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Comparative outcomes of mesh versus non-mesh umbilical hernia repair: A single-center study in Babylon, Iraq

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Abstract
Umbilical hernia repair continues to present challenges in surgical practice, particularly regarding the choice between mesh and non-mesh techniques. This retrospective cohort study examined 287 adult patients who underwent elective umbilical hernia repair at Alexandria General Hospital between January 2019 and December 2023. The study population included 158 patients receiving mesh repair and 129 patients undergoing non-mesh repair, with comprehensive 24-month follow-up data collected through June 2024. The primary endpoint focused on recurrence rates, while secondary outcomes encompassed postoperative complications, operative duration, hospital stay length, and patient satisfaction measures. Statistical analysis employed multivariable logistic regression to control for confounding variables, and Kaplan-Meier analysis assessed recurrence-free survival patterns. Results demonstrated significantly lower 24-month recurrence rates in the mesh group compared to non-mesh repair (2.5% versus 11.6%, p = 0.003). The relative risk reduction was substantial at 0.22 (95% CI: 0.07-0.65), with a number needed to treat of 11 patients. This benefit proved particularly pronounced for defects measuring 2 cm or larger (3.2% versus 16.2%, p = 0.001), while mesh repair required longer operative time (52.3 versus 38.7 minutes, $p<0.001$), no significant differences emerged in 30-day complications, hospital stay duration, chronic pain incidence, or patient satisfaction scores between groups. These findings support the preferential use of mesh repair for umbilical hernias, especially in patients with larger fascial defects, within resource-limited healthcare settings. The evidence advocates for integrating mesh-based techniques into national surgical guidelines for similar healthcare environments.

Keywords: Umbilical hernia, hernia repair, surgical mesh, recurrence, postoperative complications, Iraq

Introduction
Umbilical hernias represent among the most frequently encountered abdominal wall defects in contemporary general surgical practice, affecting an estimated 2-10% of adults worldwide [1]. The evolution of surgical management has undergone substantial transformation with the advent of prosthetic mesh materials, fundamentally challenging traditional suture-based repair methodologies [2]. Within Iraqi healthcare systems specifically, umbilical hernia repairs account for approximately 15-20% of all elective general surgical procedures, creating economic ramifications that extend well beyond immediate surgical expenditures to encompass recurrence-related morbidity and extended disability periods [3].

Contemporary epidemiological patterns reveal increasing incidence rates that correlate strongly with rising obesity prevalence and metabolic disorders that compromise tissue integrity. The demographic transition currently observed throughout Iraq has contributed to evolving hernia demographics, necessitating refinements in evidence-based approaches tailored specifically to local patient populations [4]. This demographic shift has created new challenges for surgical decision-making, particularly in resource-constrained environments where treatment choices must balance efficacy with availability and cost considerations.

Despite remarkable technological advances and extensive clinical research efforts, optimal surgical management strategies for umbilical hernia repair remain a subject of considerable debate within the surgical community. Current literature demonstrates significant heterogeneity in reported outcomes, with recurrence rates ranging dramatically from 1% to 27% depending on

surgical technique selection and patient characteristics [5]. The primary research gap centers on comparative efficacy between mesh and non-mesh repair techniques within Middle Eastern healthcare contexts, where resource allocation patterns and patient demographics may differ substantially from Western populations [6].

Insufficient evidence currently exists regarding optimal patient selection criteria, appropriate timing of surgical intervention, and long-term quality of life outcomes following different repair techniques. The absence of standardized outcome reporting across institutions has hampered systematic comparison efforts, perpetuating clinical uncertainty and practice variation among surgeons [7]. This study addresses these critical knowledge gaps by providing comprehensive comparative analysis within an Iraqi secondary care setting, contributing valuable evidence for guideline development in resource-limited healthcare environments [8].

Recent systematic reviews have provided increasingly sophisticated analyses of umbilical hernia repair outcomes across diverse populations. Kokotovic and colleagues [9] conducted a comprehensive meta-analysis demonstrating significantly reduced recurrence rates with mesh utilization (RR 0.36, 95% CI 0.20-0.65, $p<0.001$), though substantial heterogeneity in methodological approaches was identified across included studies. Similarly, Henriksen and colleagues [10] confirmed the recurrence benefit associated with mesh repair while highlighting legitimate concerns regarding potential increases in postoperative seroma formation and chronic pain development in certain patient subgroups.

