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SHORT TERM OUTCOMES OF ONLAY VS INLAY MESH REPAIR OF PARAUMBILICAL HERNIA

Original Research

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ABSTRACT

Background: Paraumbilical hernia is a common anterior abdominal wall defect often requiring surgical intervention. Mesh reinforcement techniques, including onlay and inlay methods, are widely used in open repairs. However, there remains a lack of consensus on the superior technique for minimizing short-term postoperative complications.

Objective: To compare the short-term outcomes of onlay versus inlay mesh repair in patients undergoing open paraumbilical hernia surgery.

Methods: This randomized controlled trial was conducted at the Department of Surgery, Khyber Teaching Hospital, Peshawar, over six months. A total of 282 adult patients without comorbidities and with BMI ≤ 31 kg/m² were enrolled using consecutive sampling and randomized into two equal groups. Group A underwent onlay mesh repair, and Group B received inlay mesh repair. Short-term outcomes pain score using Visual Analogue Scale (VAS), wound infection, and seroma formation were evaluated on the 7th postoperative day. Statistical analysis was performed using SPSS v25 with $p \leq 0.05$ considered significant.

Results: The mean postoperative VAS pain score was significantly lower in the onlay group (1.12 ± 0.76) compared to the inlay group (2.96 ± 1.49). Wound infection occurred in 3.5% of patients in Group A versus 12.8% in Group B. Seroma formation was noted in 1.4% of Group A and 8.5% of Group B. All differences were statistically significant.

Conclusion: Onlay mesh repair resulted in significantly better short-term outcomes than inlay repair in terms of postoperative pain, wound infection, and seroma formation, making it a preferable technique for open paraumbilical hernia repair.

Keywords: Hernia, Mesh Repair, Onlay Technique, Inlay Technique, Paraumbilical Hernia, Postoperative Pain, Seroma, Surgical Wound Infection.

INTRODUCTION

Hernias are defined as the protrusion of intra-abdominal contents through a defect in the abdominal wall, and their prevalence has made them a common concern in surgical practice worldwide. The term 'hernia' is derived from the Greek word 'heron,' meaning bulge or protrusion, highlighting its core pathological feature (1). Ventral abdominal hernias, which occur along the midline of the abdominal wall, constitute a significant subset of these cases (2). Among these, paraumbilical hernias arise near the umbilicus due to a weakness in the linea alba and are frequently encountered in clinical settings. These hernias share characteristics with other midline defects such as epigastric, umbilical, and incisional hernias the latter most often resulting from prior surgical incisions (3). The development of a hernia is closely linked to elevated intra-abdominal pressure, which may be induced by various conditions including pregnancy, obesity, ascites, or abdominal tumors, all of which lead to chronic distension (4). Notably, the incidence of paraumbilical hernias is higher in females (65%) compared to males (35%), likely due to physiological and anatomical differences (5). While the clinical presentation typically involves abdominal discomfort, particularly during physical exertion, the diagnosis is largely based on history-taking and physical examination, and is further supported by imaging modalities such as ultrasonography, CT scans, and MRI (6). Surgical repair remains the only definitive treatment, with hernia operations ranking among the most frequently performed procedures globally. In the United States alone, over 250,000 ventral hernia repairs are performed annually (7). In Pakistan, it is estimated that ventral hernias account for 15–20% of hernia cases, with umbilical and paraumbilical hernias being the most prevalent (8). Surgical strategies have evolved substantially with the introduction of prosthetic meshes, which have significantly reduced recurrence rates to below 10% (9).

