

Comparative Outcomes of Onlay and Sublay Meshplasty in Ventral Hernias

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Abstract:

Background: Ventral hernia repair is one of the most common procedures performed in general surgery. Onlay and sublay mesh repair both are well established techniques for the locations of mesh placement, but with various benefits and drawbacks. About 15-18% of all the surgical procedures performed around the world comprises of hernia repair. This study was aimed to compare the outcome of hernia repair between two techniques, common options of mesh placement in open ventral hernia repairs; over the anterior rectus sheath, the Onlay meshplasty and in the retrorectus plane, the Sublay meshplasty.

Methods: A prospective controlled study was done between March 2022 to January 2024 on 86 patients, aged 18-70 years with ventral hernia randomizing patients into 2 groups. Group A (Onlay meshplasty) and Group B (Sublay meshplasty). Primary outcome was recurrence and secondary outcomes included postoperative complications including surgical site infection, hematoma, seroma, wound dehiscence, peri-operative pain, persistent seroma, and chronic pain. Duration of surgery, post-operative pain, wound infection, duration of hospital stay and recurrences were analysed with 3 months follow up.

Results: The mean duration of surgery in group A was 67.75±23.92 minutes and in group B was 79.63±18.71 minutes. Group B experienced significantly lesser pain when compared with group A. The mean asepsis score in group A was 3.60±1.09 and in group B was 1.47±0.30 with a p value of 0.05. Group A had significantly longer hospital stay (7.85±2.41 days,) than group B (5.40±1.29 days). The recurrences were found statistically significant (Group A- 4 /9.30% patients; No patient in Group B).

Conclusions: Sublay meshplasty although required longer time to perform. Sublay repair seemed to be a better alternative than onlay repair of Ventral hernia. Randomised controlled trial with larger sample size is required to validate the result.

Keywords: Ventral hernia, Hernia repair, Mesh repair, Meshplasty, Onlay, Sublay, Retrorectus repair.

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Introduction

A hernia is the protrusion of an intra-abdominal organ through a defect in the abdominal wall. The majority of defects are present in the inguinal region, femoral region, and anterior abdominal wall. The term ventral hernia describes any hernia due to inadequacy of the anterior abdominal wall muscles.[1] In recent times, there has been a significant rise (13%–23%) in ventral hernias and its repair[2].

Etiology: The formation of ventral hernias is a multifactorial and complex process. Three types of ventral hernias are recognized: Spontaneous,

congenital, and incisional hernias. In 90% of patients, if is an acquired defect that is a direct result of increased abdominal pressure. Causes of this increased abdominal pressure included multiparous status, obesity, and cirrhosis with ascites. Numerous patient-related factors may lead to the formation of ventral hernias and included obesity, older age, male gender, sleep apnea, emphysema and other chronic lung conditions, prostatism, abdominal distention, steroids, and jaundice, although some of these causes are controversial. Some evidence suggests that certain

biochemical processes, including the metalloproteinase, may lead to both aneurysmal disease and hernia formation. These collagen defects have also been implicated in a higher rate of incisional hernia formation after aortic surgery. The concept of "metastatic emphysema," that is, the same processes that break down pulmonary tissue disturb normal fascia. Incisional hernias are unique in that they are the only abdominal wall hernias that are considered to be iatrogenic. It continues to be one of the more common complications of abdominal surgical procedures and is a significant source of morbidity and loss of time from productive employment. Many Studies have shown that transverse incisions are associated with a reduced incidence of incisional hernia compared to midline vertical laparotomies [3,4].

A meta-analysis of 11 studies examined the incidence of ventral hernia formation after various types of abdominal incisions has concluded that the risk was 10.5% for midline, 7.5% for transverse, and 2.5% for Para median incisions.[5]. A prospective randomized trial had reported no difference in hernia formation in comparing midline versus transverse incisions after 1 year but noted a higher wound infection rate in the transverse incisions [6]. A few data were available about the natural history of untreated ventral hernias. As noted, asymptomatic or minimally symptomatic inguinal hernias purposely observed during 2 years have a low incidence of complications. Whether this paradigm applied for asymptomatic ventral or incisional hernias was unclear. Because there was no prospective cohort available to determine the natural history of untreated ventral hernias, most surgeons recommend that these hernias be repaired when discovered [7].

Classification: Ventral hernias classified in to: umbilical, paraumbilical, Epigastric and incisional [8].

