

# Outcome between Laparoscopic and Open Ventral Hernia Repair: a Quasi-experimental Study

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## Abstract

**Background:** The debate on the best surgical approach to ventral hernia repair continues. We compared the outcomes of laparoscopic with open ventral hernia repair in terms of post-operative pain, recovery and patients' satisfaction on cosmesis.

**Methods:** This quasi-experimental study allocated 70 participants scheduled for ventral hernia repair into laparoscopic and open repair (allocation 1:1) from July 2020 to July 2021. The primary outcome included VAS for pain at 24, 48 and 72 hours after surgery. The secondary outcomes included duration of surgery and hospital stay, time to return to normal activity, patients' satisfaction on cosmesis and recurrence rate.

**Results:** The age, gender distribution, and size of hernia defect were comparable between the groups ( $p > 0.05$ ). Post-operative VAS scores (median, IQR) were similar at 24 hours (7, 6 - 8 vs. 7, 6 - 7,  $p > 0.99$ ) and 48 hours (4, 3 - 5 vs. 4, 3 - 4,  $p > 0.99$ ) and lesser in laparoscopic group at 72 hours (1, 1 - 2 vs. 2, 2 - 2,  $p < 0.001$ ) after surgery. The duration of surgery (mean  $\pm$  SD) was longer ( $105.14 \pm 34.88$  vs.  $87.49 \pm 29.13$  minutes,  $p = 0.02$ ) while duration of hospital stay was shorter ( $4.80 \pm 3.08$  vs.  $6.66 \pm 2.94$  days,  $p = 0.01$ ) and return to normal activity was earlier ( $6.89 \pm 2.93$  vs.  $15.40 \pm 5.65$  days,  $p < 0.001$ ) in laparoscopic group.

**Conclusion:** Laparoscopic ventral hernia repair was associated with lesser post-operative pain at 72 hours, early post-operative recovery as well as better patients' satisfaction on cosmesis as compared to open procedure.

**Keywords:** Laparoscopy; Post-operative pain; Surgical mesh; Ventral hernia

## Declarations

**Ethics approval and consent to participate:** This study was conducted with prior approval from Ethical Review Board of Nobel Medical College Teaching Hospital (Reference No. 375/2020).

**Consent for publication:** Not applicable

**Availability of data and materials:** The full data set supporting this research is available upon request by the readers.

**Competing interest:** None

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**Authors' contributions:** RY: design, data collection, data analysis and interpretation, preparation of manuscript. MG: design, data collection. AB: design, data collection, preparation of manuscript. DA: design, data collection. SS: design, data collection. NP: design, data collection, data analysis and interpretation, preparation of manuscript. All authors have read and approved the final manuscript.

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**H**ernia occurring through the anterior abdominal wall at any site besides the groin is considered as a ventral hernia [1]. The overall incidence of ventral hernia has been found to be between 15 to 20% amongst all abdominal hernias [2]. They are further categorized as umbilical, paraumbilical, incisional, epigastric and spigelian hernias [3]. Open abdominal surgeries are usually associated with an increased risk of incisional hernias [1].

Laparoscopic surgery has gained momentum due to its minimal invasiveness, short hospital stay, better patient acceptability and better post-operative outcome [4, 5]. Despite the use of various techniques for repairing ventral hernias, the debate regarding the best operative approach to the ventral hernia repair still continues [2]. As laparoscopic hernia repair is now more popular amongst patients, general surgeons prefer laparoscopic techniques compared to open repair [2].

Our primary objective was to compare the post-operative pain intensity as assessed by VAS score. The secondary objectives included comparison of duration of surgery, duration of hospital stay, time to return to normal activity, patients' satisfaction in terms of cosmesis, occurrence of post-operative complications, and recurrence rate.

## METHODS

**A**fter clearance from the Institutional Review Committee of Nobel Medical College and Teaching Hospital, this quasi-experimental study was conducted at the Department of General Surgery at Nobel Medical College Teaching Hospital from July 2020 to July 2021. The VAS score for pain at 24, 48 and 72 hours was considered as the primary outcome. The secondary outcomes included comparisons on duration of surgery, duration of hospital stay, and time to return to normal activity, patient's satisfaction on cosmesis, occurrence of post-operative complications like seroma, bleeding, mesh infection, deep vein thrombosis (DVT), and recurrence of hernia.

