



Comparative Prospective Study of Ventral Hernia Repair: Laparoscopic Versus Open Technique

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Abstract

Background: Repair of ventral hernia has changed dramatically over past decades with introduction of laparoscopy. The objective of this study is to compare outcome of patients after laparoscopic and open hernia repair in terms of duration of surgery, postoperative pain, hospital stay, return to normal activities, and recurrence of hernia.

Methods: This was a prospective observational comparative study in GSVM Medical college Kanpur. Total no of patient were 60, out of 60, 30 patients were operated by laparoscopic and 30 patients by open method.

Results: The mean age for laparoscopic repair group was 36.53 years and for open group was 46.76 with p value >0.05 . Laparoscopic hernia repair requires mean duration of surgery 94.2 min and open hernia repairs requires 80.83 with p value <0.05 . Post operative pain, hospital stay and return to normal activities were significantly low in laparoscopic group as compared to open group. There were fewer complications in laparoscopy group.

Conclusions: The findings of our study shows that laparoscopic repair requires longer duration of surgery, shorter hospital stays, lesser analgesia, fewer complications, and early return to normal activities. Hence it can be considered as the procedure of choice for ventral hernia repair.

Keywords: Ventral hernia, open ventral hernia repair, laparoscopic ventral hernia repair.

Introduction

Ventral hernia is defined by a protrusion through the anterior abdominal wall fascia. These defects can be categorized as spontaneous (primary) or acquired or by their location on the abdominal wall. Epigastric hernias occur from the xiphoid process to the umbilicus, umbilical hernias occur at the umbilicus, and hypogastric hernias are rare spontaneous hernias that occur below the umbilicus in the midline. Acquired hernias typically occur after surgical incisions and are therefore termed incisional hernias.¹ Prospective

studies have reported an incidence of between 7.4 and 11%.²

Surgical repair can be done by open and laparoscopic method. Almost 50% of incisional hernias develop within the first 2 years after the primary surgery, and 74% develop after 3 years.³ The recurrence rate of incisional hernia with primary suture repair is approx 50% and has been reduced upto 10- 23% after the introduction of prosthetic material in hernia repair.⁴ To reduce recurrence rate of open mesh repair of incisional hernia, leblanc in 1993 introduce laparoscopic incisional hernia repair using a synthetic mesh.⁵

In this modern era of surgery patient wants less hospital stay with best cosmesis hence laparoscopic surgery has gained paramount importance due to its minimally invasive technique.

Objectives of Study

1. To study “duration of surgery” between laparoscopic and open ventral hernia repair.
2. To study “postoperative pain” after laparoscopic and open ventral hernia repair.
3. To study “post operative hospital stay” after laparoscopic and open ventral hernia repair.
4. To study “return to normal activities” after laparoscopic and open ventral hernia repair.
5. To study “recurrence of ventral hernia” after laparoscopic and open ventral hernia repair

Materials and Methods

Study Design: Prospective non randomized study.

Source and method of Collection of Data

Patients admitted with ventral hernia during January 2017 to October 2018 at G.S.V.M Medical College & L.L.R and associated hospitals, Kanpur are taken up for study with the help of relevant history, clinical examination and appropriate investigations.

Inclusion Criteria

1. Patients admitted in the departments of general surgery and diagnosed to have ventral hernia between 18 to 60 yrs age.
2. Patients who would be informed about the study, would have read understood and signed the patient informed consent and would be willing to submit postoperative follow up and evaluations.

Exclusion Criteria

1. BMI more than 30kg/m².
2. Large hernia defects size more than 10cm.

3. Recurrent incisional hernia (Previous mesh plasty).
4. Patient having tubercular abdomen, abdominal malignancy, ascites, medical and surgical contra indication to general anaesthesia.
5. Patients having inguinal, femoral, obturator, parastomal, and lumbar hernia are not included in study.

Methodology

All patients were evaluated by obtaining proper history and detailed physical examination and routine investigations. All patients received antibiotic prophylaxis just before surgery.

Procedure for open surgery

Almost all the patients were operated under spinal anaesthesia. Foleys catheterization and nasogastric tube were occasionally used. Patients were placed in supine position. Skin incision was made according to the site and size of the defect and type of hernia. The hernia sac was dissected out and reduced and the defect assessed. When there were adhesions, sac was opened and contents were reduced. In onlay repair, polypropylene mesh is sutured over the anterior rectus sheath. The mesh is fixed at its four corners with non absorbable sutures. Suction drain was placed in few cases based on the surgeon's choice. Skin and subcutaneous tissue closed in layers.