Ventral hernia treatment modalities:

Ventral hernia treatment modalities vary from conservative management to surgical options such as open procedure, laparoscopic method, and further advanced robotic surgeries. Suturing alone remains acceptable for tiny defects while mesh support is recommended for elective repair of incisional hernias or a primary ventral hernia ≥ 2 cm in width with no contamination.[9,10] The gold standard management of elective ventral hernias is mesh insertion. An increased understanding of the anterior abdominal wall anatomy demonstrated different placements of the mesh. General surgeons

chose the onlay – over the rectus mesh repair and sublay – preperitoneal/retrorectus mesh repair as favourites of the open ventral hernia repairs, run deep to and opposite the external oblique. The deepest muscle layer of the abdominal wall is the transversus abdominis muscle. Its fibers course in a horizontal direction. These three lateral muscles give rise to a poneurotic layers lateral to the rectus, which contribute to the anterior and posterior layers of the rectus sheath. The medial extension of the external oblique aponeurosis forms the anterior layer of the rectus sheath. At the midline, the two anterior rectus sheaths form the tendinous linea Alba. On either side of the linea Alba are the rectus abdominis muscles, whose fibers are directed longitudinally and run the length of the anterior abdominal wall. Below each rectus muscle lies the posterior layer of the rectus sheath, which also contributes to the linea Alba. Another important anatomic structure of the anterior abdominal wall is the arcuate line, which is located 3 to 6 cm below the umbilicus. The arcuate line delineates the point below which the posterior rectus sheath is absent. Above the arcuate line, the aponeurosis of the internal oblique muscle contributes to the anterior and posterior rectus sheaths, and the aponeurosis of the transversus abdominis muscle passes posterior to the rectus muscle to form the posterior rectus sheath. Below the arcuate line, the internal oblique and transversus abdominis aponeuroses pass completely anterior to the rectus muscle. The posterior rectus sheath below the arcuate line is composed of the transversalis fascia and peritoneum only. The abdominal wall receives most of its innervation from intercostal nerves 7 through 12 and the first and second lumbar nerves. These force provide innervation to the lateral abdominal muscles and the rectus muscle and overlying skin. The nerves traverse through the lateral abdominal wall between the transversus abdominis and internal oblique muscles and penetrate the posterior rectus sheath just medial to the line a semilunaris. The lateral abdominal muscles receive their blood supply from the lower three or four intercostal arteries, deep circumflex iliac artery, and lumbar arteries. The rectus abdomen is has a more complex blood supply derived from the superior epigastric artery (a terminal branch of the internal mammary artery), inferior epigastric artery (a branch of the external iliac artery), and lower intercostal arteries. The superior and inferior epigastric arteries anastomose near the umbilicus. The periumbilical area provides critical perforator vessels that, if preserved, can decrease skin flap necrosis during extensive skin undermining [11,12].

