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Comparison of Operative and Postoperative Outcomes of Onlay, Sublay, and Laparoscopic Mesh Repair for Paraumbilical Hernia

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Abstract

Background: Paraumbilical hernias are common ventral wall defects in adults, with surgical repair required to prevent complications. Mesh repair techniques—including onlay, sublay, and laparoscopic approaches—differ in operative complexity and postoperative outcomes.

Aim: To compare operative and early postoperative outcomes of onlay, sublay, and laparoscopic mesh repair techniques for paraumbilical hernia.

Methods: A retrospective observational study was conducted on 75 adult patients who underwent elective paraumbilical hernia repair at Safeer Al-Imam Al-Hussain Surgical Hospital, Iraq, between May 2022 and February 2025. Patients were categorized into sublay (n=28), onlay (n=22), laparoscopic (n=20), and primary suture repair (n=5) groups. Demographic, clinical, operative, and early postoperative data, including seroma, infection, and drain duration, were collected.

Results: The mean age was 45.8 ± 14.5 years, with 82.7% female. Obesity (BMI ≥30) was present in 25.3%. Sublay repair required the largest mesh (105.3 ± 15.6 cm²) and longest operative time (55.9 ± 12.3 min), while laparoscopic repair had the shortest operative time (35.4 ± 9.1 min) and smallest mesh (74.9 ± 10.6 cm²). Seroma occurred in 17.9% of sublay, 18.2% of onlay, and 5% of laparoscopic repairs (p=0.164). Infection rates were 10.7%, 9.1%, and 5%, respectively (p=0.284). Drain removal was significantly shorter in laparoscopic (3.2 ± 0.9 days) and suture repair (2.8 ± 0.7 days) compared with open repairs (p<0.037). Seroma was significantly associated with BMI ≥30 (p=0.041), defect size ≥5 cm (p=0.029), and operative time ≥90 min (p=0.023). Infection was associated with BMI ≥30 (p=0.011) and operative time ≥90 min (p=0.014).

Conclusion: Laparoscopic repair offers shorter operative time, smaller mesh requirements, and lower seroma rates, making it favorable in selected patients. Sublay repair, while technically more demanding, is suitable for larger defects. Obesity and prolonged operative time are key risk factors for postoperative complications, and careful surgical planning is recommended to optimize outcomes.

Keywords: Paraumbilical hernia, onlay mesh, sublay mesh, laparoscopic repair, postoperative complications, seroma, infection

Introduction

Paraumbilical hernia is a form of ventral abdominal wall defect that occurs adjacent to the umbilicus, usually in the linea alba within 3 cm of the umbilical ring. Unlike true umbilical hernias, which are often congenital, paraumbilical hernias are acquired defects, typically developing in adulthood. [1]

Paraumbilical hernias are more common in middle-aged and elderly individuals and are associated with risk factors such as obesity, multiparity, ascites, chronic cough, and conditions that cause repeated or sustained increases in intra-abdominal pressure. [2]

The reported incidence varies between 6% and 14% of all abdominal wall hernias, with a female predominance due to pregnancy-related weakening of the abdominal wall. [3]

If left untreated, paraumbilical hernias tend to increase in size over time and carry a significant risk of complications, including incarceration and strangulation, which can present as surgical emergencies. Elective surgical repair is therefore recommended for symptomatic patients and for asymptomatic individuals with larger or progressively enlarging defects. [4]

Historically, primary suture repair was the standard operative technique; however, this was associated with unacceptably high recurrence rates, often exceeding 20%. The introduction of synthetic mesh significantly reduced recurrence, with modern recurrence rates reported to be below 5–10%, depending on technique and patient factors. [5]

Mesh repair can be performed using different anatomical placements:

- **Onlay mesh repair** involves positioning the mesh over the anterior rectus sheath after closure of the defect. It is technically straightforward and requires less anatomical dissection, but is associated with a higher risk of superficial wound complications, such as seroma and infection, due to extensive subcutaneous dissection. [6]
- **Sublay (retrorectus) mesh repair** places the mesh beneath the rectus muscles and anterior to the posterior rectus sheath, allowing better mesh integration with well-vascularized tissue and potentially reducing infection and recurrence rates. However, it requires more meticulous dissection and may increase operative time. [7]
- **Laparoscopic intraperitoneal onlay mesh (IPOM) repair** is a minimally invasive approach involving transabdominal placement of the mesh with fixation to the peritoneal surface. It offers smaller incisions, reduced postoperative pain, and faster recovery, but requires specialized equipment, surgical expertise, and carries a small risk of visceral injury and port-site complications. [8]

While numerous studies have compared open and laparoscopic mesh repairs for ventral and incisional hernias, direct comparisons focusing solely on paraumbilical hernia repair are relatively scarce. [9, 10]

Aim of the study

To compare operative and postoperative outcomes of onlay, sublay, and laparoscopic mesh repair techniques for paraumbilical hernia in a single-center series.