Procedure for laparoscopic surgery

All the patients were operated under general anaesthesia. Nasogastric tube was placed for upper abdominal hernia and a Foleys catheter for lower abdominal hernias. Both are removed after the procedure on the operating table.

Patient position: Patient is in supine position without any tilt. **Position of surgical team:** The operating surgeon stands to the left of the patient with the camera man on his right or left depending on the location of hernia.

Operative technique: Pneumoperitoneum established by verres needle in palmers point, 2 to 3cm below the left costal margin in the midclavicular line. A 10 mm camera port is placed at this point and the intraabdominal pressure is maintained at 12 mm Hg. Two additional 5mm ports are placed depending on the type of hernia under direct vision. Adhesiolysis was done using sharp dissection or monopolar diathermy.



Figure: adhesiolysis of sac

Defect is delineated. A thread was passed through the 5mm port and the defect size measured intracorporeally. The size of the mesh required is assessed. The area to be covered by the mesh is marked after the pneumo peritoneum is released and the sites for transfacial sutures marked with the defect at its centre. The mesh is rolled around the grasper and inserted through the 10 mm port.

Mesh is unfolded so that polyester side facing abdominal wall and blue side coated with polyurethane facing abdominal viscera mesh was fixed transfacially at corner with suture (polypropylene 1-0) provided along with mesh with help of spinal or cobbler needle absorbable tackers also used to fix mesh all around and corner. At the completion of the procedure, the ports are withdrawn under vision. 10 mm port is closed with 2-0 polyglactin. Skin closed with ethilon 3-0. A compression dressing is placed in the area of defect to reduce the incidence of post operativeroma.

Mesh used: In open we used polypropylene mesh and in laparoscopy we used dual or composite mesh.

All patients were followed postoperatively 1st 2nd week and 3rd 6th and 12th months for any complications. Postoperative pain was compared using visual analog score (VAS).. In VAS 0 signifies worst pain and 10 signifies no pain at all.

Statistical analysis: chi-square or fischer’s exact test has been used for categorical variables and T test for continuous variables. A P–value <0.05 taken as significant. SPSS version20 was used for statistical analysis.

Results

The study consist of 30 patients undergone open ventral hernia repair (ovhr) and 30 patients undergone laparoscopic ventral hernia repair (lvhr).

Age Distribution of Patients Studied

Table – 1

Age in years	Open group		Laparoscopic group	
	Number	Percentage	Number	Percentage
	(n)	%	(n)	%
21 – 30	2	6.6	5	16.6
31 – 40	7	23.3	15	50
41 – 50	11	36.1	9	30
51 – 60	9	30	1	3.4
0Mean age	46.76		36.53	
SD	8.57		6.45	

P = >0.05 (statistically not significant)

The maximum number of patients in open group i.e.20 (66.1%) are in the age group of (41-60) while in the laparoscopy group there are in the age

group of 31-50 i.e.24 (80%). The mean age of the patients in open group is 46.76 years whereas in laparoscopy group it is 36.83 years.

Gender Distribution

Table 2

Gender	Open group		Laparoscopic group	
	Number (n)	Percentage %	Number (n)	Percentage %
Male	17	56.6	12	40
Female	13	43.4	18	60
Total	30	100	30	100

P =0.098 (statistically not significant)

Out of the 30 patients in open group 17 (56.6%) are male while 13 (43.4%) are females whereas in

laparoscopy group. Out of 30 patients 12 (40%) are male while 18 (60%) are females.