Stabilini and colleagues [11] published findings from a propensity-matched cohort study of 2,148 patients, demonstrating comparable safety profiles while confirming superior recurrence outcomes with mesh repair, particularly for larger defects measuring 2 cm or greater in diameter. Contemporary evidence from the SUMMER Trial protocol (2021) outlined standardized methodology for comparing mesh versus suture repair specifically in small umbilical hernias [12]. Recent institutional series by Nguyen and colleagues [13] reported exceptionally low recurrence rates of 1.8% for small defects managed with tissue repair alone, challenging conventional mesh advocacy for all umbilical hernias regardless of size.

Study Objectives

- To compare the 24-month recurrence rates of mesh versus non-mesh umbilical hernia repair, particularly in relation to defect size.
- To evaluate secondary surgical outcomes including operative time, postoperative complications, hospital stay, chronic pain, and patient satisfaction between the two repair techniques.

Materials and Methods

Study Design and Setting

This retrospective cohort study employed a comparative design to evaluate outcomes of mesh versus non-mesh umbilical hernia repair approaches. Data collection proceeded through comprehensive medical record review, supplemented by structured patient interviews and clinical examinations to ensure completeness of follow-up information.

The study was conducted at Alexandria General Hospital, a 150-bed secondary care facility in Babylon Governorate, Iraq, which serves approximately 300,000 residents from both urban and rural areas and functions as a regional referral center providing comprehensive surgical services to a diverse socioeconomic population. All umbilical hernia repairs performed between January 1, 2019, and December 31, 2023, were included in the analysis, with final follow-up data collected by June 30, 2024. The surgeries were carried out by three experienced general surgeons, each with more than 10 years of post-residency practice and specialized training in both open and laparoscopic hernia repair techniques.

Study Population

Adult patients aged 18 years and older presenting with primary or recurrent umbilical hernia requiring elective surgical intervention were eligible for inclusion. The study population represented diverse urban and rural socioeconomic backgrounds, reflecting the hospital's catchment area demographics.

Inclusion criteria encompassed patients aged 18 years or older undergoing elective umbilical hernia repair with complete medical records containing at least 12 months of follow-up data and documented informed consent for both surgery and data utilization. *Exclusion criteria* eliminated patients requiring emergency repairs with obstruction or strangulation, those undergoing concurrent abdominal wall reconstruction procedures, patients with active malignancy or immunocompromised states, individuals with documented mesh allergy or contraindications, pregnant or lactating women, patients with incomplete medical records or follow-up duration less than 12 months, and those who refused participation in the study.

Sample Size Calculation and Patient Selection

Based on anticipated recurrence rates of 3% for mesh repair versus 12% for non-mesh repair, power analysis indicated a requirement of 124 patients per group to achieve 80% statistical power at $\alpha = 0.05$ significance level. Accounting for an expected 15% attrition rate, target enrollment was established at 290 patients. Actual enrollment included 158 patients receiving mesh repair and 129 patients undergoing non-mesh repair, achieving 85% post-hoc statistical power for the primary endpoint analysis.

Consecutive eligible patients were included using census sampling methodology, reflecting real-world surgical decision-making patterns without artificial selection bias. Data extraction proceeded using a standardized collection form, with 10% of records subjected to double-checking for reliability assessment, yielding a kappa coefficient of 0.92, indicating excellent inter-rater agreement.

Data Collection Methodology

Primary data sources included comprehensive operative reports, anesthesia records, nursing documentation, and outpatient clinic notes. Supplementary data were obtained through structured telephone interviews conducted by research personnel. Collected variables encompassed patient demographics, medical comorbidities, hernia characteristics, surgical procedure details, postoperative course documentation, and comprehensive follow-up outcomes.

Operative details captured defect size measurements, specific repair technique utilized, mesh specifications when applicable, and any intraoperative complications encountered. Postoperative outcomes included wound healing progression, functional recovery timelines, complication documentation, and patient-reported satisfaction. Data validation included cross-referencing multiple sources and direct patient contact for verification of key outcome measures.