Methodology

Study Design

This was a retrospective observational comparative study conducted to evaluate the clinical characteristics, operative techniques, and early postoperative outcomes of patients undergoing paraumbilical hernia repair using onlay, sublay, or laparoscopic mesh placement.

Study Setting and Duration

The study was carried out at Safeer Al-Imam Al-Hussain Surgical Hospital, Karbalaa, Iraq, over a 33-month period from May 2022 to February 2025. All operations were performed by the same experienced surgical team.

Study Population and Sample Size

A total of 92 patients with a confirmed diagnosis of paraumbilical hernia who underwent elective mesh repair during the study period were included. Patients were categorized into three groups according to the operative technique:

- *Group 1:* ***Onlay mesh repair***
- *Group 2:* ***Sublay mesh repair***
- *Group 3:* ***Laparoscopic mesh repair***
- *Group 4:* ***Primary suture repair***

Inclusion Criteria

- Adult patients age ≥ 18 years.
- Clinically and radiologically confirmed paraumbilical hernia.
- Elective repair using onlay, sublay, or laparoscopic mesh techniques.
- Availability of complete perioperative and early follow-up records.

Exclusion Criteria

- Emergency repair for incarcerated or strangulated hernia.
- Concomitant major abdominal surgery or bowel resection during the same operation.
- Incomplete data or loss to follow-up within the first 30 postoperative days.

Data Collection

Data were retrieved retrospectively from patient case files, operative notes, imaging reports, and follow-up charts.

Collected variables included:

- **Demographic data:** Age, sex, weight, height, and body mass index (BMI).
- **Comorbidities:** Hypertension (HT), diabetes mellitus (DM), smoking history (SHx), family history of hernia (FHx).
- **Clinical features:** Presenting complaints (CC), duration of symptoms, and history of previous abdominal surgery.
- **Preoperative imaging:** Ultrasound scan (USS) defect size and sac content; computed tomography (CT) defect size and content for large or complex hernias.
- **Intraoperative details:** Defect size and content, mesh size, operative time, and drain insertion.
- **Postoperative outcomes:** Seroma formation, wound infection, wound sepsis, port-site infection (laparoscopic group) and timing of drain removal.

Surgical Technique

All operations were performed under general anesthesia, following a standardized set of operative principles to ensure consistency and optimize outcomes. The type of surgical repair was selected based on hernia characteristics, patient factors, and intraoperative findings and included:

- **Onlay mesh repair** involved placement of the mesh over the anterior rectus sheath after closure of the defect, with subcutaneous dissection to allow sufficient overlap.
- **Sublay mesh repair** was performed by creating a retrorectus space, closing the defect, and placing the mesh in the sublay position with fixation as described above.
- **Laparoscopic mesh repair (IPOM)** was performed using pneumoperitoneum, adhesiolysis, intraperitoneal placement of the mesh with at least 5 cm overlap, and fixation using tacks or transfascial sutures. Port-site closure was done for all ≥10 mm trocar sites.
- **Primary suture repair:** Defect closed using non-absorbable or slowly absorbable sutures in a tension-free manner without mesh placement.

Key steps included achieving adequate exposure of the operative field, complete mobilization and excision of the hernia sac, removal of any previously placed mesh when present (complete meshectomy), meticulous release of bowel and omental adhesions, and preservation of the defect edge borders.

In open repairs, a well-defined submuscular plane was created to facilitate optimal mesh placement. The peritoneum, or the combination of peritoneum and posterior rectus sheath, was closed without tension. In cases of peritoneal loss, omentoplasty was performed to provide protective coverage and prevent direct contact between the bowel and mesh. Mesh size was selected to allow adequate overlap beyond the defect margins, and fixation to the anterior rectus sheath was achieved using separate, regularly spaced non-absorbable sutures. The anterior rectus sheath was closed in a tension-free manner; in cases where a window was created, any residual gap was securely sutured.