Distribution of Duration of Surgery

Table 3

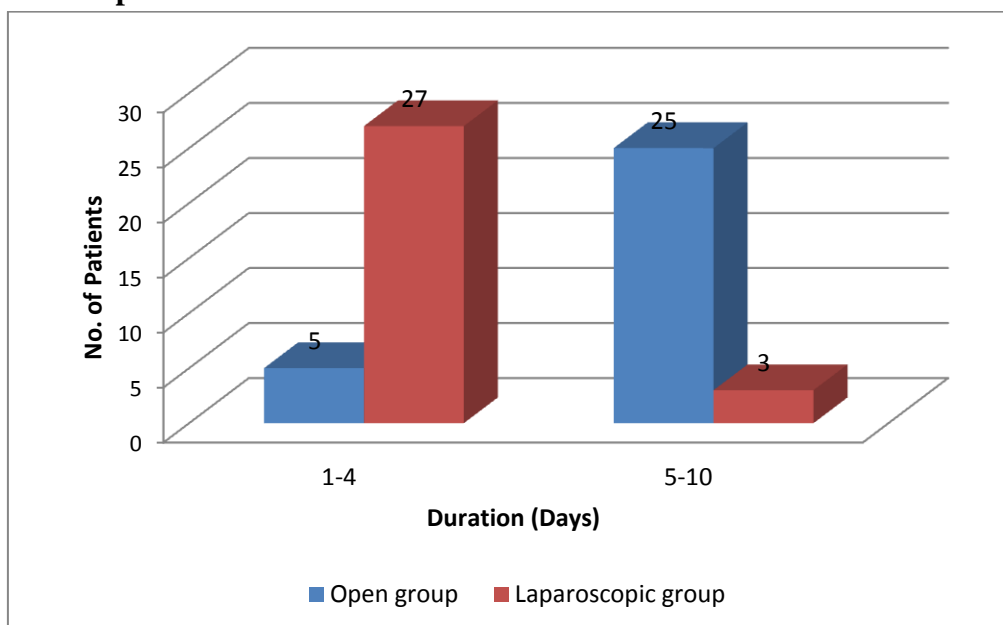
Duration of surgery (mins)	Open group		Laparoscopic group	
	Number (n)	Percentage %	Number (n)	Percentage %
61-80	16	53.4	3	10.0
81-100	14	46.6	17	56.6
101-120	0	0	9	30
>120	0	0	1	3.4
Mean	80.83min		94.2min	

P <0.001 (statistically significant)

In open group, most of the surgeries i.e.16 (53.4%) patients the duration of surgery was 61-80 minutes, while in laparoscopic group17 (56.6%) patients the duration of surgery was 81 – 100 minutes.

The mean duration of surgery in open group is 80.83 minutes while in laparoscopic group it is 94.2 minutes.

Distribution of Post Operative Pain



P <0.01 (statistically significant)

In open group 25(83.34%) patients the postoperative pain evaluated by visual analog score lasted for 4-10 days, while in laparoscopy group 27(90%)patients it was for 1 – 4 days.

The mean duration of pain was 5.66 days in open group while it is3.23 days in laparoscopy group.

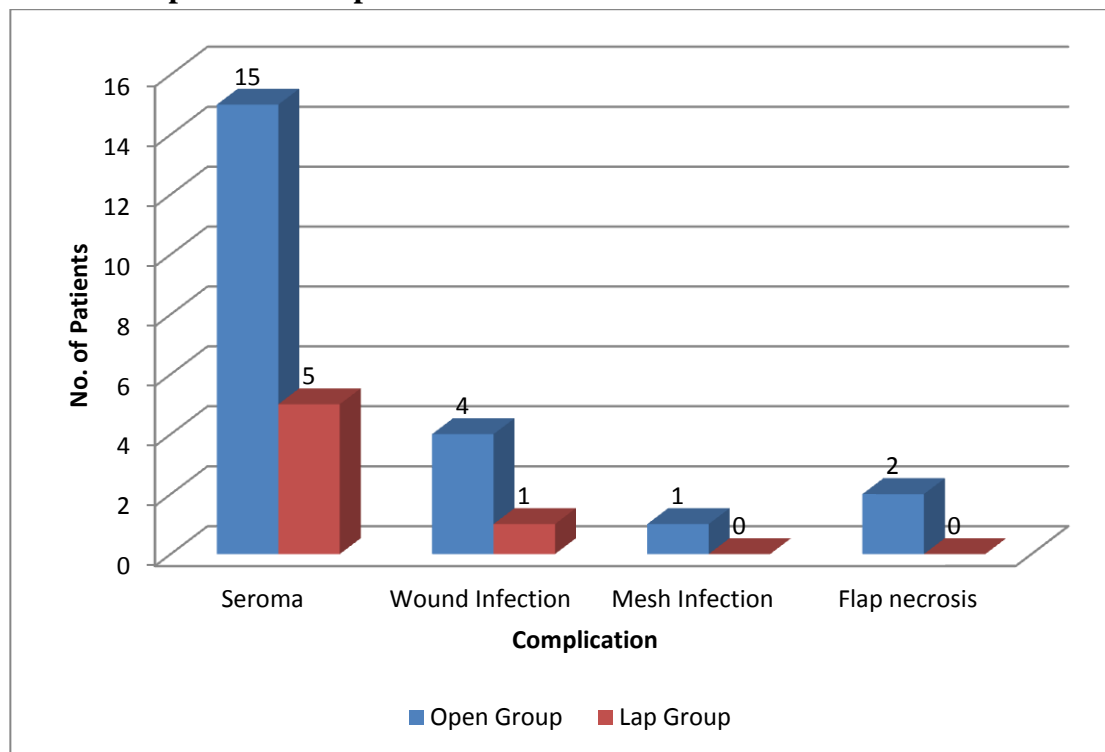
Distribution of Vas for pain at 1st 3rd and 3rd Month