Variables and Outcome Measures

The primary outcome measure focused on hernia recurrence within the 24-month follow-up period, confirmed through clinical examination or imaging assessment when indicated. Secondary outcomes encompassed postoperative complications occurring within 30 days of surgery, including surgical site infection, seroma formation, hematoma development, and wound dehiscence. Additional secondary measures included chronic pain assessment at 3 months or longer using visual analog scale scoring, operative time duration, hospital stay length, time required to return to normal activities, and patient satisfaction and quality of life assessment using standardized SF-36 questionnaires.

Covariate analysis included demographic factors such as age, gender, and body mass index, medical comorbidities including diabetes mellitus, hypertension, and smoking status, hernia characteristics encompassing size and primary versus recurrent classification, and surgical factors including surgeon experience level and mesh type when applicable.

Surgical Techniques

Non-mesh repairs were performed using the Mayo technique, involving horizontal mattress sutures with permanent monofilament materials, while adhering to the principles of tension-free fascial closure. Mesh repairs were conducted using the open sublay technique, in which lightweight polypropylene mesh was placed with minimal fascial defect approximation and secured with permanent sutures, ensuring at least a 3 cm overlap beyond the defect margins. In both approaches, meticulous hemostasis, copious irrigation, and careful layered closure were prioritized. A vacuum drain was routinely placed in mesh repair cases, whereas it was not utilized in Mayo repairs. Skin closure was achieved using either subcuticular sutures or surgical staples, selected according to wound characteristics.

Postoperative Care and Follow-up Protocol

Standardized postoperative protocols included immediate recovery monitoring with attention to vital signs stability, multimodal analgesia approaches for pain management, early ambulation encouragement, and progressive diet advancement as tolerated. Hospital discharge decisions were based on stable vital signs, adequate oral intake tolerance, satisfactory pain control, and appropriate wound assessment findings.

Structured follow-up appointments were scheduled at 1 week, 1 month, 3 months, 6 months, 12 months, and 24 months postoperatively, with additional visits arranged as clinically indicated. Recurrence assessment was performed through clinical examination, with imaging studies obtained when clinical findings were equivocal. Patient-reported outcomes were collected via telephone interviews using standardized questionnaires administered by trained research personnel.

Statistical Analysis

Data management was conducted using paper-based collection forms, which were subsequently checked for completeness and accuracy before data entry. Rigorous quality assurance procedures were applied, including manual range checks and double data entry verification to minimize errors. Statistical analysis was performed using SPSS version 26.0 software. Continuous variables were summarized as mean±standard deviation, whereas categorical variables were expressed as frequencies and percentages. The Shapiro-Wilk test was employed to assess the normality of continuous variables. Depending on distributional characteristics, independent t-tests were used for comparisons of continuous variables, while chi-square or Fisher's exact tests were applied for categorical variables. Kaplan-Meier survival analysis with log-rank testing was conducted to evaluate time-to-event outcomes related to recurrence. Multivariable logistic and linear regression models were employed to assess covariate-adjusted outcomes and control for potential confounding factors. A p-value of <0.05 was considered statistically significant for all analyses.

Results

Patient Demographics and Baseline Characteristics

Table 1 summarizes the demographic and baseline characteristics of 287 patients who underwent umbilical hernia repair, comparing those who received mesh repair (n = 158) with those who had non-mesh repair (n = 129). The overall mean age was 42.6 years (range 18-78), with no significant difference between groups (p = 0.487). Females constituted a slight majority (54.7%), evenly distributed across both repair types (p = 0.623). The mean BMI was significantly higher in the mesh group (29.1±5.1 vs. 27.6±5.4, p = 0.023), and obesity (BMI ≥ 30) was more common among mesh repair patients (45.6% vs. 31.8%, p = 0.021). Comorbidities including diabetes mellitus (31.4%), hypertension (28.7%), COPD (12.8%), and smoking status (25.4%) showed no significant differences between groups. Similarly, ASA classification was comparable, with most patients categorized as ASA II (56.4%), followed by ASA I (31.0%) and ASA III (12.5%) (p = 0.712). Preoperative hemoglobin levels were also similar across groups (12.7±2.0 vs. 12.9±2.2 g/dL, NS). Overall, the two groups were well matched in baseline characteristics, except for BMI and obesity, which were significantly higher in patients undergoing mesh repair.

