Original Article
DOI: https://doi.org/10.70749/ijbr.v3i5.2635

INDUS JOURNAL OF BIOSCIENCE RESEARCH
https://ijbr.com.pk
ISSN: 2960-2793/ 2960-2807

Outcome of Laparoscopic Repair Among Patients with Ventral Hernia Presenting at Tertiary Care Hospital

Murtaza Ayaz[1], Ayaz Gul[1], Gul Sharif[1], Muhammad Adeel[1], Gulfam Ullah[1], Aamir Fareed[1]

[1]Lady Reading Hospital MTI, Peshawar, Pakistan

ARTICLE INFO

Keywords: Diabetes mellitus, Hernia ventral, Laparoscopy, Postoperative complications, Surgical wounds, Treatment outcome

Correspondence to: Murtaza Ayaz,
Lady Reading Hospital MTI, Peshawar, Pakistan.
Email: murtazaayaz62@gmail.com

Declaration

Authors' Contribution: All authors equally contributed to the study and approved the final manuscript.

Conflict of Interest: No conflict of interest.

Funding: No funding received by the authors.

Article History

Received: 15-02-2025 Revised: 03-05-2025
Accepted: 18-05-2025 Published: 30-05-2025

ABSTRACT

Background: Ventral hernia happens when a part of intestine or tissue start coming out through a weak place in the abdominal wall. Many people develop this problem due to obesity, long pressure, or past surgery. Laparoscopic repair is now used in many hospitals because it gives less pain and faster healing, but still some complications like seroma, wound infection, and recurrence may happen. **Objective:** To determine the outcome of laparoscopic repair among patients with ventral hernia presenting at tertiary care hospital. **Study Design:** Descriptive type cross sectional study. **Duration and Place of Study:** This study was done from July 2024 to January 2025 in the Department of General Surgery, Lady Reading Hospital, Peshawar. **Methodology:** A total of 158 patients aged 25 to 70 years who had ventral hernia were included. All patients went through laparoscopic repair performed by an experienced surgeon. Early complications like seroma, wound infection, and recurrence were checked during follow-up. Chi-square test and Fisher exact test were used to check associations, and p-value of 0.05 was considered significant. **Results:** The mean age of patients was 49.06 years. Seroma was seen in 20.30% patients, wound infection in 15.20%, and recurrence in 10.10%. A significant relation was found between diabetes and seroma formation ($p = 0.025$). No meaningful association was noted between demographic factors and wound infection or recurrence ($p > 0.05$). **Conclusion:** Laparoscopic repair of ventral hernia showed good early results with acceptable complication rates. Seroma was the most common problem, and diabetic patients showed higher chances of developing seroma.

INTRODUCTION

Ventral hernia is a condition when a part of intestine or abdominal tissue start pushing out through a weak area in the abdominal wall, mostly at the site of previous surgery or due to long-term pressure problems.[1] It usually make a soft bulge that become more clear when patient cough or strain and sometimes cause mild to severe discomfort.[2] Many patients develop ventral hernia because of obesity, pregnancy, chronic cough, or repeated heavy lifting, and if not treated for long time it may lead to pain or risk of bowel obstruction.[3] The diagnosis is mostly done by physical examination and sometimes doctors also use ultrasound or CT scan to check the size and content of the hernia, but in general it is considered a common surgical problem in many hospitals.[4]

Laparoscopic repair of ventral hernia is now widely used because it is less painful and give faster recovery than open surgery.[5] In this method, surgeon make few small cuts in the abdomen and put a camera and instruments inside to fix the hernia from inside.[6] Mesh material is normally placed to give strength to the weak abdominal wall and to reduce the chance of hernia coming back.[7] This technique also allow surgeon to see the whole defect clearly with camera and fix it with more accuracy.[7]

Outcome of laparoscopic repair is mostly good but still some complications may occur like seroma formation, wound infection, and recurrence.[8] Seroma formation happen when fluid collect in the operated area, sometimes it go away by itself but sometimes doctor need to drain it.[9] Wound infection is less common in laparoscopic method than open repair because wounds are small, but still if infection happen patient may need antibiotics.[10] Recurrence of hernia also occur in some cases when mesh do not fix properly or when patient have strong risk factors like obesity or chronic cough.[11] Overall, laparoscopic repair show better healing, less pain, and lower complication rate compared to old methods, but proper patient selection and good surgical technique remain important.