Table 3

Variables	Mean		P value
	Open group	Lap group	
VAS score at day 1	4.56	5.56	<0.05
VAS score at day 3	6	8.1	<0.05
VAS score at 3 mo	8	9	<0.05

p(<.05) value is significant for VAS at day1,3, 3rd month.

Distribution of Post Operative Complications



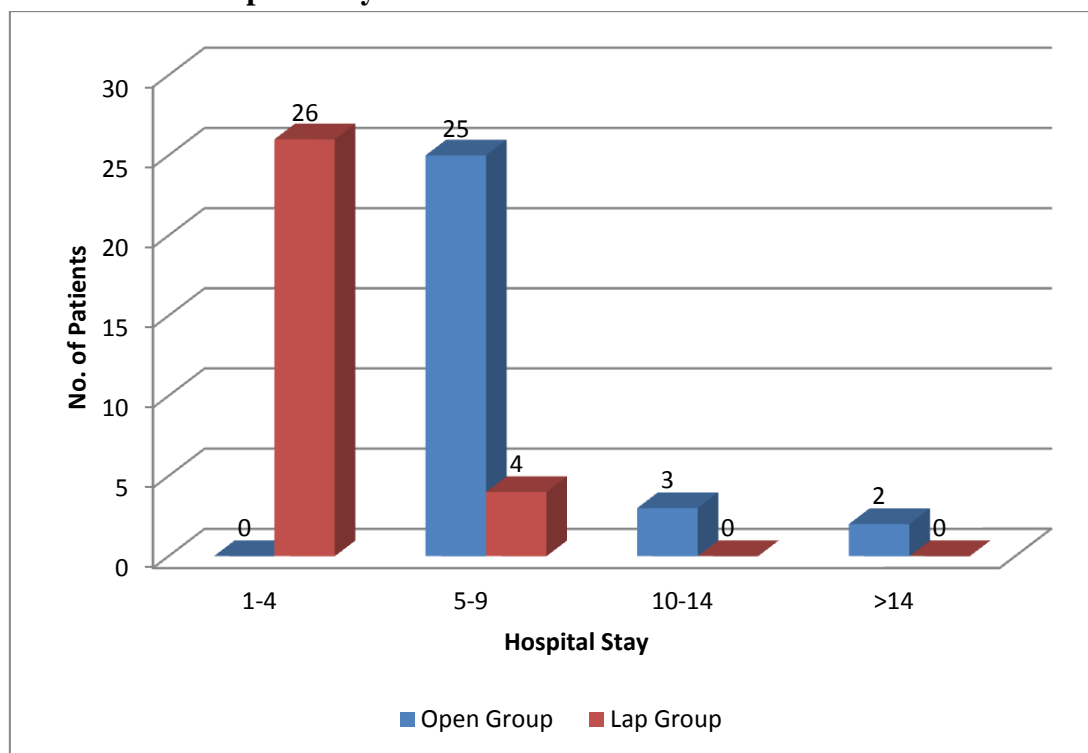
Z=5.30, p<0.05(statistical significant)

Postoperative seroma was seen in 15 (50%) patients in open group, while it was present in 5 (16.6%) in laparoscopy group. All patients in laparoscopy group, the seroma reduced with conservative management in less than 10days.in the open group, in 13 patients the seroma was managed conservatively, while in 2 patients, aspiration was done. Superficial wound infections was seen in 4 (19.5%) patients in open group, while it was present in 1(3.3%) in laparoscopy

group. Superficial infections in both group were managed conservatively by dressing and antibiotics. 1(3.3%) patient had mesh infection, requiring daily debridement and in hospital treatment for around 20 days. 2(6.6%) patients had superficial necrosis of flap margins treated by minor debridement and daily dressing.

With a P value of <0.05 laparoscopic ventral hernia repair was much better in terms of complications.

Distribution of Lenth of Hospital Stay



P value =<0.05 (Statistically significant)

In open group, length of hospital stay for most of the patients i.e. 25(83.4%) was 5-9 days, while in

laparoscopy group most of the patients i.e. 26 (86.6%) was for less than 5 days.