Skin and subcutaneous tissue closure was undertaken only when tissue viability was confirmed and without tension. Any non-viable skin or skin lacking subcutaneous fat was excised. Negative suction drains of appropriate size were placed when indicated. Postoperatively, all patients received Sefratul dressing and were provided with a properly fitted abdominal support belt to aid recovery.

All patients were given preoperative antibiotic prophylaxis with intravenous ceftriaxone (1 g or 2 g) according to body weight and clinical judgment.

2.6 Statistical Analysis

Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics version 27. Continuous variables such as age, BMI, defect size, mesh size, and operative time were expressed as mean ± standard deviation (SD), while categorical variables such as sex, comorbidities, surgical technique, and postoperative complications were presented as frequencies and percentages.

The Chi-square test or Fisher's exact test was used to compare categorical variables between the three surgical groups, and one-way ANOVA or the Kruskal–Wallis test was applied for continuous variables. Statistical significance was considered at $p < 0.05$.

2.7. Ethical approval

1. Patients' consents were obtained prior to surgery and data collection.
2. Data and information of the participants were kept confidential.
3. Administrative approvals were granted from Safeer Al-Imam Al-Hussain Surgical Hospital.

Results

The study included 75 patients undergoing paraumbilical hernia repair, their mean age was 45.8 ± 14.5 years. Nearly half of the patients (46.7%) were 25–44 years, 37.3% were 45–64 years, 12.0% were younger than 25, and 4.0% were ≥65 years.

The majority of patients were female (82.7%), while males constituted 17.3% of the sample.

Hypertension was present in 16.0% and diabetes mellitus in 12.0% of patients. Most patients had no family history of hernia (90.7%), while 9.3% reported a positive family history.

Body mass index (BMI) mean was 28.2 ± 7.8 kg/m², 1.3% were underweight, 33.3% were normal weight, 40.1% overweight, and 25.3% were obese. As shown in table 1.

Table 1. Demographic and clinical characteristics (n=75)

Variable	Frequency	Percent
Age (years)		
<25	9	12.0
25–44	35	46.7
45–64	28	37.3
≥65	3	4.0
Mean ± SD	45.8 ± 14.5	
Sex		
Male	13	17.3
Female	62	82.7
past medical history		
Hypertension	12	16.0
Diabetes mellitus	9	12.0
Family history of hernia		
Negative	68	90.7
positive	7	9.3
BMI (kg/m²)		
<18.5 (Underweight)	1	1.3

18.5–24.9 (Normal)	25	33.3
25–29.9 (Overweight)	30	40.1
≥30 (Obese)	19	25.3
Mean ± SD	28.2 ± 7.8	

Most patients were presented with painless hernia swelling (72.0%), and only 28.0% reported pain.

In clinical examination estimated defect size was <2 cm in 10.7%, 2–4 cm in 46.7%, and >4 cm in 42.7%. Ultrasound (USS) measurements of hernia defects showed <2 cm in 13.3%, 2–4 cm in 50.7%, and >4 cm in 36.0% of patients. Hernia sac contents on USS included omentum in 56.0%, bowel with omentum in 33.3%, and extraperitoneal fat in 10.7%.

Computed tomography scan (CTS) defect measurements were similar, with <2 cm in 12.0%, 2–4 cm in 48.0%, and >4 cm in 40.0%.

Operative findings revealed defect size <2 cm in 9.3%, 2–4 cm in 45.3%, and >4 cm in 45.3%, with contents being omentum in 53.3%, bowel with omentum in 36.0%, and extraperitoneal fat in 10.7%. as shown in table 2

Table 2. Clinical and hernia characteristics.

Variable	Frequency	Percent
Symptom type		
Painful	21	28.0
Painless	54	72.0
Clinical defect size (cm)		
<2	8	10.7
2–4	35	46.7
>4	32	42.7
USS defect size (cm)		
<2	10	13.3
2–4	38	50.7
>4	27	36.0
USS content		
Omentum	42	56.0
Bowel + omentum	25	33.3
Extraperitoneal fat	8	10.7
CTS defect size (cm)		
<2	9	12.0
2–4	36	48.0
>4	30	40.0
Operative defect size (cm)		
<2	7	9.3

2–4	34	45.3
>4	34	45.3
Operative content		
Omentum	40	53.3
Bowel + omentum	27	36.0
Extraperitoneal fat	8	10.7

Among the 75 patients, 37.3% underwent sublay mesh repair, 29.3% onlay mesh repair, 26.7% laparoscopic repair, and 6.7% primary suture repair. As shown in table 3.