A study by Bhardwaj P, et al, reported the outcome of laparoscopic repair among patients with ventral hernia were seroma formation 24.4%, wound infection 17.4% and recurrence in was 11.6%.[12]

There is need to do this study because ventral hernia is becoming very common problem and many patients still

not getting clear information about how well laparoscopic repair work for them. Even if this method is used in many hospitals, there is still confusion about real outcomes like how much seroma, wound infection, and recurrence happen after surgery. By studying these results in local patients, it helps doctors understand the success rate and also help improve decision making for treatment. This study also important because different patients have different risk factors, so checking outcomes in our own setting give more useful knowledge for future practice.

METHODOLOGY

This study was carried out in the Department of General Surgery at Lady Reading Hospital, Peshawar and it took place from 10th July 2024 till 10th January 2025. The work was designed as a descriptive type study. Before starting any activity, approval was taken from the institutional ethical review board. The sample size was worked out earlier by WHO software, using confidence level 95%, margin of error 5%, and keeping recurrence rate around 11.6%,[12] and the final number of selected cases became 158.

Participants were taken based on defined eligibility. Only patients aged 25 to 70 years, either male or female, and who demonstrated features of ventral hernia according to study criteria were included. People were not taken if they were pregnant, or had chronic kidney or liver disease, or any cardiac illness which could interfere with surgery. Ventral hernia in this study was considered when the patient came with swelling in abdominal wall that became more clear on standing or coughing, and later ultrasound reported a wall defect greater than 10 cm. Once a patient matched these criteria, written consent was obtained after explaining that this work was for research and did not bring them any additional risk. The demographic details like age, gender, BMI, socio-economic status, and residence were written down in the proforma before the examination started.

All patients underwent detailed history and clinical assessment after enrollment. Every patient went for laparoscopic repair under general anesthesia, with Foley's catheter and nasogastric tube positioned before the procedure. Repair was completed by a surgeon having at least five years of post-fellowship experience, and mesh fixation was done according to department protocol. After the operation, the patients were kept under follow-up for observation of early and late complications, and the study outcomes were recorded during these visits.

Seroma formation in this study was considered when after 7– 10 days the surgical area showed a soft cyst-like swelling with tenderness and clear fluid discharge coming out. Wound infection was taken as positive when after 7–10 days the wound became red and swollen and painful with VAS more than 5, together with purulent discharge. Recurrence was marked when the abdominal wall again showed bulge or swelling, and later ultrasound confirmed the return of wall defect after 30 days following the surgery. All these findings were monitored directly by physical examination and imaging when needed.

Data entry and analysis were done using SPSS version 27. Age, height, weight, and BMI were described by mean with standard deviation or by median with IQR, depending on normality which was checked through the Shapiro-Wilk test. Gender, diabetes, hypertension, socio-economic status, residence, and outcome variables like seroma formation, wound infection, and recurrence were expressed as frequency and percentages. To see the effect of modifiers such as age, BMI, gender, diabetes, hypertension, socio-economic status, and residence, stratification was applied. After that, chi-square or Fisher's exact test was used with significance level kept at 5%.