Distribution of Return to Normal Activity

Table 4

Return to normal activity (days)	Open group		Laparoscopic group	
	Number (n)	Percentage(%)	Number (n)	Percentage
1 – 5	1	3.3	23	76.6
6 – 10	26	86.7	6	20
>10	3	10	1	3.4
Total	30	100	30	100

P value <0.05 (statistically significant)

In open group, majority of the patients i.e. 26 (86.7%) patients took 6- 10 days to return to their normal activity, while in laparoscopy group almost all the patients i.e. 29 (96.6%) took less

than 10 days for the same. In open group mean time for return to normal activity is 9.43days while in laparoscopic it is 5.26days.

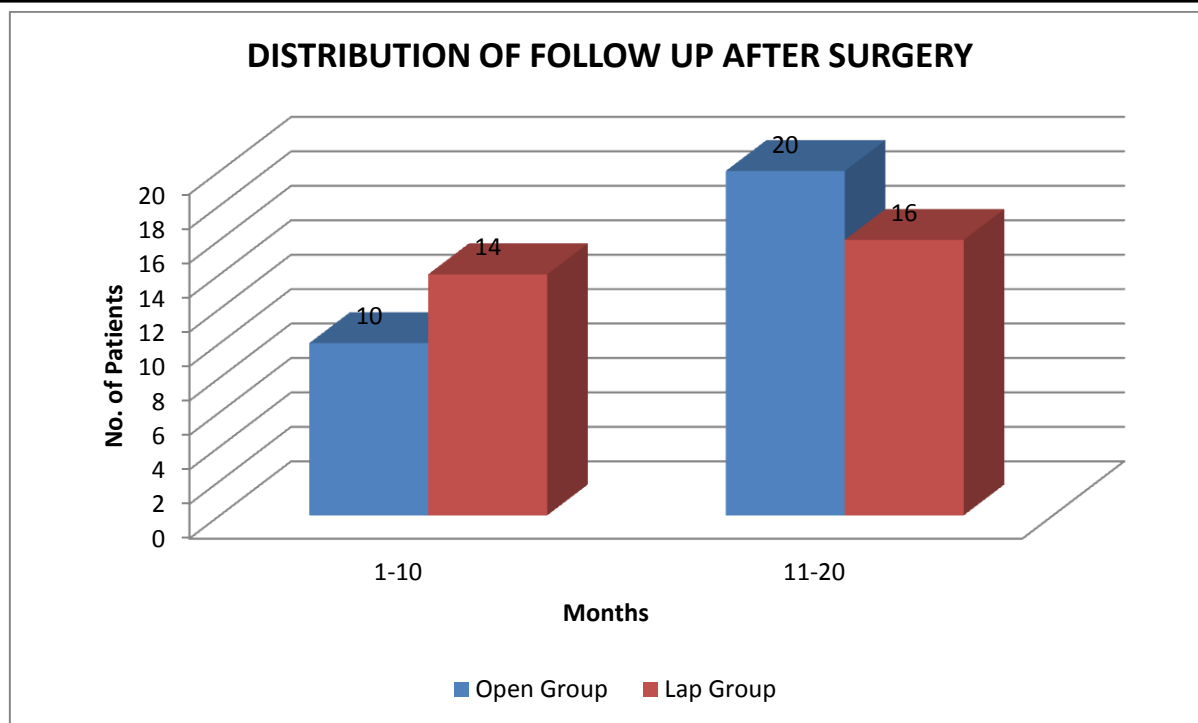
Distribution of follow up after Surgery

Table 5

Follow up months	Open group		Laparoscopic group	
	Number (n)	Percentage(%)	Number (n)	Percentage
1 – 10	10	33.4	14	46.6
11 – 20	20	66.6	16	53.4
Total	30	100	30	100
Mean	11.33months		11.03 months	

P value =>0.05 (statistically not significant)

The mean follow up in open group is 11.33 months, while in laparoscopy group is 11.03 months.



Distribution of Intraoperative Complications

Table 6

Complication	Open group		Laparoscopic group	
	Number	Percentage	Number	Percentage
	(n)	%	(n)	%
Bowel injury	1	3.3	0	0
Bleeding	0	0	1	3.3

In open group 1(3.3%) patient had bowel injury. There was no spillage and hence a mesh was placed.