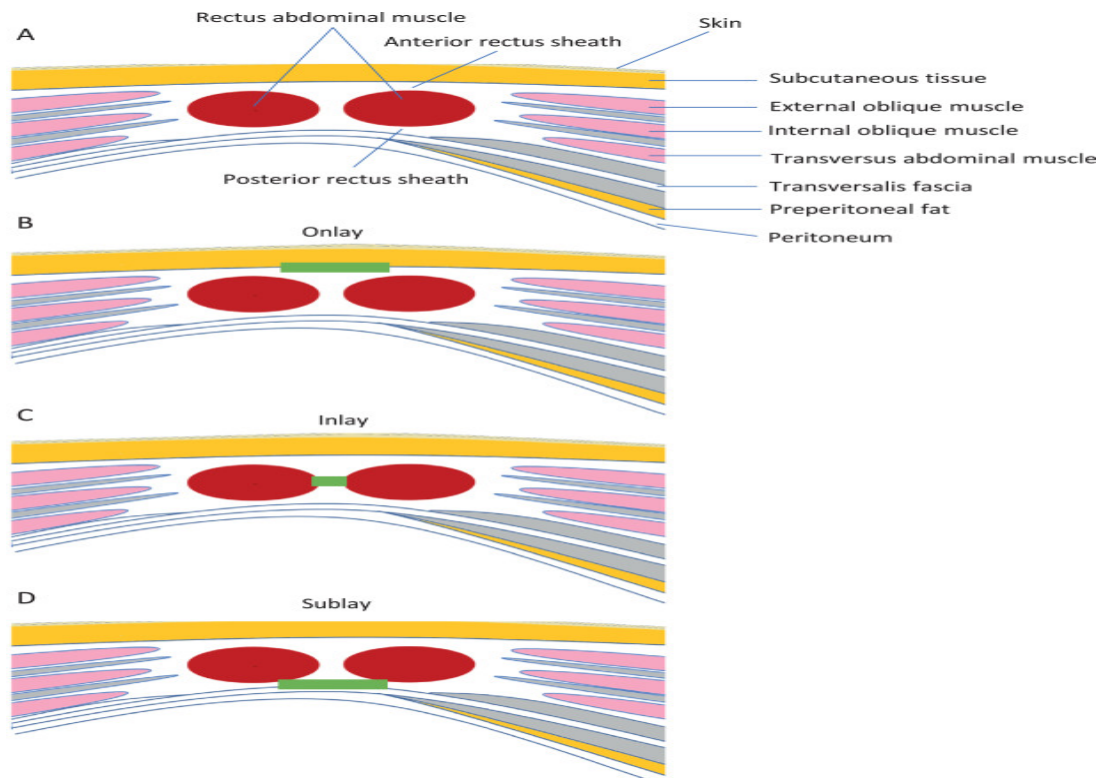


Figure 1: Several techniques of mesh repair for incisional or ventral hernia according to the location of mesh placement [11]

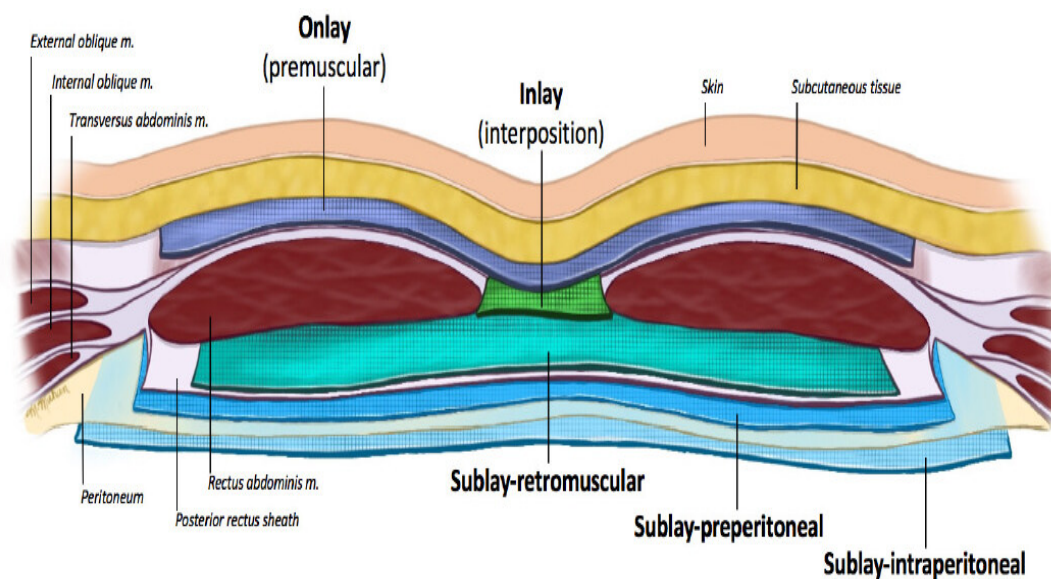


Figure 2: Abdominal wall demonstrating mesh planes [12]

The advantages of mesh implantation have first been confirmed by an influential trial [7]. Open mesh repair was superior to suture repair in terms of recurrences and an insufficient evidence as to which type of mesh or which mesh position (on- or sublay) should be used [13,14].

Many studies demonstrated an increased risk for wound complications with mesh placement including surgical site infections, seroma and flap necrosis. The risks of these complications are

affected by where the mesh is placed. For example, mesh exposed to intra-abdominal contents potentially increases the risks of adhesions, bowel obstruction, and fistula formation [15]. While repair of ventral hernias with mesh was considered routine, there was no consensus on the best location to place the mesh [16]. The aim of the present study was to find a comparison between the postoperative and short-term outcomes of onlay

and retrorectus (sublay) mesh placements as ventral hernia repair methods.

Materials and Methods:

The study was carried out on 86 patients, aged 18-70 years with ventral hernia at the Department of Surgery, Hind Institute of Medical Sciences, Safedabad, Barabanki, UP, India, from March 2022 to January 2024. All study patients were randomly divided into 2 groups. Group A (Onlay meshplasty) and Group B (Sublay meshplasty); with 43 patients in each group irrespective of their sex.

Inclusion Criteria: All patients with ventral hernia, including paraumbilical, epigastric, and incisional, except with defect more than 6 cm, aged 18-70 years without sex discrimination were included.