The inclusion criteria was clinically confirmed ventral hernia (any of umbilical, paraumbilical, epigastric or incisional hernia) scheduled for surgery after clearance for anesthesia in pre-anesthetic clinic. Patients who had recurrent abdominal hernia or any prior history of intestinal obstruction, unwilling to give consent or comply with study requirements and follow-up schedule, and unfit for general anesthesia

were excluded. The ultrasonography or Computed Tomography scan of the abdomen-pelvis was used to identify the size of the hernial sac. Purposive sampling technique was used. Patients were recruited into either of the two groups in the preoperative period—laparoscopic technique or open repair technique. All patients were offered to choose between the two techniques of surgery. Non affording patients and those in whom laparoscopy was contraindicated also underwent open surgery. Based on a previous report on the VAS scores (mean  $\pm$  SD) for pain 24 hours post-operatively for open and laparoscopic groups as  $4.37 \pm 0.84$  and  $3.63 \pm 0.69$  respectively and considering 80% power and 95% confidence interval, the sample size calculated was 68 [2]. To allow for loss to follow up, 35 patients were enrolled in each group.

After general anesthesia, prior to the incision, 1.2 g IV amoxicillin + clavulanic acid was given to all the patients (all patients were kept in supine position).

In the laparoscopic group, repair was done using the underlay technique. The abdomen was painted and draped. A Veress needle was inserted in the left hypochondrium at Palmer's point and a pneumoperitoneum was created. A primary port was created using a 10 mm safety trocar cannula. Secondary ports were placed under direct vision. Other working ports were created as required laterally from the site of hernia. Adhesiolysis was performed for any adhesions. The content of the hernia (omentum/ bowel) was returned into the abdomen and the extent of the defect was assessed. Any hernia defect of size more than 2 cm was approximated with Prolene number 1 suture. A composite mesh of standard quality and adequate size that covered the whole defect overlapping nearly 5 cm from the edge of the defect was selected. The mesh was then rolled and inserted through the 10 mm port in the abdominal cavity. The rolled mesh was unrolled and fixed with transfascial sutures to the abdominal wall and was also fixed by means of non-absorbable tackers to the abdominal wall without dissecting the peritoneum. After fixing the hernial mesh, pneumoperitoneum was released and the 10 mm port site was sutured using Vicryl suture. All skin incisions were closed with skin stapler (**Fig. 1 and 2**).

In the open repair group, the position and size of the defect were marked on the skin with a skin pencil after which the abdomen was painted and draped. A linear incision on the skin overlying the hernia was made. The subcutaneous fat and underlying structures

were explored until the peritoneum of the sac, or its covering of extra-peritoneal fat or thinned fascia, was encountered. A plane was then developed between this and the surrounding subcutaneous fat. This plane led to the edges of the fascial defect. The subcutaneous fat was cleared off the fascia for a few centimeters around the defect to aid the subsequent repair. Any intra-peritoneal viscous adherent to the sac was freed and returned into the abdomen. The redundant sac was excised, and the abdominal defect was closed with interrupted non-absorbable polypropylene sutures. If there was no plane between the peritoneum and the abdominal fascia, both layers were closed together with polypropylene sutures. The mesh was then placed over the closed defect so that it was in contact with normal tissue for some distance on either side of the closure, and a few sutures were used to prevent it from getting displaced in the immediate post-operative period. Hemostasis was ensured. A vacuum drain was placed above the mesh and the overlying muscles were approximated with polydioxanone suture number 1 suture. Any significant dead space in subcutaneous fat was obliterated with polyglactin suture. The skin incision was closed with 3-0 nylon monofilament sutures. **(Fig. 3 and 4)**

In the postoperative period all the patients were administered IV paracetamol 1g 8 hourly for 3 days, oral tablet diclofenac 50 mg 8 hourly for the next 5 days for post-operative analgesia. IV ketorolac 30 mg and IV tramadol 50 mg were given depending upon severity of pain which was based on the surgeon's discretion. All patients received IV sulbactam and amoxicillin 1.2 g every 8 hours for 3 days.