In laparoscopy group 1(3.3%) had an accidental injury to inferior epigastric artery was controlled by a transfascial suture. Drain was placed which was removed on postoperative day 3

Discussion

The present study includes a total of 60 patients, 30 in the open group and 30 in the laparoscopy group. In one of the largest studies conducted by Carbajo et al⁶ there were a total of 60 patients, 30 in open group and 30 in laparoscopy group. In one of the recent RCT conducted by Itani et al⁷ in 2010, a total of 146 patients are randomized such that 73 patients underwent conventional repair and 73 underwent laparoscopic repair

In the present study, the mean age is comparable between the two groups: 46.76 yrs. in open group

and 36.53 yrs. in laparoscopy group. In the study conducted by Misra et al⁸ in 2006 the mean age of the patients in open group is 45.2 yrs. and laparoscopy group is 45.96 yrs. In the study conducted by Barbaros et al⁹ the mean age in laparoscopy group was 50.7 yrs. and in open group was 54.1 yrs.

In the present study of ventral hernia consisting of epigastric, umbilical, para umbilical and incisional hernias, majority of the patients in open group had incisional hernia (43.4%) while in laparoscopy group majority were umbilical hernia (46.7%)

In our study, male to female ratio was 1:1.03 which is comparable to studies by Goel et al¹⁰ (1981) reported male to female ratio as 1:1.25, and Shukla et al¹¹ (1998) reported ratio 1:9.19,20 Higher incidence in female population is explained as the gynecologic surgeries are the leading cause of incisional hernia.

In the present study most of the patients were males in open (56.6%) whereas in laparoscopy group most were females (60%). In the study conducted by Itaniet al⁷ majority were men in both open (91.8%) and laparoscopy (91.8%) groups. In the study conducted by Misraet al⁸ about 80% were females in both the groups

In the present study, majority of patients i.e. 15(50%) had defect size less than 3x3 cms. in open group whereas in laparoscopy group 18(60%) patients had defect size less than 3x3 cms. In the study conducted by Rogmark et al¹² the mean defect size was 25cm² in open group and 36cm² in laparoscopy group. In the study conducted by Navarro et al¹³ mean defect size was 45.2cm² and 37.2cm².

The operating time is one of the detrimental factors in the assessment of the effectiveness of the procedure. In the present study, the mean operating time was 80.83mins in open group and 94.2mins in laparoscopy group. The above values (P = <0.05) are significant statistically.

In the study conducted by Asencio et al¹⁴ and Eker et al¹⁵ reported lesser operating times in open group. In the studies conducted by Olmi et al¹⁶ and Carbajo et al⁶, showed significant reduced time in laparoscopic surgery when compared to conventional surgery.

Laparoscopic approach carries the risk of intestinal or bladder injury intraoperatively. In the present study 2 events of intra operative complications have occurred. One bowel injury are reported in open group and the one intra operative complication that occurred in the laparoscopy group is the bleeding from the inferior epigastric artery, which was controlled by transfascial sutures. Studies showed variable rates of bowel injuries like Rogmark et al¹², with 4.6% for laparoscopic group versus 1.4 for open group; Barbaros et al⁹, with 4.3% for laparoscopic group and no bowel injury in open group; and Itani et al⁷, with 4.1% for laparoscopic group and no bowel injury in open group

In the present study, the mean duration of postoperative pain in open group is 5.66 days,

while in laparoscopy group is 3.23 days, P <0.05, which is statistically significant

This goes with the study of Navarra et al¹³ with significant difference in postoperative pain between laparoscopic and open groups, as mean analgesic requirement was 1.4 for laparoscopic group versus 4.9 for open group. However, in Eker et al¹⁵ at the 4-week follow-up, 25% of the laparoscopic group and 24% of the open group reported persisting pain, requiring prolonged analgesia use.

One of the main advantages of laparoscopic repair is the decreased wound related complications. Almost all the RCTs except Asencio et al¹⁴ 2009 reported decreased wound related complications with laparoscopic repair. Amongst all, the most common complications are seroma formation and superficial wound infection. Seroma rates are higher in open group in the studies conducted by Asencio et al¹⁴ Misraet al⁸ and Pring et al¹⁷, while Itani et al⁷ 2010 reported lower seroma rates in laparoscopy group. Wound infection rates are higher in open group in all the studies. Heniford BT et al¹⁸ concluded from his study that wound infection is lower in laparoscopic hernia repair compared to open, as there is decreased extent of tissue dissection in the former. Similar results were seen in to Lomanto D et al¹⁹, Itani KM et al⁷, McGreevy JM et al²⁰ that Laparoscopic repair had fewer postoperative complications than those receiving open mesh repair.