Exclusion Criteria: (1) Patients under the age of 18 years. (2) Groin hernia and complicated hernia. (3) HIV, HBSAO, HCV, and immunocompromised patients. (4) Pregnancy. (5) Recurrent hernia. (6) Incision hernia with defect more than 6 cm. (7) Patients with liver cirrhosis and end-stage liver disease. (8) Patients with abdominal malignancy. (9) Chronic obstructive pulmonary disease.

Methods:

Patients who met the inclusion and exclusion criteria were enrolled in this single center prospective study after obtaining informed consent.

The study included all cases operated for ventral hernias, including incisional hernia, umbilical, supraumbilical, and epigastric hernias, which underwent onlay or sublay mesh repair.

Intraoperative duration of surgery and postoperative complications such as surgical site infections, seroma formation, flap necrosis, duration of hospital stay, and recurrence were evaluated.

Operative technique: Onlay meshplasty: Under general anesthesia, a skin incision was made over the bulge or defect, and subcutaneous flaps were raised above the anterior rectus sheath. The hernia sac was dissected, and its contents were reduced. The margins of the defect were held by Kocher forceps, and the sac was dealt with and reduced. The defect in the linea alba was closed with non-absorbable suture, and a prolene mesh of appropriate size was placed on the rectus sheath and secured with stitches. Hemostasis was secured, and the wound was closed over a suction drain. All patients were given 1 gm of third-generation cephalosporin antibiotic preoperatively at the time of induction, which was continued until the third postoperative day twice daily.

Sublay meshplasty: After the hernia sac was dissected and delineated, the defect was opened, and the preperitoneal space was created between the posterior rectus sheath and the rectus muscle for the placement of the mesh. The posterior rectus sheath and the peritoneum were closed with non-absorbable sutures. A prolene mesh tailored to the size was placed in the already created plane behind the recti. The mesh was secured with a few interrupted 2/0 polypropylene sutures. The anterior rectus sheath was closed with continuous 1/0 polypropylene suture, and the skin was closed.

Southampton wound grading system: The Southampton system is much simpler than the ASEPSIS system, with wounds being categorized according to complications, if any, and their extent. Southampton scale by using the worst wound score recorded and information about any treatment instituted either in hospital or the community, wounds were regarded in four categories: a. Normal healing b. Minor complication c. Wound infection d. Major hematoma. It was used in our study.

Table 1: Southampton wound assessment scale [14]

Grade	Appearance
0	Normal healing
I	Normal healing with mild bruising or erythema
	I a Some bruising
	I b Considerable bruising
II	I c Mild erythema
	Erythema plus other signs of inflammation
	II a At one point
	II b Around sutures
	II c Along wound
III	II d Around wound
	Clear or haemoserous discharge
	III a At one point only (≤ 2 cm)
	III b Along wound (>2 cm)
	III c Large volume
IV	III d Prolonged (> 3 days)
	Pus
	IV a At one point only (≤ 2 cm)
V	IV b Along wound (>2 cm)
	Deep or severe wound infection with or without tissue breakdown; hematoma requiring aspiration

Statistical analysis: The collected data were tabulated according to the pre-designed proforma and analyzed with IBM SPSS statistics software version 23.0.

The Chi-Square test was used to find the significance in categorical data. The significant level was set at a probability value of ≤ 0.05

Results: A total of 86 patients with a ventral hernia, aged 18-70 years; were divided equally into

two groups based on the procedure followed for placement of mesh in hernia repair, namely, onlay (group-A) and sublay (group-B). Each group had 43 patients.

The mean age was 42.13 ± 11.71 years. There were 57 (66.27%) females and 29 (33.72%) males. The mean value of body mass index (BMI kg/m^2) was $27.15 \pm 4.04 \text{ kg/m}^2$. The demographics of all included patients were listed in Table-2 and figure-3.

Table 2: Age (years) and Gender distribution of patients of two groups

Age Years	Onlay, N=43		Sublay, N=43	
	Male N=16	Female N=27	Male N=13	Female N=30
≥ 18	1/6.25 %	2/7.4 %	1/7.69	4/13.33%
21-30	3/18.75 %	5/18.51%	2/15.38	3/10%
31-40	1/6.25	3/11.11 %	1/7.69	2/6.660
41-50	4/25.00	4/14.81%	2/15.38	6/20%
51-60	7/43.75	11/40.74%	6/46.15%	13/43.33%
61-70	0	2/7.40%	1/7.69	2/6.66%