Patients' age, sex, type of hernia and size of the defect were noted. The post-operative pain was analyzed by Visual Analog Scale (VAS) at 24, 48, and 72 hours after surgery. The VAS scale has a score ranging from 0 to 10 where zero score means no pain while 10 means the maximum possible pain.

Patients were followed up after 1 week, 2 weeks, and 3 months. Any post-operative complications (seroma, bleeding, mesh infection and DVT) were noted. The recurrence of hernia, which was defined as reappearance of the hernia near or at the location of a previous repair was noted at 3 months of follow-up. Patients' satisfaction on cosmesis was assessed with a satisfaction scale where 1 is the best possible cosmesis and 10 is the worst possible cosmesis as perceived by the patient.

The statistical analysis was done using Statistical

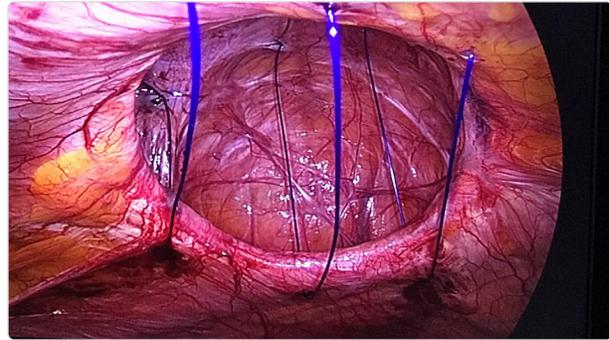


Figure 1: Laparoscopic hernial defect closure.



Figure 2: Composite mesh fixation.



Figure 3: Open dissection and closure of hernial sac.



Figure 4: Mesh fixation during open repair.

Package for the Social Sciences (SPSS) version 25. The continuous variables were expressed using mean  $\pm$  SD or median and interquartile range. Comparison of continuous variables was done using Student's t-test. Chi-square test/ Fisher's exact test was used to determine the significance of study parameters on categorical scale between two or more groups. Variables on categorical measurements were expressed using number (%). A p-value of  $< 0.05$  was considered significant.

## RESULTS

A total of 70 patients were included in the study amongst which 35 underwent laparoscopic surgery and 35 underwent open surgery. The age of the patients (mean  $\pm$  SD) in laparoscopic group was  $51.23 \pm 13.16$  y and in open group was  $43.71 \pm 13.54$  y. The size of the hernia defect (mean  $\pm$  SD) in laparoscopic group was  $3.86 \pm 1.38$  cm and in open group was  $3.47 \pm 1.57$  cm. The majority (54.29%) of the patients who underwent open repair had umbilical hernia ( $p = 0.05$ ), and the majority (51.42%) of patients who underwent laparoscopic repair had incisional hernia ( $p = 0.05$ ) (Table 1).

The duration of the surgery (mean  $\pm$  SD) was  $96.31 \pm 33.12$  minutes. Laparoscopic repair took a longer duration compared to open technique ( $105.14 \pm 34.88$  vs.  $87.49 \pm 29.13$  minutes,  $p = 0.02$ ). Post-operative VAS score (median, IQR) was similar in the laparoscopic and the open repair groups at 24 h (7, 6 - 8 vs. 7, 6 - 7,  $p > 0.99$ ) and 48 h (4, 3 - 5 vs. 4, 3 - 4,  $p > 0.99$ ) while lower in laparoscopic group at 72 h (1, 1 - 2 vs. 2, 2 - 2,  $p < 0.001$ ) after surgery (Fig. 5). Lesser duration of hospital stay ( $4.80 \pm 3.08$  vs.  $6.66 \pm 2.94$  days,  $p = 0.01$ ) and earlier return to normal activity ( $6.89 \pm 2.93$  vs.  $15.40 \pm 5.65$  days,  $p < 0.001$ ) were seen in patients undergoing laparoscopic surgery. The patients in the laparoscopic surgery group perceived better cosmetic satisfaction score ( $1.60 \pm 1.91$  vs.  $4.77 \pm 1.11$ ,  $p < 0.001$ ). (Table 2)

