while accommodating the anatomical structures of the spermatic cord.

3. *Formation of the Superficial Inguinal Ring*: Care was taken to maintain the size of the superficial inguinal ring, facilitating the free passage of the spermatic cord and preserving the overall integrity of the canal.

This approach effectively reduced the risk of recurrence and complications by providing robust reinforcement of the inguinal canal through the use of aponeurotic structures.

Study overview

The study flow chart is shown in Figure 8.

A total of 200 patients diagnosed with inguinal hernias were enrolled in the study and randomly assigned to either Group B (tension-free aponeuroplasty, n = 104, 52.0%) or Group A (Lichtenstein mesh repair, n = 96, 48.0%).

The mean age of participants was 42.2 ± 15.1 years (median: 40 years; range: 18-75 years), with a predominance of males (97.0%) across both groups.

The average duration of hernia prior to surgery was 24.6 ± 17.7 months (median: 20 months; range: 5-77 months). Obesity, defined as a *body mass index* (BMI) greater than 30 kg/m², was present in 30 patients (15.0%). Comorbidities were reported as follows: a history of anemia in 22 patients (11.0%), a history of diabetes in 31 patients (15.5%), and a history of benign prostatic hyperplasia in 52 patients (26.0%). Additionally, 60 patients (30.0%) were identified as active smokers.

Characteristic	Subgroup	Total	Group B (n = 104; 52.0%)	Group A (n = 96; 48.0%)	p-value
Age (years)	Mean ± SD	42.2 ± 15.1	41.1 ± 14.4	43.3 ± 15.7	0.315
Gender	Men	194 (97.0)	101 (97.1)	93 (96.9)	1.000
	Female	6 (3.0)	3 (2.9)	3 (3.1)	
Laterality	Left	80 (40.0)	40 (38.5)	40 (41.7)	0.751
	Right	120 (60.0)	64 (61.5)	56 (58.3)	
Duration of Hernia Prior to Operation (months)	Mean ± SD	24.6 ± 17.7	25.7 ± 19.4	23.5 ± 15.7	0.390
Smoking	Yes	60 (30.0)	34 (32.7)	26 (27.1)	0.477
	No	140 (70.0)	70 (67.3)	70 (72.9)	
Obesity (BMI > 30 kg/m²)	Yes	30 (15.0)	13 (12.5)	17 (17.7)	0.405
	No	170 (85.0)	91 (87.5)	79 (82.3)	
History of Anemia	Yes	22 (11.0)	10 (9.6)	12 (12.5)	0.671
	No	178 (89.0)	94 (90.4)	84 (87.5)	
History of Diabetes	Yes	31 (15.5)	18 (17.3)	13 (13.5)	0.589
	No	169 (84.5)	86 (82.7)	83 (86.5)	
History of Benign Prostatic Hyperplasia	Yes	52 (26.0)	23 (22.1)	29 (30.2)	0.201
	No	148 (74.0)	81 (77.9)	67 (69.8)	
Hernia Calcification	Small	28 (14.0)	15 (14.4)	13 (13.5)	0.630
	Medium	81 (40.5)	45 (43.3)	36 (37.5)	
	Large	91 (45.5)	44 (42.3)	47 (49.0)	

BMI: Body mass index; SD: Standard deviation.
A p-value of less than 0.05 was considered statistically significant and is presented in bold within the table.

Table 1.
Comparative analysis of patient and hernia characteristics between groups.

Characteristic	Subgroup	Total	Group B (n = 104; 52.0%)	Group A (n = 96; 48.0%)	p-value
Operative Time (minutes)	Mean ± SD	46.3 ± 11.6	39.6 ± 9.3	53.5 ± 9.2	< 0.001
Length of Hospital Stay (days)	Mean ± SD (Range)	2.7 ± 0.5 (2.0-3.5)	2.7 ± 0.5 (2.0-3.5)	2.7 ± 0.5 (2.0-3.5)	0.281
Complication	Yes	29 (14.5)	13 (12.5)	16 (16.7)	0.428
	No	171 (85.5)	91 (87.5)	80 (83.3)	
Postoperative Hydrocele	No	191 (95.5)	103 (99.0)	88 (91.7)	0.015
	Yes	9 (4.5)	1 (1.0)	8 (8.3)	
Need for Pethidine	Yes	17 (8.5)	12 (11.5)	5 (5.2)	0.132
	No	183 (91.5)	92 (88.5)	91 (94.8)	
Recurrence	No	195 (97.5)	102 (98.0)	913 (96.88)	0.613
	Yes	5 (2.5)	2 (2.0)	3 (3.12)	

SD: Standard deviation.
A p-value of less than 0.05 was considered statistically significant and is presented in bold within the table.