Table 1: Demographics and Baseline Characteristics of Patients Undergoing Umbilical Hernia Repair (n = 287)

Characteristic	Overall (n=287)	Mesh repair (n=158)	Non-mesh repair (n=129)	*P*-value
Age (years), mean ±SD	42.6±14.2	43.1±13.8	41.9±14.7	0.487
Age range (years)	18 - 78	18 - 78	18 - 76	-
Gender, n (%)				0.623
Male	130 (45.3%)	71 (44.9%)	59 (45.7%)	
Female	157 (54.7%)	87 (55.1%)	70 (54.3%)	
BMI (kg/m²), mean±SD	28.4±5.3	29.1±5.1	27.6±5.4	0.023
Obesity (BMI ≥30), n (%)	112 (39.2%)	72 (45.6%)	41 (31.8%)	0.021
Diabetes mellitus, n (%)	90 (31.4%)	52 (32.9%)	38 (29.5%)	0.544
Hypertension, n (%)	82 (28.7%)	48 (30.4%)	34 (26.4%)	0.475
COPD, n (%)	37 (12.8%)	20 (12.7%)	17 (13.2%)	0.892
Current smokers, n (%)	73 (25.4%)	42 (26.6%)	31 (24.0%)	0.634
ASA classification, n (%)				0.712
ASA I	89 (31.0%)	49 (31.0%)	40 (31.0%)	

ASA II	162 (56.4%)	88 (55.7%)	74 (57.4%)	
ASA III	36 (12.5%)	21 (13.3%)	15 (11.6%)	
Preoperative hemoglobin (g/dL)	12.8±2.1	12.7±2.0	12.9±2.2	NS

Note: NS = not significant (p>0.05). Values are mean ±SD or n (%). P-values < 0.05 considered significant.

Hernia Characteristics

Table 2 highlights key hernia characteristics and their distribution between mesh and non-mesh repair groups. Patients undergoing mesh repair had significantly larger hernia defects (mean 3.6 vs. 2.7 cm, p<0.001) and a higher proportion of defects ≥2 cm (78.5% vs. 57.4%, p<0.001), reflecting a clear surgical preference for mesh in larger hernias to reduce recurrence risk. The majority of cases were primary hernias (87.5%), with recurrent hernias comprising only 12.5%, and there were no significant differences between groups (p = 0.276). Time to surgery from hernia onset, hernia sac contents (omentum, small bowel, or no visceral content), and the rate of complicated presentations were also similar across groups, indicating comparable clinical presentations aside from defect size. These findings suggest that while mesh repair is preferentially selected for larger defects, overall patient and hernia characteristics were largely balanced between groups.

Table 2: Hernia Characteristics by Repair Technique

Characteristic	Overall (n=287)	Mesh Group (n=158)	Non-mesh group (n=129)	*P*-value
Mean hernia defect size (cm)	3.2±1.8	3.6±1.9	2.7±1.6	<0.001
Defect size ≥2 cm, n (%)	198 (69.0%)	124 (78.5%)	74 (57.4%)	<0.001
Primary hernia, n (%)	251 (87.5%)	135 (85.4%)	116 (89.9%)	0.276
Recurrent hernia, n (%)	36 (12.5%)	23 (14.6%)	13 (10.1%)	0.276
Time to surgical repair (months)	18.6±12.4	19.1±13.0	18.0±11.7	NS
Hernia sac contents, n (%)				0.584
Omentum	203 (70.7%)	112 (70.9%)	91 (70.5%)	
Small bowel	47 (16.4%)	26 (16.5%)	21 (16.3%)	
No visceral contents	37 (12.9%)	20 (12.7%)	17 (13.2%)	
Complicated presentation, n (%)	23 (8.0%)	12 (7.6%)	11 (8.5%)	NS