RESULTS

The mean age of patients was 49.06 ± 9.47 years with mean height of 1.64 ± 0.09 meters and mean weight was 72.96±10.96 kilograms. The mean BMI of study population were calculated as 26.94±2.82 kg/m^2. Regarding socio-economic status, 26 patients (16.5%) belongs to upper class, 67 patients (42.4%) was from middle class and 65 patients (41.1%) were from lower socio-economic class. The education status shows that 76 patients (48.1%) was literate while 82 patients (51.9%) were illiterate. Majority of patients 93 (58.9%) was residing in urban areas while 65 patients (41.1%) belongs to rural areas. Among comorbidities, diabetes mellitus was present in 44 patients (27.8%) and hypertension were found in 65 patients (41.1%) of study population (as shown in Table 1).

Table 1

Patient Demographics

Demographics		Mean ± SD or n (%)
Age (years)		49.06 ± 9.47
Height (m)		1.64 ± 0.09
Weight (kg)		72.96 ± 10.96
BMI		26.94 ± 2.82
Socio-economic status	Upper	26 (16.5%)
	Middle	67 (42.4%)
	Lower	65 (41.1%)
Education status	Literate	76 (48.1%)
	Illiterate	82 (51.9%)
Residence	Urban	93 (58.9%)
	Rural	65 (41.1%)
Diabetes	Yes	44 (27.8%)
	No	114 (72.2%)
Hypertension	Yes	65 (41.1%)
	No	93 (58.9%)

The early post-operative complications after laparoscopic ventral hernia repair was documented in study. Seroma were the most common complication which was observed in 32 patients with frequency of 20.30%. Wound infection was occurred in 24 patients representing 15.20% of study population. Recurrence of hernia were noted in 16 patients with frequency of 10.10% (as shown in Table 2).

Table 2

Frequency of Early Post-Operative Complications After Laparoscopic Ventral Hernia Repair

Complication	Frequency	% age
Seroma	32	20.30%
Wound infection	24	15.20%
Recurrence	16	10.10%

Age groups shows that 8 patients (30.8%) in ≤40 years group and 24 patients (18.2%) in >40 years group

developed seroma with p-value of 0.144 which was not statistically significant. BMI stratification revealed that 7 patients (18.9%) with BMI ≤25 kg/m^2 and 25 patients (20.7%) with BMI >25 kg/m^2 has developed seroma (p=0.817). Socio-economic status distribution shows 5 patients (19.2%) from upper class, 14 patients (20.9%) from middle class and 13 patients (20.0%) from lower class developed seroma with p-value of 1.000 using Fischer Exact Test. Education status shows seroma in 12 literate patients (15.8%) and 20 illiterate patients (24.4%) with p-value 0.179. Urban residence was associated with seroma in 19 patients (20.4%) while rural residence shows 13 patients (20.0%) with p-value 0.947. Diabetes mellitus shows statistically significant association where 14 diabetic patients (31.8%) developed seroma compared to 18 non-diabetic patients (15.8%) with p-value of 0.025. Hypertension shows 13 patients (20.0%) with hypertension and 19 patients (20.4%) without hypertension developed seroma with p-value 0.947 (as shown in Table 3).

Table 3

Association of Seroma with Demographic Factors

Demographic Factors	Group	n (%)	p-value
Age group (years)	≤40	8 (30.8 %)	0.144
	>40	24 (18.2 %)	
BMI group (kg/m^2)	≤25	7 (18.9 %)	0.817
	>25	25 (20.7 %)	
Socio-economic status	Upper	5 (19.2 %)	1.000*
	Middle	14 (20.9 %)	
	Lower	13 (20.0 %)	
Education status	Literate	12 (15.8 %)	0.179
	Illiterate	20 (24.4 %)	
Residence	Urban	19 (20.4 %)	0.947
	Rural	13 (20.0 %)	
Diabetes	Yes	14 (31.8 %)	0.025
	No	18 (15.8 %)	
Hypertension	Yes	13 (20.0 %)	0.947
	No	19 (20.4 %)	