Table 2.
Comparative analysis of operative and postoperative characteristics between groups.

Hernia classification revealed sizes as follows: small in 28 patients (14.0%), medium in 81 patients (40.5%), and large in 91 patients (45.5%). Importantly, no statistically significant differences were observed between the groups in terms of demographic characteristics, comorbidities, or hernia type. A comprehensive summary of the baseline characteristics of patients and hernias, along with intergroup comparisons, is presented in Table 1.

Operative time was significantly shorter in the tension-free aponeuroplasty group (Group B) (mean ± SD: 46.3 ± 11.6 minutes) compared to the Lichtenstein mesh group (Group A) (mean ± SD: 53.5 ± 9.2 minutes; $p < 0.001$). In contrast, the length of hospital stay (mean ± SD: 2.7 ± 0.5 days; range: 2.0-3.5 days) showed no statistically significant difference between the groups ($p = 0.281$) (Table 2).

Postoperative complications occurred in 29 patients (14.5%), with no significant difference in the overall complication rate between the groups ($p = 0.428$) (Table 3). Notably, the incidence of postoperative hydrocele was lower in the tension-free aponeuroplasty group (Group B) (4.5%) compared to the Lichtenstein mesh group (Group A) (8.3%; $p = 0.015$). Fewer patients in Group A required pain medication (8.5% *vs.* 5.2%; $p = 0.132$). Although the recurrence rate was lower in Group B (n = 2, 2.0%) compared to Group A (n = 3, 3.12%), this difference was not statistically significant ($p = 0.613$) (Table 3).

Table 3.
Postoperative complications (n = 29).

Complication Type	N (%)
Cord Edema	6 (3.0%)
Wound Seroma	7 (3.5%)
Hematoma	4 (2.0%)
Chronic Pain	2 (1.0%)
Testicular Pain	5 (2.5%)
Urinary Tract Infection	3 (1.5%)
Bath Hypoesthesia	2 (1.0%)

Some patients reported more than one complication.

Characteristic	Subgroup	Group B (n = 104; 52.0%)	Group A (n = 96; 48.0%)	OR (95% CI)	p-value
Operative Time (minutes)	Mean ± SD	39.6 ± 9.3	53.5 ± 9.2	1.15 (1.11-1.20)	< 0.001
Postoperative Hydrocele	No	103 (53.9%)	88 (46.1%)	Ref	0.093
	Yes	1 (11.1%)	8 (88.9%)	8.15 (1.00-188.68)	

OR: odds ratio, CI: confidence interval, SD: standard deviation.
A p-value of less than 0.05 was considered statistically significant and is presented in bold within the table.

Table 4.
Results of the regression model for statistically significant predictive factors.

Regression analysis revealed two key predictive factors associated with the Lichtenstein mesh group (Group A). Firstly, longer operative time was linked to an increased risk of complications in the Lichtenstein mesh group (Group A), with an odds ratio (OR) of 1.15 (95% confidence interval: 1.11-1.20, $p < 0.001$). Secondly, the occurrence of postoperative hydrocele was predicted with an OR of 8.15 (95% CI: 1.00-188.68, $p = 0.093$) (Table 4).

Discussion

This randomized controlled trial aimed to compare the outcomes of two prominent inguinal hernia repair techniques: aponeuroplasty for posterior wall strengthening versus the Lichtenstein mesh repair, conducted in a low-resource setting. Our findings suggest that aponeuroplasty serves as a viable alternative to prosthetic mesh repair, particularly where surgical materials are limited.