However, despite these advancements, the optimal technique for mesh placement during hernia repair continues to be debated among surgeons (10). Two widely practiced open surgical methods for mesh placement in hernia repair are the onlay and inlay techniques. In the onlay approach, the defect is first closed and then reinforced with a synthetic mesh placed over the anterior abdominal wall. Conversely, the inlay technique involves placing the mesh directly into the defect and anchoring it to the margins, effectively bridging the gap (11). Comparative data suggest that the onlay technique may offer superior short-term outcomes. For instance, one study reported lower post-operative pain scores (1.09±0.76 vs. 2.85±1.56), reduced wound infection rates (3.34% vs. 12.6%), and a lower incidence of seroma formation (1.3% vs. 8.5%) in the onlay group compared to the inlay group (12). Despite the widespread application of these techniques, there remains a lack of robust, localized evidence regarding their relative effectiveness in the management of paraumbilical hernias, particularly within resource-constrained healthcare systems. Understanding the short-term outcomes of these approaches is critical for optimizing patient care and minimizing post-operative complications. Therefore, this study aims to compare the short-term outcomes specifically pain intensity, wound infection, and seroma formation of onlay versus inlay mesh repair in open paraumbilical hernia surgery, with the objective of identifying the superior surgical technique in terms of immediate post-operative recovery.

METHODS

A randomized controlled trial was conducted at the Department of Surgery, Khyber Teaching Hospital, Peshawar, following approval from the hospital's Institutional Review Board (IRB). The duration of the study spanned six months from the date of synopsis approval. Patients were enrolled using a non-probability consecutive sampling technique. The sample size was calculated using the WHO sample size calculator based on an anticipated proportion of seroma formation of 1.3% in the onlay group and 8.5% in the inlay group, with a power of 80% and a 95% confidence level. A total of 282 patients were included, divided equally into two groups of 141 each. Participants included adult patients aged 18 years and above of both genders, who had no known comorbidities such as hypertension or diabetes. Patients with a BMI greater than 31 kg/m² and those who did not provide informed consent were excluded. Eligible patients were recruited from the surgical indoor unit. After obtaining written informed consent and explaining the study's purpose, risks, and benefits, baseline demographic and clinical data were recorded, including age, gender, BMI, duration of hernia-related complaints, residential status, education level, occupation, and socioeconomic background. Randomization was carried out using a blocked randomization method to ensure equal distribution between the two intervention groups. Group A underwent onlay mesh repair, whereas group B received inlay mesh repair. All surgeries were performed under general anesthesia by a single surgical team led by a consultant general surgeon with a minimum of five years of experience, with the researcher assisting in all procedures. Postoperative management,

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including antibiotic coverage, fluid therapy, daily dressing, and analgesia, followed a standardized hospital protocol to minimize variability in care.

All patients were observed in the recovery unit postoperatively before being shifted to the surgical ward upon stabilization. Patients were discharged with instructions for home medications and scheduled for a follow-up visit one week after surgery in the outpatient department. During follow-up, pain at the surgical site was evaluated using the Visual Analogue Scale (VAS), a validated 0–10 scale, and physical examination was performed to detect wound infection or seroma formation, defined per the operational criteria (13,14). All outcome data were recorded by the primary researcher using a structured and predesigned proforma. Statistical analysis was performed using IBM SPSS version 25. The normality of continuous data was tested using the Shapiro-Wilk test. Depending on data distribution, continuous variables such as age, BMI, duration of symptoms, and VAS scores were expressed as means with standard deviations or medians with interquartile ranges. Categorical variables like gender, profession, residence, wound infection, and seroma incidence were summarized using frequencies and percentages. The primary comparison of mean VAS scores between the two groups was performed using the independent samples t-test or Mann–Whitney U test, as appropriate. Wound infection and seroma were analyzed using chi-square or Fisher's exact tests at a 5% level of significance. Stratification was carried out for age, gender, BMI, and duration of symptoms to control for potential confounders, followed by post-stratification application of the same statistical tests, with $p \leq 0.05$ considered statistically significant.