*Fischer Exact Test

Wound infection association with demographic factors was also evaluated. Age stratification shows 4 patients (15.4%) in ≤40 years group and 20 patients (15.2%) in >40 years group with p-value 1.000 using Fischer Exact Test. BMI groups shows 6 patients (16.2%) with BMI ≤25 kg/m^2 and 18 patients (14.9%) with BMI >25 kg/m^2 developed wound infection (p=0.842). Socio-economic distribution revealed 3 patients (11.5%) from upper class, 12 patients (17.9%) from middle class and 9 patients (13.8%) from lower class with p-value 0.730 by Fischer Exact Test. Education status shows equal distribution with 12 literate patients (15.8%) and 12 illiterate patients (14.6%) having wound infection (p=0.84). Urban patients show 16 cases (17.2%) while rural patients show 8 cases (12.3%) with p-value 0.399. Diabetes status shows 7 diabetic patients (15.9%) and 17 non-diabetic patients (14.9%) with wound infection (p=0.876). Hypertension shows 10 patients (15.4%) with hypertension and 14 patients (15.1%) without hypertension developed infection with p-value 0.955 (as shown in Table 4).

Table 4

Association of Wound Infection with Demographic Factors

Demographic Factors	Group	n (%)	p-value
Age group (years)	≤40	4 (15.4 %)	1.000*
	>40	20 (15.2 %)	
BMI group (kg/m^2)	≤25	6 (16.2 %)	0.842
	>25	18 (14.9 %)	
Socio-economic status	Upper	3 (11.5 %)	0.730*
	Middle	12 (17.9 %)	
	Lower	9 (13.8 %)	
Education status	Literate	12 (15.8 %)	0.84
	Illiterate	12 (14.6 %)	
Residence	Urban	16 (17.2 %)	0.399
	Rural	8 (12.3 %)	
Diabetes	Yes	7 (15.9 %)	0.876
	No	17 (14.9 %)	
Hypertension	Yes	10 (15.4 %)	0.955
	No	14 (15.1 %)	

*Fischer Exact Test

The recurrence of hernia was stratified according to demographic variables. Age groups shows 4 patients (15.4%) in ≤40 years and 12 patients (9.1%) in >40 years group with p-value 0.474 using Fischer Exact Test. BMI stratification revealed 5 patients (13.5%) with BMI ≤25 kg/m^2 and 11 patients (9.1%) with BMI >25 kg/m^2 experienced recurrence (p=0.533). Socio-economic status shows 5 patients (19.2%) from upper class, 5 patients (7.5%) from middle class and 6 patients (9.2%) from lower class with p-value 0.258 by Fischer Exact Test. Education status distribution shows 11 literate patients (14.5%) and 5 illiterate patients (6.1%) with recurrence (p=0.113). Residence distribution shows 12 urban patients (12.9%) and 4 rural patients (6.2%) with p-value 0.191 using Fischer Exact Test. Diabetes shows 2 diabetic patients (4.5%) compared to 14 non-diabetic patients (12.3%) experienced recurrence with p-value 0.238. Hypertension shows 7 patients (10.8%) with hypertension and 9 patients (9.7%) without hypertension developed recurrence with p-value 1.000 by Fischer Exact Test (as shown in Table 5).

Table 5

Association of Recurrence with Demographic Factors

Demographic Factors	Groups	n (%)	p-value
Age group (years)	≤40	4 (15.4 %)	0.474*
	>40	12 (9.1 %)	
BMI group (kg/m^2)	≤25	5 (13.5 %)	0.533*
	>25	11 (9.1 %)	
Socio-economic status	Upper	5 (19.2 %)	0.258*
	Middle	5 (7.5 %)	
	Lower	6 (9.2 %)	
Education status	Literate	11 (14.5 %)	0.113*
	Illiterate	5 (6.1 %)	
Residence	Urban	12 (12.9 %)	0.191*
	Rural	4 (6.2 %)	
Diabetes	Yes	2 (4.5 %)	0.238*
	No	14 (12.3 %)	
Hypertension	Yes	7 (10.8 %)	1.000*
	No	9 (9.7 %)	