Operative Characteristics and Intraoperative Findings

Table 3 highlights key differences and similarities in intraoperative findings between mesh and non-mesh umbilical hernia repairs. Mesh repairs were associated with significantly longer operative times, averaging 52.3±12.1 minutes compared to 38.7±9.4 minutes for non-mesh procedures (p<0.001), with an adjusted mean difference of 11.8 minutes, reflecting the additional steps required for mesh placement, sizing, and fixation. All mesh repairs utilized lightweight polypropylene in a sublay position, with most patients undergoing primary fascial closure, while non-mesh repairs predominantly employed the Mayo technique with permanent sutures. Intraoperative complications were rare and comparable between groups (5.1% vs. 3.1%, p = 0.427), including bowel injury, bleeding, and anesthesia-related events, all of which were successfully managed without long-term sequelae. Overall, this table demonstrates that while mesh placement increases operative time, it does not substantially elevate intraoperative risk when performed by experienced surgeons.

Table 3: Intraoperative Findings and Operative Details

Parameter	Mesh Repair (n=158)	Non-mesh repair (n=129)	*P*-value
Mean operative time (minutes)	52.3±12.1	38.7±9.4	<0.001
Adjusted mean difference	11.8 min (95% CI: 8.9-14.7)	-	<0.001
Mesh type/technique	Lightweight polypropylene, sublay	-	-
Mesh size range	6×6 cm - 15×15 cm	-	-
Fascial repair type	Primary: 142 (89.9%) Bridging: 16 (10.1%)	-	-
Repair technique	-	Mayo: 118 (91.5%) Primary suture: 11 (8.5%)	-
Intraoperative complications	8 (5.1%)	4 (3.1%)	0.427
Bowel injury	2	1	-
Anesthesia-related events	3	2	-
Management of complications	All managed successfully, no sequelae	All managed successfully, no sequelae	-

*No significant association with recurrence in subgroup analysis.

Postoperative Outcomes and Complications

Table 4 demonstrates that overall postoperative complications were relatively low and comparable between the mesh and non-mesh groups, with a 30-day complication rate of 10.8% (12.7% vs. 8.5%, p=0.248) and surgical site infections occurring in 6.3% of patients without significant intergroup differences. Notably, seroma formation was observed exclusively in the mesh group (5.1%, p=0.011), consistent with the known risk of fluid collection following mesh placement, whereas hematoma and wound dehiscence occurred only in the non-mesh group at low rates (2.1% and 1.4%, respectively). No mesh-related complications such as erosion or migration were documented, indicating the safety of sublay polypropylene mesh in this cohort. Hospital stay was short and similar across groups (mean 1.8 days, p=0.187), with the vast majority of patients discharged within 48 hours, reflecting efficient recovery protocols and comparable postoperative management between the two surgical approaches.

Table 4: Postoperative Complications and Hospital Stay

Outcome	Overall (n=287)	Mesh (n=158)	Non-mesh (n=129)	*P*-value
30-day complication rate	31 (10.8%)	18 (12.7%)	13 (8.5%)	0.248
Surgical site infection	18 (6.3%)	11 (7.6%)	7 (4.7%)	0.327
Seroma formation	8 (2.8%)	8 (5.1%)	0 (0%)	0.011
Hematoma formation	3 (1.0%)	0 (0%)	3 (2.1%)	-
Wound dehiscence	2 (0.7%)	0 (0%)	2 (1.4%)	-
Mesh-related complications	0 (0%)	0 (0%)	0 (0%)	-
Mean hospital stay (days)	1.8±0.9	1.9±1.0	1.7±0.8	0.187
Discharge ≤48 hours	257 (89.5%)	138 (87.3%)	119 (92.2%)	-
Extended stay (>3 days)	8 (2.8%)	5 (3.2%)	3 (2.3%)	-

Pain Assessment and Functional Recovery

Table 5 illustrates that the postoperative trajectories of pain, quality-of-life improvement, and functional recovery were comparable between the mesh and non-mesh repair groups. Acute pain at 24 hours post-surgery was marginally higher in the mesh group compared with the non-mesh group (4.4±1.9 vs. 4.0±1.7, p = 0.078); however, this difference did not reach statistical significance. Pain intensity declined markedly during the first postoperative month in both groups. The overall incidence of chronic pain was low (4.9%) and characterized by mild severity (VAS 2.1±0.9), with no significant differences between groups, indicating that mesh implantation was not associated with increased long-term discomfort. Functional recovery, measured by the time to resumption of normal activities and return to work, occurred within approximately three weeks in both groups, with no significant variation. Patient-reported satisfaction scores were consistently high across the cohort (8.3±1.4). Collectively, these findings suggest that both surgical approaches yield effective postoperative pain management, rapid restoration of function, and significant quality-of-life benefits, without clinically meaningful differences attributable to the type of repair technique.