RESULTS

The study enrolled 282 participants, with 141 patients each assigned to Group A (Onlay) and Group B (Inlay). The mean age of participants in Group A was 45.3 ± 11.2 years, while Group B had a mean age of 46.1 ± 10.8 years. Gender distribution in Group A included 54 males and 87 females, compared to 50 males and 91 females in Group B. Mean BMI was 26.8 ± 2.7 kg/m² for the Onlay group and 27.1 ± 2.5 kg/m² for the Inlay group. Socioeconomic status distribution in Group A was 32 patients in the lower class, 92 in middle, and 17 in upper, while Group B had 29, 94, and 18 in the respective categories. Regarding occupation status, 79 patients were employed in Group A versus 76 in Group B, with the remainder unemployed. Urban residents comprised the majority in both groups, with 83 in Group A and 80 in Group B. Short-term outcome data revealed that mean postoperative VAS pain scores were significantly lower in the Onlay group (1.12 ± 0.76) than in the Inlay group (2.96 ± 1.49). Wound infections were observed in 5 patients (3.5%) in Group A and in 18 patients (12.8%) in Group B. Seroma formation was detected in 2 patients (1.4%) in the Onlay group and in 12 patients (8.5%) in the Inlay group. These results suggest that Group A demonstrated overall better short-term postoperative outcomes in terms of pain, infection, and seroma rates compared to Group B. The attached charts visually compare VAS pain scores and wound infection rates between the two groups.

Table 1: Demographics of Study Participants

Variable	Group A (Onlay)	Group B (Inlay)
Mean Age (years)	45.3 ± 11.2	46.1 ± 10.8
Gender		
Male	54	50
Female	87	91
Mean BMI (kg/m²)	26.8 ± 2.7	27.1 ± 2.5
Socioeconomic Status		
Lower	32	29
Middle	92	94
Upper	17	18
Occupation Status		
Employed	79	76
Unemployed	62	65
Residence		
Rural	58	61
Urban	83	80

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Table 2: VAS Score Comparison Between Groups