In the present study, the seroma rate is 50.0% in open group when compared to 16.6% in laparoscopy group. Itnai et al⁷ also reported lower seroma in laparoscopic group. The wound infection rate in open group is 13.4% in open group when compared to 3.3% in laparoscopy group (p <0.05), Heinford et al¹⁸ reported that wound infection is lower in laparoscopic hernia compared to open as there is less tissue dissection in lap group. Mesh infection is observed in 1 (3.3%) patients in open group and no patients in laparoscopy group. Mesh infection was controlled by conservative methods.

In the present study, the mean length of hospital stay was 7.20 days in open group compared to 3.46 days in laparoscopy group. The Pvalue is <0.05, which is statistically significant. In two RCTs conducted by Carbajo et al⁶(lap2.23 days) & (open9.06days) and Moreno egea et al²¹(lap 1 day) & (open 5.2days)showed significant difference between the two groups and favoured laparoscopy.

In present study return to normal activities in open group was 9.43 days and in laparoscopic group 5.26days which is stastitatically significant(<0.05) Return to normal work (in days) was also earlier in laparoscopic repair (10.6) as compared to open mesh repair (14.75) and the difference was statistically significant (p=0.0002). Itani KM et al⁷ showed laparoscopic group had shorter

postoperative duration for return to normal work (28.5 days) as compared to those who had open mesh repair (23.0 days).²⁶ But Rosen MJ et al²² showed that there is no significant difference in return to regular work.

In our study recurrences of hernia was observed in none of our patients.it may because of less number of patients and less follow up time.Rogmark et al¹² study also does not show any recurrence. In other studies, Lomanto D et al¹⁹ rate of recurrence after laparoscopic repair was 2% as compared to open group (10%). In Itani KM et al⁷, over all recurrence at 2 years was 12.5% in lap group and 8.2% in open group. Eker et al¹⁵ shows a recurrence rate of 18.05% in lap group and 14% in open group.

Comparison with other Studies

Reference	Patient(s)		Operating time(Min)		Length of hospital stay (days)		Infection%		Seroma		Follow up months		Recurrence	
	Open	Lap	Open	Lap	Open	Lap	Open	Lap	Open	Lap	Open	Lap	Ope n	Lap
Hoiziman et al	16	20	98	128	5	1.6	6	5	5	0	19	10	13	10
Ramshaw et al	174	79	82	58	2.8	1.7	3	0			21	21	7	0
Mishra et al	33	33	75	86	1.47	3.43	33.3	6.06	3.03	12.1	12.17	13.73	3.3	6.2
Parke et al	49	56	78	95	6.5	3.4	2	00	2	4	54	24	35	31
carbajo et al	30	30	112	87	9.1	2.2	18	00	67	13	27	27	7	0
Itani et al	73	73	-	-	4	3.9	24.66	5.47	24.6	8.2	24	24	8.	12.5
Present study	30	30	80.83	94.2	7.20	3.46	13.4	3.3	50	16.6	11.3	11.3	0	0

Conclusion

Although the duration of surgery is an important issue, it depends on many factors like surgeon expertise, type of adhesions, size of defect. In our study duration of surgery in open repair is less than laparoscopic repair which is statistically significant

In the present study we found that post perative pain was marginally less in laparoscopic group as compared to open group (mean VAS score on day 1 5.56 and 4.56 respectively).

Most of our patients in lap group were subjectively more comfortable in post op period and were ambulant on POD 1 day while in open group on 2nd POD.

In aspect of postoperative complications like seroma formation, wound infection, mesh

infection we found that laparoscopy gives best result.

In our study laparoscopy group also shows less hospital stay and early return to work in comparison of open group.

There is no recurrence of hernia in our study in any group, which is statistically in significant (as duration of follow up is less)

Cost factor need to be addressed with respect to LVHR main contributor to cost of lap repair is use of dual mesh and use of disposable tacker to fix mesh in place. The minimal hospital stay and better post op satisfactory level in LVHR with respect to OVHR compensates the cost of tacker and dual mesh.

Nowadays, laparoscopic repair of ventral hernia is being accepted by most of surgeons and patients.

Almost all ventral hernia can be repaired by laparoscopy regardless of morbid obesity and age group.

Laparoscopic hernia repair is a complex but very efficient method in experienced hands. To achieve the best possible result it requires an acceptance of a learning curve, Laparoscopic ventral hernia repair has shown promising results and a clear advantage over open repair in regard with reduced postoperative pain, decreased postoperative complications, reduced length of hospital stay, and less time for return to normal activity . Hence, laparoscopic ventral hernia repair is a safe and feasible alternative to open repair.