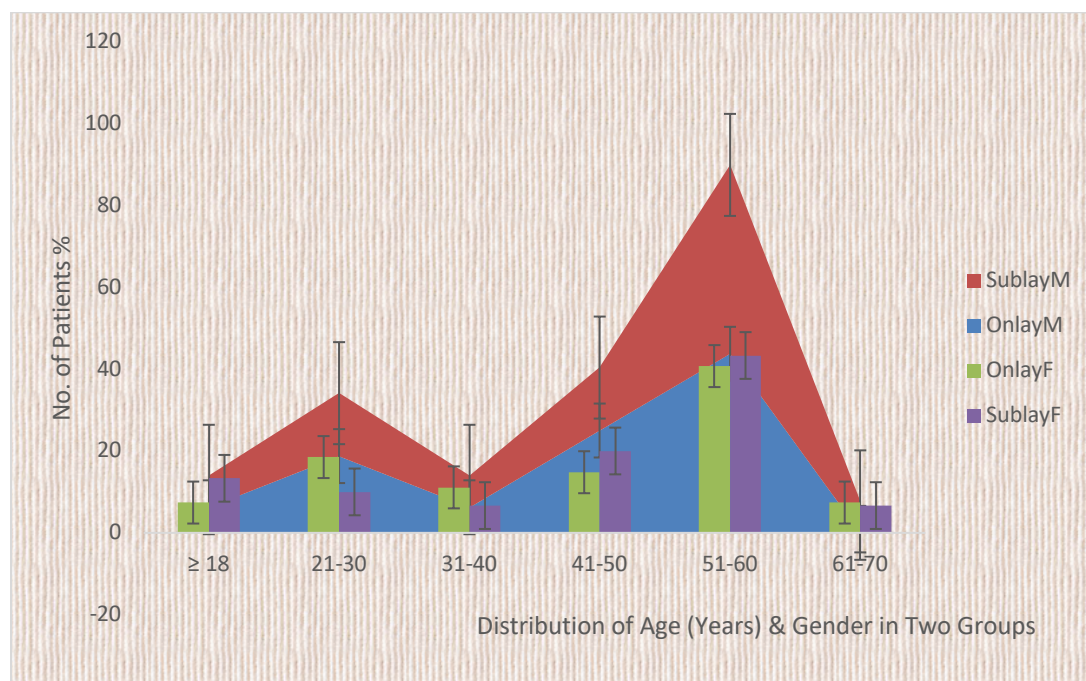


Figure 3: Age (years) and Gender distribution of patients of two groups

Table-2 and figure-3, revealed that the maximum number of patients (Group-A, Male-43.75%, Female-40.74%, whereas in Group-B, Male-46.15%, Female-43.33%) were found in the age group of 51-60 years, whereas minimum number of patients were observed in the age group of 61-70 years. In this study the demographic and clinical parameters were compared between the groups of placements of mesh, age, gender, BMI, comorbidities and past surgical history. In most of the cases the difference was found significant statistically ($P < 0.05$).

Table 3: Types of hernia in studied patients (N=86) of both groups.

Type of hernia	Frequency, N=86 %	Onlay, N=43 %	Sublay, N=43, %
Paraumbilical hernia	40/ 46.51%	22/ 51.62%	18 /41.86%
Epigastric hernia	16/ 18.60%	7/16.27%	9 /20.93 %
Incisional hernia	30/34.88%	14/32.55%	16/37.20%
Total	86	43	43