Group	Mean VAS Score (±SD)
Onlay (A)	1.12 ± 0.76
Inlay (B)	2.96 ± 1.49

Table 3: Wound Infection Distribution

Wound Infection	Onlay (A)	Inlay (B)
Yes	5	18
No	136	123

Table 4: Seroma Distribution

Seroma	Onlay (A)	Inlay (B)
Yes	2	12
No	139	129

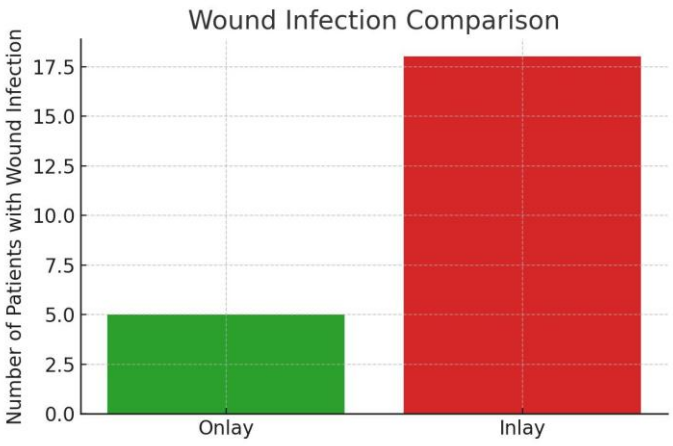

Figure 1 Wound Infection Comparison

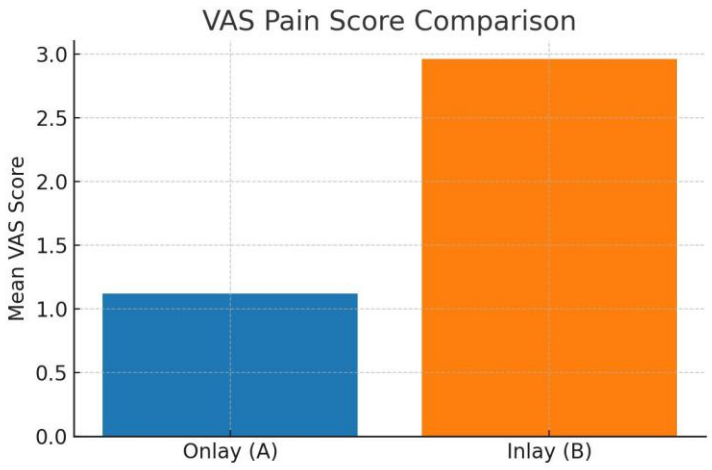

Figure 2 VAS Pain Score Comparison

DISCUSSION

The findings of this study demonstrated that open onlay mesh repair for paraumbilical hernia was associated with superior short-term postoperative outcomes compared to inlay mesh repair. Patients in the onlay group reported significantly lower postoperative pain scores and had a lower incidence of wound infection and seroma formation. These results align with several recent studies and reinforce the evolving consensus that mesh placement technique plays a pivotal role in surgical success and patient recovery. The significantly lower VAS pain scores in the onlay group (mean 1.12 ± 0.76) compared to the inlay group (mean 2.96 ± 1.49) reflect reduced postoperative discomfort and possibly better functional recovery. These findings are consistent with a randomized study, where patients undergoing subcutaneous onlay laparoscopic repair experienced less pain than those with intraperitoneal onlay mesh (IPOM) placement (15,16). Similarly, a study found lower postoperative pain and higher efficacy in patients undergoing sublay repair versus onlay mesh techniques (17). Wound infection rates in the current study were lower in the onlay group (3.5%) than in the inlay group (12.8%), which reinforces findings of a study which observed slightly higher wound infection and seroma rates among patients undergoing onlay mesh repair, although the differences were not statistically significant (18). However, other studies have reported variable infection rates depending on surgical technique and institutional protocols. For instance, a study reported notably higher wound infection and seroma rates in the onlay group compared to the sublay technique (19).

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The lower incidence of seroma in the onlay group (1.4%) also stands in contrast to prior research suggesting higher seroma formation with superficial mesh placement. A study reported 13.3% seroma in the onlay group and only 6.7% in the sublay group, arguing that deeper mesh placement may reduce fluid accumulation (20). This inconsistency may be attributed to surgical technique, drain use, or patient-related factors such as obesity and tissue handling. One strength of this study lies in its randomized controlled design and standardized postoperative care, minimizing potential confounders. Moreover, uniformity in surgical technique across both groups, with a single surgical team performing all operations, enhanced procedural consistency. The use of a validated pain assessment tool (VAS) and clearly defined operational criteria for wound infection and seroma strengthened the reliability of outcome measurements. However, the study was not without limitations. The use of non-probability consecutive sampling may limit generalizability, and short-term outcomes alone cannot capture late complications such as mesh rejection, chronic pain, or recurrence. Additionally, the exclusion of patients with comorbidities may have led to underestimation of complications that are typically higher in real-world populations. Lack of long-term follow-up data also precludes conclusions about recurrence, which remains a major consideration in hernia surgery. Furthermore, although randomization was performed, allocation concealment methods were not described, which may introduce bias.

The broader literature suggests that sublay (retrorectus) mesh placement may offer a balance between low recurrence and acceptable complication rates, though it requires greater technical skill and longer operative times (21,22). Although sublay and laparoscopic approaches are gaining traction globally, resource constraints and surgeon experience often guide the selection of techniques in developing healthcare settings. Future research should focus on long-term outcomes, including hernia recurrence and chronic pain. Comparative studies involving sublay, onlay, inlay, and laparoscopic approaches with larger multicentric samples could offer more definitive guidance on best practices. Furthermore, inclusion of cost-effectiveness analysis would help inform healthcare policy, especially in resource-limited settings. In conclusion, this study supports the use of onlay mesh repair in paraumbilical hernia surgery due to its favorable short-term outcomes in terms of pain, wound infection, and seroma. However, broader comparative and long-term studies remain essential to establish the most effective and safe technique tailored to patient-specific and institutional factors.

CONCLUSION

This study concludes that onlay mesh repair offers better short-term outcomes than inlay mesh repair for paraumbilical hernias, with significantly lower postoperative pain, wound infection, and seroma rates. These findings support the preference for onlay technique in clinical settings where rapid recovery and reduced complications are priorities. Adopting this approach can enhance patient outcomes and optimize surgical care efficiency.

AUTHOR CONTRIBUTION

Author	Contribution
Sanan Khan	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Mahmud Aurangzeb*	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Zaryab Khan	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Samina Bibi	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Asim Ullah	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Muhammad Sohail	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Arsalan Roghani	Contributed to study concept and Data collection Has given Final Approval of the version to be published

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