*Fischer Exact Test

DISCUSSION

The average age of patients was 49.06 ± 9.47 years, indicating that ventral hernia usually occurs in middle-

aged patients. This occurs due to weakness of abdominal wall muscles and fascias in older age and gradual increase in risk factors over the years. The average BMI was 26.94 ± 2.82 kg/m^2, indicating majority being obese. The more obese individual would be more exposed to intra-abdominal pressure and delayed healing of wound due to reduced blood supply in adipose tissues. Seroma complications were seen mostly in 32 patients (20.30%) compared to others. The reason being widespread tissue planes leading to formation of dead spaces in which serous fluid gets collected. Significant association observed in seroma formation in diabetes mellitus patients (p=0.025) in which 14 patients (31.8%) developed seroma compared to 18 non-diabetes patients (15.8%). The reason being reduced inflammation and delayed absorption of fluids because of micro-vascular pathologies in diabetes.

Wound infection occurred in 24 patients (15.20%) due to bacterial colonies and poor tissue perfusion. There were no significant relations with variables indicative that the incidence of the complication may be more closely linked with surgical skill than patient factors. The incidence of recurrence in 16 patients (10.10%) is an acceptable rate. This occurs if there be insufficient fixation of the mesh or if there be insufficient overlap of the mesh beyond the margins of the hernias or undue tension on the repair. Although no significant relations exist in this context, there be higher incidence of recurrence in patients < 40 years (15.4%) and in those with BMI < 25 kg/m^2 (13.5%) possibly owing to more physically strenuous life style.

The average age observed in the current research was 49.06 ± 9.47 years; this result was compatible with those observed in other researches conducted by Baghdady et al. [13] with 42.3 ± 7.1 years and those of Muhammad et al. [14] with 43.7 ± 15.0 years. Likewise, Kalyan et al. [15] observed 51.6 ± 12.4 years. This identical result emerged because most patients with ventral hernias are in the middle-aged category due to gradual weakening of the abdominal wall. However, Khan et al. [16] and Shahabuddin et al. [17] observed older ages of 59.7 ± 9.3 years and 52-56 years due to late onset of illness in those regions.

The average BMI was 26.94 ± 2.82 kg/m^2 which was comparable to Baghdady et al. [13] who found 25.4 ± 3.7 kg/m^2. This indicates the presence of overall higher body mass being a common risk factor due to high BMI values leading to pressure in the abdominal region. The study represented 27.8% diabetic and 41.1% hypertensive patients.

Seroma formation was seen in 32 patients (20.30%) in the current study, which was less compared with Kalyan et al. [15] in open group 32%, but there was 0% incidence in the laparoscopic procedure. Misiakos et al. [18] noted seroma identification up to 100% in the ultrasonic examination; however, only 30-35%cases had clinical manifestation. The significant correlation between diabetes and seroma formation (p=0.025) with 31.8% in diabetics versus 15.8% in non-diabetics was significant because diabetes reduces fluid absorption due to microvascular impairment. This correlation has not been evaluated in either of the studies compared.

Wound infections were observed in 24 cases (15.20%) in the current study, which are more compared to many studies. However, Baghdady et al. [13] and Kiani et al. [19] observed no mesh infections in their studies, while 13.5% rate of infection was observed in the study by Muhammad et al. [14] in comparison to the current study. Rates of 7.1% and 2-3% were observed in laparoscopic procedures in the studies by AlWadaani et al. [20] and Misiakos et al. [18] respectively.