Hernia surgeries are among the oldest surgical procedures, evolving from Bassini's repair and its modifications to the Lichtenstein tension-free repair (14). Despite its widespread adoption, the Shouldice technique remains relevant, particularly in specialized contexts, with reported recurrence rates below 1% at *Shouldice Hospital*, although they may reach 15% in general practice (14). High recurrence rates in non-specialist centers underscore the limitations of tissue-based repairs, prompting many surgeons to adopt prosthetic materials across various techniques, including open surgery and minimally invasive laparoscopic approaches (15, 16). These advancements raise concerns about the long-term implications of mesh use, including infection risks and adverse effects on testicular and sexual function. The search for cost-effective surgical methods with low recurrence and complication rates continues, emphasizing the importance of techniques that general surgeons can perform with minimal technology (14, 17, 18).

Numerous non-mesh hernia repair techniques have emerged, categorized into tension and tension-free methods. Tension methods, such as the Modified Bassini and Shouldice techniques, aim to reinforce the inguinal canal by suturing the external oblique muscle over the spermatic cord (19, 20). In contrast, the tension-free Desarda technique transfers an undetached strip of the external oblique aponeurosis to the inguinal canal's posterior wall. This approach is increasingly favored globally, as it enhances the posterior wall without mesh, offering a reliable option when synthetic materials are unavailable (19). The ideal surgical technique should balance scientific evidence and cost-effectiveness (21). The Lichtenstein technique is considered the gold standard for inguinal hernias, yet its application in emergency settings raises concerns about infection risk associated with foreign body introduction and potential chronic pain incidences (22). In developing contexts, where over 80% of inguinal hernia surgeries utilize tissue repair methods, techniques like Desarda remain essential (19, 23, 24). Recent meta-analyses demonstrate no significant short-term differences in success rates between the Desarda and Lichtenstein techniques for uncomplicated hernias (23).

Our novel aponeuroplasty technique presents distinct advantages over traditional approaches of non-mesh and mesh repairs, including the Lichtenstein repair and laparoscopic methods. While the modified Andrews' repair uses only the external aponeurosis, our method combines both the external oblique and transversus abdominis aponeuroses, providing enhanced support and minimizing tension on vital structures. It is particularly valuable in resource-limited settings, as it requires fewer specialized instruments and shows efficacy even in recurrent hernia cases (25, 26). Furthermore, it has been associated with lower postoperative pain and complications, likely due to reduced tissue manipulation. In contrast, the Lichtenstein repair's dependence on synthetic mesh poses infection and chronic pain risks, while laparoscopic techniques necessitate advanced training and equipment that may not be accessible, potentially extending operative times and increasing anesthesia-related risks (26).

In our study, the operative time for the Lichtenstein mesh repair technique was significantly longer (53.5 ± 9.2 minutes) compared to our approach, which closely resembles the Desarda and modified Andrews' techniques, averaging 39.6 ± 9.3 minutes. This finding is consistent with the literature, including studies by *Manyilirah et al.* and *T. Youssef et al.*, indicating that hernia repairs utilizing techniques similar to Desarda typically require less surgical time (11, 27). The extended duration associated with the Lichtenstein procedure can be attributed to the complexities of mesh implantation. In contrast, our technique, benefiting from prior surgical experience, allows for a more streamlined and efficient process. A systematic review by *Pereira et al.* corroborated these observations, noting that although the Lichtenstein technique exhibited longer operative durations, there were no significant differences in recovery outcomes between the two approaches (10). Furthermore, our investigation into the aponeuroplasty technique demonstrated a significant reduction in operative time, thus enhancing surgical efficiency, particularly in resource-constrained settings. This improved efficiency is crucial in high-volume surgical environments, enabling the effective management of more patients within limited timeframes. To advance the field, future research should focus on long-term outcomes associated with these techniques and examine the influence of surgeon experience on operative efficiency. Additionally, the establishment of standardized training protocols could optimize surgical

methods, reducing operative times while maintaining stringent standards of patient safety and care quality.

We observed lower postoperative analgesia requirements in the aponeuroplasty group, along with a significantly reduced incidence of hydroceles compared to the Lichtenstein technique. These findings indicate potential long-term benefits, as reduced analgesic needs may stem from less tissue trauma and inflammation associated with the avoidance of prosthetic materials (11, 28). The undetached aponeurotic strip integrates physiologically into the posterior inguinal wall, potentially enhancing repair durability and decreasing recurrence risks (29).