All patients received post operative antibiotic prophylaxis with I.V. ceftriaxone and all the surgical wounds were covered with Fucidin embedded pads (Sefratul).

Table 3. Operative and postoperative details

Variable	Frequency	Percent
Type of repair		
Sublay	28	37.3
Onlay	22	29.3
Laparoscopic	20	26.7
Suture repair	5	6.7

When comparing the different techniques, sublay repair required the largest mesh (105.3 ± 15.6 cm^2), followed by onlay (91.6 ± 12.6 cm^2) and laparoscopic repairs (74.9 ± 10.6 cm^2). Primary suture repairs did not require mesh. Operation time differed significantly among techniques ($p < 0.001$), with sublay averaging 55.9 ± 12.3 min, onlay 51.7 ± 11.2 min, laparoscopic 35.4 ± 9.1 min, and suture repair 25.9 ± 6.2 min.

Postoperative seroma occurred in 17.9% of sublay, 18.2% of onlay, and 5.0% of laparoscopic repairs, with none in the suture group ($p = 0.164$). Postoperative infection rates were 10.7% for sublay, 9.1% for onlay, and 5.0% for laparoscopic repair, with no infections in the suture group ($p = 0.284$). Mean duration of drain removal was shortest in suture repair (2.8 ± 0.7 days) and laparoscopic repair (3.2 ± 0.9 days), compared with sublay (5.8 ± 1.5 days) and onlay (6.0 ± 1.8 days) with statistically significance P value ($p < 0.037$). Needle aspiration for seroma was required in 14.3% of sublay, 13.6% of onlay, 10.0% of laparoscopic repairs, and none in the suture repair group ($p = 0.173$). as shown in table 4

Table 4. Comparison of surgical techniques for primary umbilical hernia repair in terms of mesh size, operative time, and postoperative outcomes

Parameter	Sublay (n=28)	Onlay (n=22)	Laparoscopic (n=20)	Suture repair (n=5)	p-value*
Mesh size (cm^2) Mean ± SD	**105.3 ± 15.6**	**91.6 ± 12.6**	**74.9 ± 10.6**	**—**	**0.021**

Operation time (min) Mean ± SD	55.9 ± 12.3	51.7 ± 11.2	35.4 ± 9.1	25.9 ± 6.2	<0.001
Postoperative seroma n (%)	5 (17.9)	4 (18.2)	1 (5.0)	0 (0.0)	0.164
Postoperative infection n (%)	3 (10.7)	2 (9.1)	1 (5.0)	0 (0.0)	0.284
Drain removal (days) Mean ± SD	5.8 ± 1.5	6.0 ± 1.8	3.2 ± 0.9	2.8 ± 0.7	<0.037
Seroma needle aspiration n (%)	4 (14.3)	3 (13.6)	2 (10.0)	0 (0.0)	0.173

Postoperative complications were analysed in relation to patient and surgical factors (Table 5). Among the 12 patients who developed seroma, 75% had a BMI ≥30, which was significantly associated with seroma formation (p = 0.041). Larger hernia defects (≥5 cm) were present in 66.7% of seroma cases, also showing a significant association (p = 0.029). Prolonged operative time (≥90 minutes) was strongly correlated with seroma, affecting 83.3% of these patients (p = 0.023).

The type of repair also effected seroma rates, with onlay repairs accounting for 50% of seroma cases, but this did not reach statistical significance (p = 0.062). Diabetes mellitus was present in 33.3% of patients with seroma, without a significant association (p = 0.181).

Regarding postoperative infections, 66.7% occurred in patients with BMI ≥30, demonstrating a significant correlation (p = 0.011). Extended operative time (≥90 minutes) was also significantly associated with infection, present in 83.3% of cases (p = 0.014).

Defect size ≥5 cm and onlay repair type were observed in 50% of infection cases, but these associations were not statistically significant (p = 0.392 and 0.127, respectively). Diabetes mellitus was noted in 50% of patients with infection, but not statistically significance (p = 0.063).