The rate of recurrence was 10.10% (16 patients) and this rate was higher compared with most other studies. The rate of ≤ 7% of recurrence was recorded by Misiakos et al. [18] in 2012, no recurrence was recorded by Baghdady et al. [13] in 2013 and by Kiani et al. in 2013.[19] The rate of 3% and 0.7% of recurrence was recorded by Shahabuddin et al. in 2013 [17] and Shrestha et al. in 2013,[21] in 2013, respectively. However, the rate of 11.3% of recurrence was recorded by Muhammad et al. in 2012.[14] This could be explained by the lack or insufficiency of overlap or fixation. Also, the trend towards young age

The rate of overall complications was found acceptable compared with the literature values. The rate of overall complications of 7.97% was found by Shrestha et al. [21] and 21.4% in the emergency department by AlWadaani et al. [20] The absence of mortality in the current study and most other studies [13,14,16,19] was satisfying; however, 40% mortality rate in case of missed enterotomy was seen in Misiakos et al. [18]

The current study also has several limitations that should be noted. First, this is a single center study that may not be generalizable in other centers with different patient population and different surgical practice. Second, the patient population studied only consisted of 158 patients, which may not be sufficient in terms of power in detecting various associational outcomes especially those that are rare. Third, the follow-up studied only lasted for three years, and this may result in underestimating the rate of recurrence because hernias may recur after many years. Fourth, this study did not compare laparoscopic repair with open repair methods in terms of advantages. Fifth, this study did not consider the experiences in terms of different peaks in terms of different outcomes.

CONCLUSION

The current research has found that there are acceptable early postoperative outcomes in terms of complications in laparoscopic ventral hernia repair. Seroma formed the majority complication followed by wound infections and recurrence of hernias. The current research has found significant association between complications like seroma formation and diabetes, thus requiring attention in the postoperative period in both diabetic patients and those with obesity.

Acknowledgments: We want to thank the workers in the medical department. They kept the patient files in order and handled all the data very properly, and without their help this study was not possible.

Ethical Approval: This study was allowed by the Ethical Committee. Everything we did followed their rules and also followed the Helsinki Declaration.

Patient Consent: Every patient signed a paper before joining the study. They were informed that their details will be kept secret and they could stop taking part whenever they want.