After two years, recurrence rates were lower in Group B (2.0%) compared to the Lichtenstein mesh group (3.12%), although difference was not statistically significant (p = 0.613). All recurrences were linked to sliding hernia cases, with no early recurrences noted in either technique. Findings from *Youssef et al.* (11). corroborate our results, indicating comparable recurrence rates for Desarda and Lichtenstein repairs from the existing literature (10). Recurrences were confined to expected sites near the pubic tubercle in the mesh group and the reconstructed deep internal ring in our approach which similar to *Youssef et al.* report (11). Contrary to the findings of *Szopinski et al.* (30), our exclusion criteria, which removed patients with weak or thin aponeuroses, may explain the absence of generalized weakness in the reconstructed posterior wall.

However, our method may need an experienced surgeon with high insight into inguinal canal anatomy. Several modifications to Bassini's technique have been proposed by various surgeons, including those by *Halsted, McVay*, and the *Shouldice Hospital*. These methods hinge on the principles of suturing the internal oblique and transversus abdominis muscles to anatomical structures such as the inguinal ligament, Cooper's ligament, or iliopubic tract. Concerns have surfaced regarding the inherent tension associated with the suture line, which contradicts essential surgical principles, alongside the use of compromised musculature and transversalis fascia that may further undermine structural integrity (31). A comparative study by *Hay et al.* indicated a recurrence rate of 6% for the Shouldice technique, 8.6% for Bassini, and 11% for Cooper's ligament repair, with specialized centers demonstrating significantly lower recurrence rates compared to those reported by general surgeons (18). Therefore, while these historical approaches continue to be prevalent, they frequently fall short of contemporary surgical standards, particularly when conducted by less experienced surgeons, resulting in inadequate reinforcement of the posterior wall and an elevated risk of recurrence.

The demographic characteristics of our study population were similar between groups, reducing confounding variables. However, larger studies with diverse populations and hernia presentations are necessary for greater generalizability.

Study limitations

This study has several limitations. The monocentric design and limited sample size restrict generalizability. Additionally, the two-year follow-up may inadequately assess long-term outcomes, and factors influencing surgical outcomes – such as educational level, occupation, surgeon experience, medications, quality of life, and chronic scrotal pain – were not comprehensively analyzed. Conducted in educational hospitals in Yemen, the findings may not be applicable to other contexts. Despite these limitations, the study offers valuable insights into inguinal hernia repair techniques in resource-constrained environments. Future research should address these gaps through multi-center trials and extended follow-up assessments to validate the safety and efficacy of the aponeuroplasty technique relative to other surgical approaches.

Conclusions

This study demonstrates that aponeuroplasty, a technique that reinforces the posterior inguinal wall, significantly outperforms traditional prosthetic mesh repair regarding operative time and the incidence of postoperative hydrocele development. These findings highlight aponeuroplasty as an efficient and effective option for inguinal hernia repair, particularly in resource-limited settings with restricted access to advanced surgical materials. Given its advantages, aponeuroplasty serves as a viable alternative to conventional mesh-based approaches and may enhance patient outcomes in such contexts. To further validate these findings and investigate the long-term efficacy and safety of aponeuroplasty, additional research is needed. This research will be critical in providing evidence-based guidelines for inguinal hernia repair across diverse clinical environments.

Declarations

Registration of Trial Details: *UMIN ID: TEST000001823.*

Receipt Number: *T000009059.*

Ethical approval: *Approval for the study protocol and all related procedures was granted by the Institutional Ethics Committee of Ibb University (ID number IBBUNI.AC.YEM.2022.49), in accordance with the Declaration of Helsinki. The study protocol was established on June 1, 2020, and registered with the University Hospital Medical Information Network Clinical Trials Registry (UMIN-CTR) in Japan under number R000057639 (see: https://center6.umin.ac.jp/cgi-open-bin/ctr_e/ctr_view.cgi?recptno=R000057639).*

Availability of data and material: *All the data was included in this study.*

Competing interests: *The author declares no potential conflict of interest.*

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Authors' contributions: *All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis, and interpretation, or all these areas; took part in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.*

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