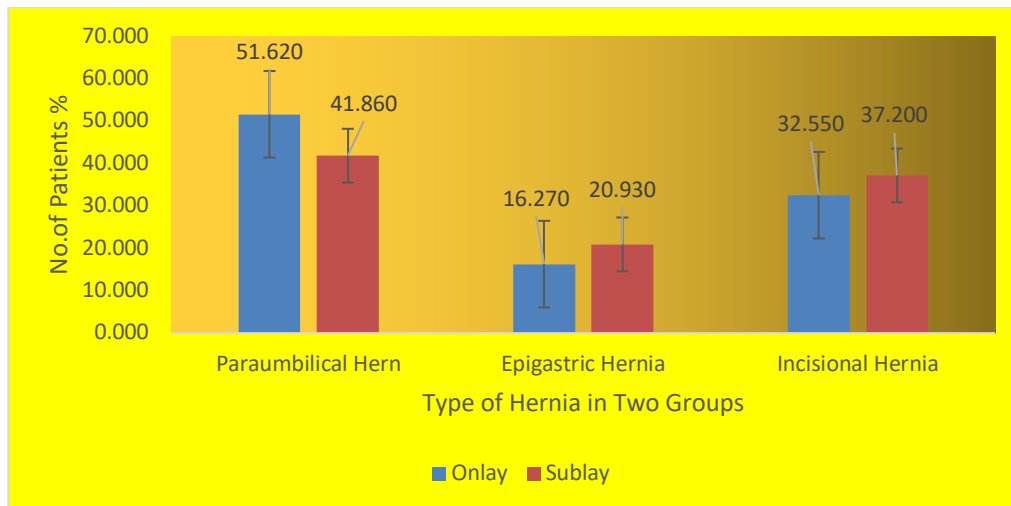


Figure 4: Types of hernia in studied patients (N=86) of both groups

Table-3 and figure-4, illustrated that the out of 86 patients, 40, 46.51% patients were under paraumbilical hernia, it was also found that the 22 (51.62%) patients were in onlay (group-A) group, whereas 18 (41.86%) patients were in sublay (group B) group. Epigastric hernia was observed in only 16 (18.60%) patients out of 86.

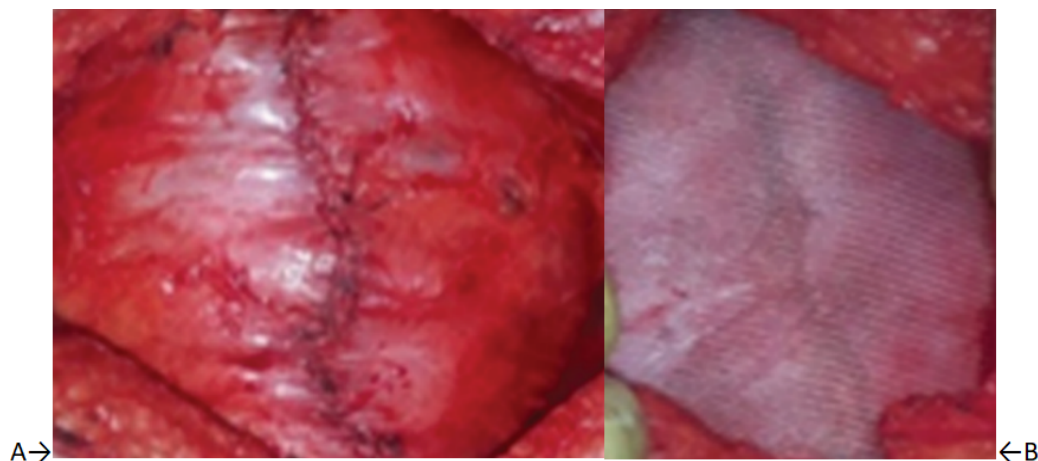


Figure 5 (A & B): A-Creation of plane between posterior sheath and the rectus muscle before putting mesh. B-Prolene mesh was placed in the plane created behind the recti creation of plane between posterior sheath and the rectus muscle.

Table 4: Surgical Characteristics

Characteristics	Mean±SD		P value
	Onlay (n=43)	Sublay (n=43)	
Duration of surgery (min)	67.75±23.92	79.63±18.71	0.05
Duration of drain (days)	7.02±3.24	5.80±2.63	0.05
Day of discharge (POD)	7.85±2.41	5.40±1.29	0.05
Size of defect (cm)	3.8±0.61	3.9± 0.83	0.05
Pain score (1-10)	4.61±0.88	3.58±0.75	0.05

P ≤ 0.05 was considered statistically significant. SD: Standard deviation, POD: Postoperative day.

Table-4, illustrated that the mean duration of surgery was 70.75 ± 23.92 min, in group A, and 79.63±18.71min in group B; the duration of the drain was 7.02 ± 3.24 days in onlay group whereas it was 5.80±2.63 in sublay group and the pain score was 4.61 ± 0.88 in Group A and 3.58±0.75 in group B. It was found significant, p=0.05

Table 5: Incidence of surgical site infection as per the Southampton wound scoring between study groups

SSI (yes)	Frequency (%)		P value
	Onlay (n=43)	Sublay (n=43)	
2	31/72.09%	37/86.04%	0.05
3a	2 /4.65%	3 /6.97%	0.05
3b	2 /4.65%	2/4.65%	0
3c	3 /6.97%	1/2.32%	0.05
3d	2 /4.65%	0	0.05
4a	1 /2.32%	0	0.05
4b	1 /2.32%	0	0.05
5a	1 /2.32%	0	0.05

P=0.2184. SSI: Surgical site infections. Table-5: Mild erythema and inflammation ie. Grade II was found in maximum number of postoperative patients of both groups, it was 72.09% in Onlay group and 86.04% in Sublay group, but deep or severe wound infection ie. Grade Va, was found in only in onlay group. It was found significant, p=0.05. There was a higher incidence of high severity SSIs as per the Southampton wound scoring reported in onlay group than sublay group (grade-III to V).