REFERENCES

1. Kunaprayoon S, Brown C, Bangla V, Lagziel T, Leitman IM. Risk factors and outcomes for early returns to the operating room following abdominal wall hernia repairs. *Surg Pract Sci*. 2025; 21:100283. https://doi.org/10.1016/j.sipas.2025.100283
2. Henriksen NA, Bougard H, Gonçalves MR, Hope W, Khare R, Shao J, *et al.* Primary ventral and incisional hernias: comprehensive review. *BJS Open*. 2024; 9(1):zrae145. https://doi.org/10.1093/bjsopen/zrae145
3. Gianazza S, Grappolini N, Morabito M, Palillo A, Ripamonti M, Inversini D. Spontaneous bowel evisceration through umbilical hernia sites in adult patients: a systematic review of the literature. *Clin Pract*. 2025; 15(6):99. https://doi.org/10.3390/clinpract15060099
4. Head W, Satija D, Shannon K, Edwards P, Renshaw S, Arhos E, *et al.* Is there a link between physical function testing and ventral hernia size? *Surg Endosc*. 2025. https://doi.org/10.1007/s00464-025-12224-z
5. Pereira C, Rai R. Open versus laparoscopic ventral hernia repair: a randomized clinical trial. *Cureus*. 2021; 13(12):e20490. https://doi.org/10.7759/cureus.20490
6. Özdemir K, Akin E, Muhtaroğlu A, Kamburoğlu B, Gönüllü E, Bayhan Z, *et al.* Evaluating surgical techniques for incarcerated incisional hernia: laparoscopic vs. open repair in a tertiary care setting. *Hernia*. 2025; 29(1):116. https://doi.org/10.1007/s10029-025-03311-0
7. Roth JSS, Ramshaw B, Renard Y, Passot G, Berrevoet F, Bayliss K, *et al.* New synthetic resorbable mesh for open ventral hernia repair: the multicentre, single-arm, prospective study of Transorb self-gripping resorbable mesh (RECOVER) protocol. *BMJ Open*. 2025; 15(7):e100294. https://doi.org/10.1136/bmjopen-2025-100294
8. Elhadidi A, Shetiwy M, Al-Katary M. Comparative analysis of laparoscopic, retro-muscular, and open mesh repair techniques for ventral and incisional hernias: a comprehensive review and meta-analysis. *Updates Surg*. 2025; 77(1):217–229. https://doi.org/10.1007/s13304-024-02049-1
9. Wilters S, Alfarawan F, Fahrenkrog C, Bockhorn M, El-Sourani N. To drain or not to drain in minimal invasive ventral hernia surgery. *Langenbecks Arch Surg*. 2025; 410(1):97. https://doi.org/10.1007/s00423-025-03668-x
10. Lai SD, Smith NJ, Park B, Vandal A, MacCormick AD. Laparoscopic versus open approach for emergency repair of groin hernias: a systematic review and meta-analysis. *World J Surg*. 2025; 49(10):2733–2741. https://doi.org/10.1002/wjs.70076
11. Bhardwaj P, Huayllani MT, Olson MA, Janis JE. Year-over-year ventral hernia recurrence rates and risk factors. *JAMA Surg*. 2024; 159(6):651–658. https://doi.org/10.1001/jamasurg.2024.0233
12. Dal NA, Abro AH, Memon ZA, Qureshi ZZ, Khaskheli NA, Bhurgri AR. Outcome of laparoscopic repair in ventral hernia. *Pak J Med Health Sci*. 2022; 16(11):153–154. https://doi.org/10.53350/pjmhs20221611153
13. Baghdady ASM, Mostafa HA, Salem AEAA, Abdullah HA, Saad MR. Short outcome evaluation of laparoscopic ventral hernia repair. *Egypt J Hosp Med*. 2021; 83:1338–1343. https://doi.org/10.21608/ejhm.2021.168248
14. Muhammad J, Altaf MB, Khan S, Bibi S, Niazi EA. To compare the short-term outcome of open repair versus laparoscopic repair in abdominal incisional hernia repair. *J Health Rehabil Res*. 2023; 3(2). https://doi.org/10.61919/jhrr.v3i2.196
15. Kalyan M, Rathore SS, Verma V, Sharma S, Choudhary M, Irshad I, *et al.* Laparoscopic versus open ventral hernia repair: experience at a tertiary care center in western Rajasthan. *Cureus*. 2022; 14(7):e27279. https://doi.org/10.7759/cureus.27279
16. Khan JS, Qureshi U, Farooq U, Hassa ZF, Hassan H. The comparison of open and laparoscopic ventral hernia repairs. *J Postgrad Med Inst*. 2012; 26(4):397–401.
17. Shahabuddin M, Taslima A. Exploring ventral hernia repair: a comparison and future outlook on laparoscopic versus open techniques. *Int J Res Med Sci*. 2025; 13(6):2404–2408. https://doi.org/10.18203/2320-6012.ijrms202515186
18. Misiakos EP, Patapis P, Zavras N, Tzanetis P, Machairas A. Current trends in laparoscopic ventral hernia repair. *JSLS*. 2015; 19(3):e2015.00048. https://doi.org/10.4293/JSLS.2015.00048
19. Kiani MA, Razzaq Z, Afzal M. Laparoscopic and open mesh repair of ventral hernias: a randomized clinical trial. *J Postgrad Med Inst*. 2014; 28(1):62–67.
20. AlWadaani HA, Memon AQ. Outcome of the incarcerated abdominal wall hernias managed by open and laparoscopic approaches. *Pak J Med Sci*. 2024; 40(5):946–950. https://doi.org/10.12669/pjms.40.5.6470
21. Shrestha BB, Mishra S, Shrestha S, Ghimire P, Pandey MR. Outcome of laparoscopic ventral hernia repair in a tertiary centre: a descriptive cross-sectional study. *Nepal J Med Sci*. 2025; 10(2):46–53. https://doi.org/10.3126/njms.v10i2.63642