Table 5. Association of patient and surgical factors with postoperative seroma and infection

Variable	Seroma (n=12)	p-value	Infection (n=6)	p-value
BMI ≥30	9 (75.0%)	0.041	4 (66.7%)	0.011
Defect size ≥5 cm	8 (66.7%)	0.029	3 (50.0%)	0.392
Operative time ≥90 min	10 (83.3%)	0.023	5 (83.3%)	0.014
Repair type: Onlay	6 (50.0%)	0.062	3 (50.0%)	0.127
Diabetes mellitus	4 (33.3%)	0.181	3 (50.0%)	0.063

Discussion

This study compared operative and early postoperative outcomes among onlay, sublay, laparoscopic mesh repairs, and primary suture repair for paraumbilical hernias in a single-center. The study was predominantly female (82.7%), reflecting the known female predominance of paraumbilical hernias, often attributed to pregnancy-related weakening of the abdominal wall and hormonal influences on connective tissue. [11]

The mean age was (45.8 years) aligns with a study by

Burcharth et al. indicating that most cases present in middle-aged adults. [12]

Obesity was common (25.3% with BMI ≥30), consistent with the strong association between elevated BMI and ventral hernia development due to chronic intra-abdominal pressure. **Owei et al.** concluded that A higher body mass index (BMI) is not only a risk factor for umbilical hernia but also associated with an elevated risk of surgical, medical, and respiratory complications following open ventral hernia repair. Individuals with a BMI over 40 kg/m² face more than double the risk of complications, with the likelihood rising as BMI category increases. [13]

Sublay mesh repair required the largest mesh size and the longest operative time. This is in agreement with findings by **Shah et al.** who noted that the retrorectus approach involves more extensive dissection and meticulous closure, increasing surgical duration but potentially reducing recurrence rates due to optimal mesh positioning within well-vascularized tissue planes. They concluded that the onlay repair showed a shorter operative time, whereas sublay repair was linked to lower rates of surgical site infections, chronic pain, and hernia recurrence compared to onlay repair. Overall, sublay mesh repair demonstrated better outcomes for ventral hernia management, although no single technique could be deemed definitively superior. [14]

In our study, sublay repairs had moderate rates of seroma (17.9%) and infection (10.7%), similar to the complication rates reported by **Venclauskas et al.** for umbilical hernia repairs.[15]

Laparoscopic repair demonstrated the shortest operative time (35.4 min) and smallest mesh size requirement. These findings are consistent with **Hajibandeh et al.** who reported reduced operative times, smaller incisions, and faster recovery in laparoscopic ventral hernia repairs.[16]

The lower seroma rate (5%) in our laparoscopic group also agrees with **Korukonda et al.**, suggesting that minimal tissue dissection limits postoperative fluid accumulation. [17]

Postoperative seroma was significantly associated with obesity (p = 0.041), larger defect size (p = 0.029), and prolonged operative time (p = 0.023). Similar associations have been documented by **Hillejan et al.**, who highlighted that high BMI increases dead space and impairs lymphatic drainage. [18]

Beckers et al. also concluded that compared with sublay ventral hernia repair, the onlay approach carries a notably higher risk of seroma formation. In contrast, no significant differences were found between laparoscopic and open ventral hernia repair procedures. [19]

Postoperative infection was significantly related to obesity (p = 0.011) and prolonged operative time (p = 0.014), consistent with **Kaoutzanis et al.** who emphasized obesity as a strong predictor of surgical site infection in hernia repair. [20]

Arita et al. also found that laparoscopic repair reduces the incidence of surgical site infections across all types of ventral hernias compared to open mesh repair, without affecting recurrence rates. [21]

The current study findings support tailoring the choice of repair technique to patient-specific factors. Laparoscopic repair may be favored for patients with smaller to moderate defects and higher infection risk, given its shorter operative time and lower superficial complication rates. Sublay repair remains a robust option for larger defects where long-term recurrence prevention is prioritized, despite its longer operative time. Onlay repair may be reserved for cases where sublay dissection is not feasible, with careful attention to seroma prevention strategies such as drain placement and meticulous hemostasis.

Conclusion

In elective paraumbilical hernia repair, surgical technique influences operative duration, mesh requirements, and early complication profiles. Laparoscopic repair offers advantages in terms of shorter surgery and reduced seroma risk, while sublay repair provides strong reinforcement for larger defects at the cost of longer operative time. Obesity and prolonged operative time are key modifiable factors linked to postoperative complications, and optimizing these may improve patient outcomes.

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