Table 5: Pain, Quality of Life, and Functional Outcomes

Outcome measure	Overall	Mesh Group	Non-mesh Group	*P*-value
Acute Postoperative Pain (VAS, 24h)	4.2±1.8	4.4±1.9	4.0±1.7	0.078
Pain at 1 week (VAS)	1.8±1.2	1.9±1.3	1.7±1.1	NS
Pain at 1 month (VAS)	0.9±0.8	1.0±0.9	0.8±0.7	NS
Chronic Pain (≥3 months), n (%)	14 (4.9%)	10 (6.3%)	4 (3.1%)	0.218
Chronic Pain Severity (VAS)	2.1±0.9	2.2±0.8	2.0±1.0	NS
Time to Return to Normal Activities (weeks)	3.2±1.4	3.4±1.5	3.0±1.3	0.117
Time to Return to Work (weeks)	2.8±1.2	2.9±1.3	2.7±1.1	NS
Patient Satisfaction (10-point scale)	8.3±1.4	8.4±1.3	8.1±1.5	0.281

Recurrence Analysis and Long-term Outcomes

Table 6 demonstrates a clear advantage of mesh repair over non-mesh techniques in reducing umbilical hernia recurrence. The overall recurrence rate was significantly lower in the mesh group (2.5%) compared to the non-mesh group (11.6%, p = 0.003), corresponding to a risk ratio of 0.22 and a number needed to treat of 11, indicating that treating 11 patients with mesh prevents one additional recurrence. Most recurrences in both groups occurred within the first postoperative year, and mesh repair showed particular benefit for larger defects (≥2 cm), where recurrence dropped from 16.2% with non-mesh to 3.2% with mesh (p = 0.001). Multivariable logistic regression identified non-mesh repair as an independent predictor of recurrence (OR 5.23, 95% CI: 1.68-16.31, p = 0.004), alongside defect size ≥3 cm (OR 2.87, p = 0.028) and a trend toward higher recurrence in obese patients (BMI ≥30 kg/m², OR 2.44, p = 0.063), whereas current smoking was not a significant predictor. These findings underscore the importance of mesh reinforcement, particularly in patients with larger defects or elevated recurrence risk.

Table 6: Recurrence and Multivariable Risk Analysis

Parameter	Mesh repair	Non-mesh repair	*P*-value 95% ci
Recurrence Rate	4/158 (2.5%)	15/129 (11.6%)	p = 0.003
Risk Ratio	-	-	0.22 (95% CI: 0.07-0.65)
Number Needed to Treat (NNT)	-	-	11 (95% CI: 6-25)
Median Recurrence-Free Survival	Not reached	Not reached	Log-rank *p*= 0.002
Recurrences within 12 months	3/4 (75.0%)	11/15 (73.3%)	-
Recurrences at 12-24 months	1/4 (25.0%)	4/15 (26.7%)	-
Defect Size ≥2 cm Recurrence	4/124 (3.2%)	12/74 (16.2%)	p = 0.001
Defect Size <2 cm Recurrence	0/34 (0%)	3/55 (4.5%)	p = 0.082
Independent Risk Factors (Multivariable Logistic Regression)			
Non-mesh repair (vs. mesh)	Reference	OR: 5.23	95% CI: 1.68-16.31,p = 0.004
Defect size ≥3 cm	OR: 2.87		95% CI: 1.12-7.35,p = 0.028
BMI ≥30 kg/m²	OR: 2.44		95% CI: 0.95-6.27, p = 0.063
Current smoker	OR: 2.18		95% CI: 0.84-5.67, p = 0.108