Seroma formation was the major post-operative complication (18%), all of which resolved with conservative management. Three patients (4.28%) developed bleeding during laparoscopic repair which were controlled intra-operatively by ligature. There was no major vessel injury in any patients. One patient developed mesh infection in open repair group which was managed conservatively with antibiotics and

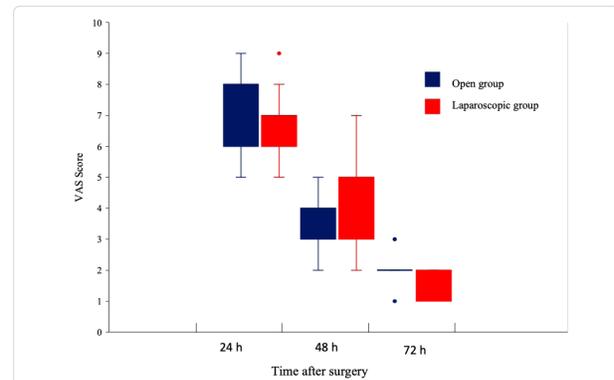


Figure 5: Box and whisker plot comparing VAS scores at different times.

regular dressing. The patients were put on regular follow up and the infection resolved within three months. Overall, 14.28% patients with open repair and 10% patients with laparoscopic repair developed post-operative complications ( $p = 0.15$ ). Post-operative ileus or DVT did not occur in any patient. None of the patients developed recurrence of hernia during the 3 months follow up period. (Table 2).

## DISCUSSION

Ventral hernia repair is one of the most common surgeries [6]. With 10-20 % of overall occurrence in laparotomy incisions, ventral hernias not only reduce the daily activities of patients but also increase socioeconomic burden [7, 8]. Widespread concept of tension-free repair and use of mesh to cover the hernial defect nowadays has reduced the failure rate in hernia surgery. As laparoscopy in hernia repair has become more popular than open repair, it carries the potential to replace open repair technique [9].

The ratio of male to female in our study was 0.458 with mean age of 51.23 y in laparoscopic repair group and 43.71 y in open repair group. This is comparable to the findings of another study [10]. Higher incidence of the hernia among women in our study may be due to weak abdominal wall musculature. Both of the groups had comparable pain within the first 48 hours. Despite the longer duration of surgery, the post-operative pain intensity was significantly less in laparoscopic group compared to the open repair technique. Thota et al. found that laparoscopy is associated with reduced pain incidence [1]. However, persistent pain after laparoscopic repair when assessed at the 4-week follow up have also been reported [11]. Incisions created during the operation, mesh fixation materials and

**Table 1: Demographic profile of patients. Values are presented as mean  $\pm$  SD or number.**

Variable	Laparoscopic group (n = 35)	Open group (n = 35)	p- value
Age (y)	51.23 $\pm$ 13.16	43.71 $\pm$ 13.54	0.02
Sex (M:F)	1:1.25	1:1.9	0.60
Size of defect (cm)	3.86 $\pm$ 1.38	3.47 $\pm$ 1.57	0.27
<b>Types of hernia</b>			
Epigastric	4	3	0.16
Incisional	18	10	0.05
Paraumbilical	1	0	
Supra umbilical	1	3	
Umbilical	11	19	