Table 6: Distribution of patients according to postoperative complications in two procedure groups

Postoperative complications	Frequency (%)		P value
	Onlay (n=43),%	Sublay (n=43),%	
Seroma	8 /13.95%	2 /4.65%	0.05
Wound edge necrosis	5/ 11.62%	2 /4.65	0.05
Wound hematoma	1/2.32%	0	0.05
Mesh removal	1/ 2.32%	0	0.05
Recurrence	4 /9.30%	0	0.05
Neuralgia	1/ 2.32	0	0.05

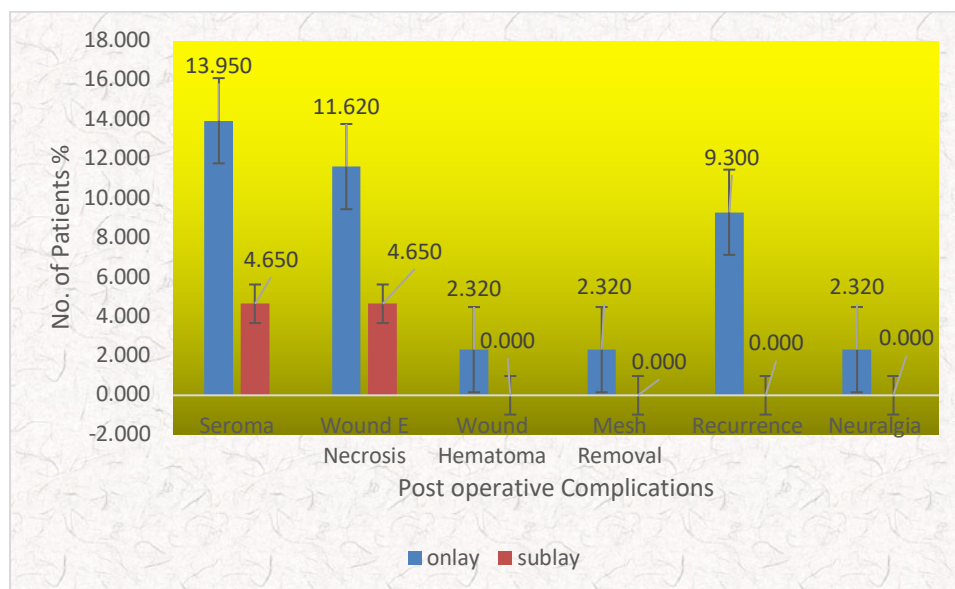


Figure 6: Distribution of patients according to postoperative complications in two procedure groups

Table-6 and figure-6, illustrated that the seroma, wound edge necrosis and recurrence were found in maximum number of patients in onlay group as compared to sublay. It was also found statistically significant, p=0.05. Neuralgia was also found in one patient (2.32%) in onlay group. The most common postoperative complication recorded was Seroma followed by wound edge necrosis.

Table 7: Distribution of patients according to pain score in two procedure groups

Pain Score	Frequency (%)		P value
	Onlay (n=43)	Sublay (n=43)	
3	1/2.32%	2/4.65%	0.69
4	29/67.44%	30/69.76%	0.05
5	11/25.58%	10/23.25%	0.05
6	1/2.32%	1/2.32%	-
7	1/2.32%	0	0.05

The pain scores were found significantly higher in the groups A as compared to group B. The above data were summarized in Table-7.

Discussion

The repair of ventral hernias varies from primary closure only, primary closure with relaxing incisions, primary closure with onlay mesh reinforcement, onlay mesh placement only, inlay mesh placement, and intraperitoneal mesh placement. Primary closure techniques are usually performed for small fascial defects less than 5 cm in greatest diameter [17]. Mesh repair is an excellent method of repair, preferred for patients with a large defect in the anterior abdominal wall, especially with more than 4-cm size defect. An excellent method that had been used is called Rives-Stopa technique, where mesh was placed between the peritoneum and abdominal wall or rectus muscle and posterior rectus sheath [18]. The reinforcement of sublay technique decreased the recurrence rates and gave a better outcome, concluding it to be the standard of care of ventral hernia [19].