Declarations

Funding: None

Conflicts of interest: None declared.

Ethical approval: The work has been approved by the institutional ethics committee, GSVM Medical college, Kanpur UP ,india.

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References

1. Mark A. Malangoni, Michael J. Rosen. Sabiston textbook of surgery, 19th edition. United States, Saunders;2012:1128-9.
2. Cassar K, Munro A. Surgical treatment of incisional hernia. Br J Surg. 2002;89:534-45.
3. Anthony T, Bergen PC, Kim LT, Henderson M, Fahey T, Rege RV, et al. Factors affecting recurrence following incisional herniorrhaphy. World J Surg. 2000;24:95–100.
4. Luijendijk R, Hop W, Van den Tol MP, de Lange DC, Braaksma MM, IJzermans JN, et al. A comparison of suture repair with mesh repair for incisional hernia. N Eng J Med. 2000;343:392–8.
5. Leblanc KA, Booth WV. Laparoscopic repair of incisional abdominal hernias using polytetrafluoroethylene: preliminary findings. Surg Laparosc Endosc. 1993;3:39–41.
6. Carbajo MA, Martin del Olmo JC, Blanco JI et al (1999) Laparoscopic treatment vs open surgery in the solution of major incisional and abdominal wall hernias with mesh. Surg Endosc 13:250–252.
7. Itani KM, Hur K, Kim LT et al (2010) Comparison of laparoscopic and open repair with mesh for the treatment of ventral incisional hernia: a randomized trial. Arch Surg 145:322–328.
8. Misra MC, Bansal VK, Kulkarni MP et al (2006) Comparison of laparoscopic and open repair of incisional and primary ventral hernia: results of a prospective randomized study. Surg Endosc 20:1839–1845.
9. Barbaros U, Asoglu O, Seven R et al (2007) The comparison of laparoscopic and open ventral hernia repairs: a prospective randomized study. Hernia 11:51–56.
10. Goel TC, Dubey PC. Abdominal incisional hernia- anatomical technique of repair. Ind J Surg. 1981;43:324-7.
11. Shukla VK, Gupta A. Cardiff repair of incisional hernia : a university hospital experience. Eur J Surg. 1998;164:271-4.
12. Rogmark P, Petersson U, Bringman S et al (2013) 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 258:37–45
13. Navarra G, Musolino C, De Marco ML et al (2007) Retromuscular sutured incisional hernia repair: a randomized controlled trial to compare open and laparoscopic approach. Surg Laparosc Endosc Percutan Tech 17:86–90.

14. Asencio F, Aguilo J, Peiro S et al (2009) Open randomized clinical trial of laparoscopic versus open incisional hernia repair. *Surg Endosc* 23:1441–1448
15. Eker HH, Hansson BM, Buunen M et al (2013) Laparoscopic vs. open incisional hernia repair: a randomized clinical trial. *JAMA Surg* 148:259–263
16. Olmi S, Scaini A, Cesana GC et al (2007) Laparoscopic versus open incisional hernia repair: an open randomized controlled study. *Surg Endosc* 21:555–559.
17. Pring CM, Tran V, O'Rourke N et al (2008) Laparoscopic versus open ventral hernia repair: a randomized controlled trial. *ANZ J Surg* 78:903–906.
18. Heniford BT, Park A, Ramshaw BJ, Voeller G. Laparoscopic ventral and incisional hernia repair in 407 patients. *J Am Coll Surg*. 2000;190:645-50.
19. Lomanto D, Iyer SG, Shabbir A, Cheah WK. Laproscopic versus open ventral hernia mesh repair. *Surg Endosc*. 2006;20(7):1030-5.
20. McGreevy JM, Goodney PP, Birkmeyer CM, Finalayson SRG, Laycock WS, Birkmeyer JD. A prospective study comparing complications rates between laparoscopic and open ventral hernia repairs. *Surg Endosc*. 2003;17(11):1778-80.
21. Moreno-Egea A, Carrasco L, Girela E et al (2002) Open vs laparoscopic repair of spigelian hernia: a prospective randomized trial. *Arch Surg* 137:1266–1268.
22. Rosen MJ, Duperier T, Onders R, Hardacre J, Ponsky J, Ermlich B, Laughinghouse M. Prospective randomized double blind placebo controlled trial of post-operative pain pump devices used after laparoscopic hernia repair. *Surg Endosc*. 2009;23(12):2637-43.