**Table 2: Comparison of outcome between two study groups. Values are presented as mean  $\pm$  SD or number.**

Variable	Laparoscopic group (n = 35)	Open group (n = 35)	p- value
Duration of surgery (minutes)	105.14 $\pm$ 34.88	87.49 $\pm$ 29.13	0.02
<b>Post-operative complications</b>			
Seroma	4	9	0.15
Bleeding	3	0	0.12
Mesh infection	0	1	0.07
DVT	0	0	0.31
Hospital stays (days)	4.80 $\pm$ 3.08	6.66 $\pm$ 2.94	0.01
Return to normal activity (days)	6.89 $\pm$ 2.93	15.40 $\pm$ 5.65	< 0.001
Cosmesis (score)	1.60 $\pm$ 1.91	4.77 $\pm$ 1.11	< 0.001

sutures used are the factors leading to post-operative pain[11]. In our study both the groups received NSAIDS after the surgery. The average duration of surgery was longer than that for open repair. Similar findings have been reported in other studies [8, 11-13]. On the contrary, comparable duration of surgery have also been reported elsewhere [1]. Closure of the hernial defect and transfascial suturing used for mesh fixation was the cause for longer surgical duration [1]. The INCH trial has reported lesser time to full recovery in laparoscopy surgery making it more cost-effective than open approach [14]. Our patients in laparoscopy group also required shorter hospital stay. Similarly, other reports have also favored laparoscopy in terms of earlier recovery [15, 16]. However, contradictory results have also been reported [11, 17]. Recent studies have shown decreased recurrence rate, ease of use in obese patients and better patients satisfaction in terms of cosmesis compared to that in open technique [1, 18, 19].

The most common complication that occurred in our study was seroma formation. Common advantages of laparoscopic technique like reduced bleeding, lower

incidence of post-operative ileus, wound infections and DVT was also observed in our study. Even though these findings were not statistically significant, the observed finding was clinically significant in terms of reduction in the post-operative burden to the patients [20]. We had a single incidence of mesh infection in open repair group which was managed conservatively with IV antibiotics and regular wound dressing. The mesh removal was not required. Three of our patients developed bleeding. Some studies have reported no incidence of infection or bleeding [1]. In our patients, the type of surgery for hernia defect was not dependent on the size of hernia. In all patients where mesh was used, a minimum of 5 cm overlap was maintained to cover the fascial defect.

The major limitations of this study include selection of patient regardless of their age and type of hernia, and a shorter duration of follow-up. Since our results are based on a single center experience, a multi-centric and stratified randomized trial may be required for generalization of the study results

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## CONCLUSION

Laparoscopic repair is better than open method for repair of the ventral hernias in terms of post-operative pain, duration of hospital stay, cosmesis, and return to normal activities.

## References

1. Thota A, Ravishankar KS, Rao KV, Ramesh BS, Ananda BB. Comparative study between open and laparoscopic ventral hernia repair: a prospective non-randomized single institutional study. *Journal of Dr. NTR University of Health Sciences*. 2017;6(4):217. DOI: 10.4103/JDRNTRUHS.JDRNTRUHS\_115\_16.
2. Prakash KS, Dumbre R, Phalgune D. A comparative prospective study of laparoscopic and open-mesh repair for ventral hernia. *Indian J Surg*. 2020;82(4):465-71. DOI: 10.1007/s12262-019-01995-0.
3. Sajid MS, Bokhari SA, Mallick AS, Cheek E, Baig MK. Laparoscopic versus open repair of incisional/ ventral hernia: a meta-analysis. *Am J Surg*. 2009;197(1):64-72. DOI: 10.1016/j.amjsurg.2007.12.051.
4. Buia A, Stockhausen F, Hanisch E. Laparoscopic surgery: a qualified systematic review. *World J Methodol*. 2015;5(4):238-54. DOI: 10.5662/wjm.v5.i4.238.
5. Olmi S, Magnone S, Erba L, Bertolini A, Croce E. Results of laparoscopic versus open abdominal and incisional hernia repair. *JLS*. 2005;9(2):189-195. PMID: 15984708
6. Leithy M, Elhady A, Fayed A, Elghazaly A. Comparative study of laparoscopic versus open repair of incisional hernia. *Menoufia Medical J*. 2019;32(2):517-2. DOI: 10.4103/mmj.mmj\_825\_17.
7. Misiakos EP, Patapis P, Zavras N, Tzanetis P, Machairas A. Current trends in laparoscopic ventral hernia repair. *JLS*. 2015;19(3). DOI: 10.4293/jls.2015.00048.
8. Basheer M, Negm A, El-Ghadban H, Samir M, Hadidy A, Dawoud I. Laparoscopic versus open ventral hernia repair: a comparative study. *The Egyptian Journal of Surgery*. 2018;37(4):465-71. DOI: 10.4103/ejs.ejs\_53\_18.
9. Al Chalabi H, Larkin J, Mehigan B, McCormick P. A systematic review of laparoscopic versus open abdominal incisional hernia repair, with meta-analysis of randomized controlled trials. *Int J Surg*. 2015;20:65-74. DOI: 10.1016/j.ijsu.2015.05.050.
10. Meyer R, Hage A, Zimmermann M, Bruch HP, Keck T, Hoffmann M, et al. Is laparoscopic treatment of incisional and recurrent hernias associated with an increased risk for complications? *Int J Surg*. 2015;19:121-7. DOI: 10.1016/j.ijsu.2015.05.046.