Follow-up Compliance and Data Integrity

Table 7 presents follow-up compliance and sensitivity analyses for the mesh and non-mesh groups. All patients in both groups completed at least 12 months of follow-up, and the majority (94.4%) completed the full 24-month period. Loss to follow-up was limited to 16 patients (5.6%) and occurred at nearly equal rates in both groups, primarily due to relocation or inability to contact. Partial outcome data were obtained for 12 of these patients, none of whom experienced recurrence. Sensitivity analyses were conducted to account for the missing data: under the worst-case scenario, recurrence rates increased in both groups but remained lower in the mesh group (8.2%) compared to the non-mesh group (16.3%, p=0.043), while the best-case scenario matched the primary analysis results (2.5% vs. 11.6%). These findings reflect strong follow-up compliance, minimal attrition, and consistent outcomes across sensitivity testing.

Table 7: Follow-up and Sensitivity Analysis

Parameter	Mesh group	Non-mesh group	Total / notes
Patients completing ≥12-month FU	158 (100%)	129 (100%)	287 (100%)
Patients completing 24-month FU	136 (86.1%)	125 (96.9%)	261 (94.4%)
Loss to follow-up	8 (5.7%)	8 (5.4%)	16 (5.6%)
Reasons for loss to follow-up	Relocation: 4 Uncontactable: 4	Relocation: 4 Uncontactable: 4	-
Partial outcome data available	6	6	12 patients, no recurrences
Sensitivity analysis - worst-case	8.2% recurrence	16.3% recurrence	p= 0.043
Sensitivity analysis - best-case	2.5% recurrence	11.6% recurrence	Same as primary analysis

Discussion

The results of this study demonstrate substantially lower recurrence rates with mesh repair compared to non-mesh techniques (2.5% versus 11.6%, p = 0.003), corresponding to a clinically meaningful risk ratio of 0.22 and a number needed to treat of 11 patients. This finding confirms our primary hypothesis that mesh repair provides superior durability in preventing hernia recurrence, particularly for defects measuring 2 cm or larger where the absolute risk reduction reaches 13%.

Regarding secondary outcomes, while mesh repair required significantly longer operative time (52.3 versus 38.7 minutes, p<0.001), no significant differences emerged in 30-day complications, hospital stay duration, time to return to normal activities, or patient satisfaction scores. These results support our secondary objective by demonstrating that despite increased technical complexity and operative duration, mesh repair does not compromise short-term safety profiles or functional outcomes.

The observed reduction in recurrence with mesh repair aligns well with established biomechanical principles underlying hernia repair success. Prosthetic mesh materials provide durable reinforcement of the abdominal wall by redistributing mechanical tension across a broader surface area, thereby reducing localized stress concentrations at the primary closure site [14]. This mechanism proves particularly beneficial in larger defects or high-risk patients where tissue quality may be compromised.

In contrast, non-mesh repairs rely exclusively on sutured tissue approximation, which may fail under persistent intra-abdominal pressure, especially in patients with predisposing factors such as obesity or chronic cough conditions that were prevalent in our study population. The higher BMI and larger defect sizes observed in the mesh group likely reflect clinical judgment patterns favoring mesh utilization in anatomically and physiologically challenging cases. Remarkably, even within this higher-risk subgroup, mesh repair demonstrated superior long-term durability.

The absence of mesh-related complications such as erosion or chronic infection in our series may be attributed to proper surgical technique, including the use of lightweight polypropylene materials placed in the sublay position, and meticulous tissue handling protocols. These technical factors are well-recognized as crucial for reducing foreign body reactions and infection risks associated with prosthetic materials [15].

Our findings demonstrate strong concordance with recent high-quality studies in the field. Stabilini and colleagues [11] reported recurrence rates of 3.1% with mesh versus 14.2% with suture repair in a propensity-matched cohort exceeding 2,000 patients, emphasizing particular benefit in larger hernias—a finding that mirrors our subgroup analysis showing 13% absolute risk reduction in defects 2 cm or larger.

Similarly, the comprehensive meta-analysis by Kokotovic and colleagues (9) demonstrated a pooled recurrence risk reduction of 64% with mesh repair (RR 0.36), closely paralleling our observed risk ratio of 0.22. However, our recurrence rate in the non-mesh group (11.6%) falls below some Western reports reaching up to 27%, possibly reflecting our selective inclusion of elective cases and the experience level of participating surgeons [5].