When considering the best location for placement of mesh, a number of features are to be considered. Firstly, techniques that avoid the devascularisation of flaps will prevent wound complications like infections, flap necrosis and surgical site infections. Secondly, technical ease and duration of surgery may affect the surgeon's choice. Sublay repair allows tissue integration from two load-bearing tissues from both sides: posterior rectus sheath and the anterior myo-fascial complex. In addition, Sublay mesh placement protects the mesh from exposure from superficial wound complications, intra-abdominal adhesions, and contamination. Creation of devascularizing skin flaps is avoided. Onlay allows for tissue in growth from two directions, the skin flaps are not load bearing. Mesh placed in the onlay location is vulnerable forcing the surgeon to create devascularizing skin flaps and leaving the mesh susceptible to superficial wound complication [13].

In our study the duration of surgery was significantly lesser in onlay repair compared to sublay repair, whereas the duration of the drain was statistically lower in sublay mesh group compared to onlay. The age, BMI, did not differ among the groups. There was an significantly higher incidence of seroma, wound edge necrosis, and SSIs in onlay

group as compared to sublay. Duration of surgery: Mean duration of surgery in our study, in cases that underwent onlay mesh plasty was 67.75±23.92 mins and in pre-peritoneal mesh repair it took more time and the average duration of surgery was 79.63±18.71 mins. The difference could be accounted to more time required for dissection for creating pre-peritoneal space. A similar study had reported a mean duration of 49.35 min for onlay and a mean duration of 63.15 min for pre-peritoneal mesh repair (P < 0.0001)[20], while in another study series the mean duration for onlay and pre-peritoneal mesh repair were 42 and 70.5 min, respectively [21].

Seroma was the most common complication observed in our study, it was 10 patients. Out of patients, 2 (4.65%) were in preperitoneal and 8 (13.95%) in onlay mesh repair group. This complication was managed with seroma drainage. Onlay technique had more seroma formation, due to the fact that onlay technique requires significant subcutaneous dissection to place the mesh, which can lead to devitalized tissue. A study of 100 patients, which reported 14 percent in onlay group and 4% in sublay group [21]. A Similar study also reported 18 and 4 percentages in onlay and sublay group respectively [22].

Surgical site infections, the superficial location of the mesh also put it in danger of becoming infected if there is a superficial wound infection. Wound infection (edge Necrosis) was found in 7 cases. Out of these, 2 (4.65%) were in a pre-peritoneal group and 5 (11.62%) were in onlay group. In a study of 60 patients found surgical site infection (wound edge necrosis) in 6 cases (10%). Out of these, 2 (6.66%) were in a pre-peritoneal group and 4 (13.33%) [23]. this was similar to our study. These patients were treated with appropriate antibiotics and regular dressing. No patient required removal of mesh because the infection was superficial and responded well to antibiotics [23].

Wound hematoma, it was seen in one patient. The one patient (2.32%) was seen in onlay group with a nil occurrence in sublay group. This was similar to a study conducted with a group of 100 patients, 8(16%) developed discoloration of skin in onlay meshplasty with nil occurrence in sublay group. All the patients were treated conservatively for wound hematoma [24].

Hospital stay, the duration of post-operative hospital stay is an indirect indication of the degree of morbidity in terms of postoperative complications. Average post-operative hospital stay period for onlay mesh repair was 7.85 ± 2.41 days, as compared to 5.40 ± 1.29 days for preperitoneal mesh repair ($P < 0.05$), which were comparable to previous studies [24,25]. Recurrence, the recurrence rates by onlay and sublay mesh repair techniques remain controversial. According to a previous study the recurrence rates were similar by onlay and sublay mesh repair techniques. In a randomized controlled trial with a 5-year follow-up, reported that sublay mesh repair has a significantly higher recurrence rate than onlay mesh repair (20% vs. 12%, respectively)[26]. A study also reported recurrence rates of 7.4% by onlay mesh repair and 13.6% by sublay mesh repair [27]. Moreover, a similar study reported recurrence rates of 10.5% using onlay mesh repair and 2% using sublay mesh repair [28]. A meta-analysis, reported no difference in recurrence rates [29]. Our study has shown 9.30% recurrence in onlay group only. In a study, the recurrence rates using onlay and sublay mesh repair techniques were found to be similar, ie. 8% using onlay mesh repair and 4% using sublay mesh repair [30].

Conclusion

Sublay mesh repair is a good alternative to onlay mesh repair that may be applicable to all forms of ventral hernia as the mesh related overall complication rate like seroma, surgical site infections, flap necrosis, hospital stay and recurrence are less compared to onlay meshplasty. Although time taken for surgery in sublay mesh repair is significantly higher compared to onlay mesh repair, complications and morbidity associated with it are significantly lower than onlay repair. Hence, sublay mesh repair could be used as the preferred method of choice for the treatment of ventral hernias.

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