11. Eker HH, Hansson BM, Buunen M, Janssen IM, Pierik RE, Hop WC, et al. Laparoscopic vs. open incisional hernia repair: a randomized clinical trial. *JAMA Surg.* 2013;148(3):259-63. DOI: 10.1001/jamasurg.2013.1466.
12. Ramshaw BJ, Esartia P, Schwab J, Mason EM, Wilson RA, Duncan TD, et al. Comparison of laparoscopic and open ventral herniorrhaphy. *Am Surg.* 1999;65(9):827-31. PMID: 10484084
13. Asencio F, Aguilo J, Peiro S, Carbo J, Ferri R, Caro F, et al. Open randomized clinical trial of laparoscopic versus open incisional hernia repair. *Surg Endosc.* 2009;23(7):1441-8. DOI: 10.1007/s00464-008-0230-4.
14. Poelman M, Apers J, van den Brand H, Cense H, Consten E, Deelder J, et al. The INCH-Trial: a multicentre randomized controlled trial comparing the efficacy of conventional open surgery and laparoscopic surgery for incisional hernia repair. *BMC Surgery.* 2013;13(1):18. DOI: 10.1186/1471-2482-13-18.
15. Holzman MD, Purut CM, Reintgen K, Eubanks S, Pappas TN. Laparoscopic ventral and incisional hernioplasty. *Surg Endosc.* 1997;11(1):32-5. DOI: 10.1007/s004649900290.
16. Froylich D, Segal M, Weinstein A, Hatib K, Shiloni E, Hazzan D. Laparoscopic versus open ventral hernia repair in obese patients: a long-term follow-up. *Surg Endosc.* 2016;30(2):670-5. DOI: 10.1007/s00464-015-4258-y.
17. Rogmark P, Petersson U, Bringman S, Eklund A, Ezra E, Sevoni D, et al. Short-term outcomes for open and laparoscopic midline incisional hernia repair: a randomized multicenter controlled trial: The ProLOVE (Prospective Randomized Trial on Open Versus Laparoscopic Operation of Ventral Eventrations) Trial. *Ann Surg.* 2013;258(1):37-45. DOI: 10.1097/SLA.0b013e31828fe1b2.
18. Lee J, Mabardy A, Kermani R, Lopez M, Pecquex N, McCluney A. Laparoscopic vs open ventral hernia repair in the era of obesity. *JAMA Surg.* 2013;148(8):723-6. DOI: 10.1001/jamasurg.2013.1395.
19. Zhang Y, Zhou H, Chai Y, Cao C, Jin K, Hu Z. Laparoscopic versus open incisional and ventral hernia repair: a systematic review and meta-analysis. *World J Surg.* 2014;38(9):2233-40. DOI: 10.1007/s00268-014-2578-z.
20. Sains PS, Tilney HS, Purkayastha S, Darzi AV, Athanasiou T, Tekkis PP, et al. Outcomes following laparoscopic versus open repair of incisional hernia. *World J Surg.* 2006;30(11):2056-64. DOI: 10.1007/s00268-006-0026-4.