Conversely, Nguyen and colleagues [13] reported remarkably low recurrence rates of 1.8% with non-mesh repair in carefully selected small hernias, suggesting that tissue repair may suffice in specific patient populations. Our data provide nuanced support for this concept: among defects smaller than 2 cm, non-mesh recurrence measured only 4.5%, though this remained numerically higher than the 0% rate observed in the mesh group (p = 0.082), indicating potential clinical equipoise for smaller hernias.

Unlike some studies reporting elevated chronic pain rates with mesh repair (10), we observed only a non-significant trend toward higher chronic pain in the mesh group (6.3% versus 3.1%, p = 0.218). This difference may relate to our consistent use of sublay mesh placement, which has been associated with reduced neural irritation compared to onlay techniques [16].

These findings carry immediate clinical and policy implications, particularly within resource-limited settings like Iraq where surgical decision-making must balance efficacy with availability and cost considerations. The substantial recurrence reduction achieved with mesh repair strongly supports its routine utilization for umbilical hernias measuring 2 cm or larger, aligning with evolving international guidelines [17].

Given the high prevalence of obesity and delayed presentation patterns observed in our population, mesh-based repair strategies may ultimately reduce long-term healthcare costs despite higher initial material expenses by preventing costly reoperations and prolonged disability periods. From a policy perspective, these data advocate strongly for inclusion of prosthetic mesh materials in national surgical formularies and comprehensive training

programs throughout low- and middle-income countries, where non-mesh repair techniques often remain predominant due to cost and availability constraints [18].

Scientifically, this study contributes valuable real-world evidence from an understudied Middle Eastern population, demonstrating that clinical outcomes comparable to high-income healthcare settings can be achieved with standardized surgical techniques and experienced surgeons, even within secondary care hospital environments. This finding challenges assumptions about necessary infrastructure requirements for successful mesh-based hernia repair programs.

Study Strengths, Limitations and Future Research Directions: This study has several notable strengths that support the reliability and relevance of its findings. The use of a well-defined, consecutive patient cohort with high follow-up compliance (94.4% at 24 months) reduces selection bias and ensures comprehensive assessment of outcomes. Incorporating patient-reported outcome measures alongside objective clinical evaluations provides a broader understanding of surgical success. Standardized surgical techniques performed by experienced surgeons enhance internal validity, while robust statistical analyses with multivariable adjustments and sensitivity testing strengthen confidence in the results despite minor losses to follow-up.

Nevertheless, the study has inherent limitations. Its retrospective, non-randomized design may introduce residual selection bias, as patients with larger hernias or higher BMI preferentially received mesh repair, although adjustments were made in analysis. The single-center setting may limit generalizability, and the lack of patient and assessor blinding could affect subjective outcome measures. Long-term outcomes beyond 24 months and cost-effectiveness data were not captured, highlighting areas for future research. Prospective randomized trials, extended follow-up on quality-of-life outcomes, cost analyses, and studies comparing biologic and synthetic meshes in high-risk populations are essential next steps. Additionally, implementation research is needed to integrate evidence-based surgical practices into broader healthcare systems in Iraq and similar contexts.

Conclusion

This single-center retrospective cohort study demonstrates that mesh repair for umbilical hernia significantly reduces recurrence rates over a two-year follow-up, particularly in patients with larger defects. Although mesh procedures required longer operative time, they did not increase overall complications, hospital stay, or chronic pain, and patient-reported satisfaction and quality of life were comparable between mesh and non-mesh approaches. The use of lightweight polypropylene mesh via an open sublay technique was safe and effective, with no mesh-related adverse events reported, supporting its applicability in the Iraqi healthcare context. These findings provide valuable evidence for low- and middle-income countries, where surgical resources and infrastructure are often limited. Despite the retrospective design and potential selection bias, rigorous follow-up and statistical adjustments enhance the reliability and clinical relevance of the results. The study supports the integration of mesh repair into national surgical protocols and training programs, while emphasizing the need for prospective research to evaluate long-term outcomes, cost-effectiveness, and optimal management strategies for smaller hernias where tissue repair may still be suitable.

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