

On-Lay Versus Sub-Lay Mesh Repair for Ventral Hernia: A Retrospective Cohort Study

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Abstract

Background: The most feared complication of hernia surgery is recurrence. There is no standard technique by which recurrence can be avoided.

Objective: This study was conducted to test the hypothesis of whether the outcomes of sub-lay mesh are better than on-lay mesh repair for ventral hernias.

Methods: This retrospective cohort study was conducted on patients who underwent open ventral hernia repair from 1st June 2016 - 31st April 2021. The primary outcome was recurrence and secondary outcomes were operative time, Surgical Site Infection (SSI) within 30 days, and seroma.

Results: A total of 187 patients underwent ventral hernia repair and 69 were included in the study *i.e.* 35 in the sub-lay and 34 in the on-lay group. Both the groups were comparable for the baseline variables *i.e.* age, gender distribution, BMI, type of hernia, and content, with mean \pm standard deviation age of 48.89 years \pm 15.32 in the sub-lay and 52.7 \pm 12.3 in the on-lay group; however, the on-lay mesh was observed to be a preferred approach in patients with obesity or small defect $<$ 5 cms. No statistically significant difference was observed between sub-lay and on-lay groups for recurrence (2.9% vs. 5.7%, p-value 0.51), SSI (8.6% vs. 2.9%, p-value: 0.31), Mesh infection (2.9% vs. 2.9% p-value: 0.74), duration of surgery (median: 120 vs. 121 minutes, p-value 0.36) and seroma formation (2.9% vs. 2.9%, p-value 0.74), respectively.

Conclusion: This study demonstrates no significant differences between sub-lay vs. on-lay mesh placement in terms of recurrence, seroma formation, and operative time; however, with the slightly higher (statistically insignificant) frequency of SSI in the sub-lay group.

Keywords: Surgical Site Infection, Seroma, Recurrence, Mesh infection, Paraumbilical hernia, Incisional hernia.

INTRODUCTION

Ventral hernias are a common encounter in surgical clinics. One Danish study reports the 5-year prevalence of umbilical hernia to be 0.53% [1]. The incidence of incisional hernia may be up to 11% after major abdominal surgery [2]. The risk of recurrence after open repair without mesh is reported to be higher than repair with mesh [2-4] and has led to the usage of mesh as the standard of care [5, 6]. Depending on a surgeon's preference, the mesh may be placed in any of the three fashions: Sub-lay, on-lay, and inlay. Different techniques have variable outcomes [7].

There is a paucity of literature comparing the outcomes of various mesh placement techniques, with inconclusive results regarding the use of one technique over another [7, 8]. Recurrence was reported to be higher in the on-lay technique when compared with sub-lay (10.5% vs. 2%) in one study [9] and (20% vs. 4%) in another study, respectively, with complication rates similar in both [10]. Sevinç *et al.* described recurrence rates to be similar in both techniques *i.e.* 6% [11]. Post-operative wound complication rate was higher in the on-lay group when compared with sub-lay (49.1% vs. 24%) according to one study [9].

The objective of this study is to test the hypothesis of whether the outcomes of sub-lay mesh are better than on-lay mesh repair for the treatment of ventral hernias

METHODS

This retrospective cohort study was conducted in the department of general surgery at a tertiary care hospital on patients aged 18-80 years who underwent open ventral hernia repair starting 1st June 2016 to 31st April 2021 and had a minimum of six months follow-up from surgery. Patients who underwent any other procedure at the same time as hernia repair and those, in whom critical data (exposure and outcomes) was missing, were excluded from the study.

After taking approval from Hospital Ethics Committee (PH/IRB/2021/122), a list of patients was retrieved from Hospital Information Management System (HIMS) using International Classification of Diseases (ICD-9) codes 551.20 (ventral hernia), 553.21 (Incisional hernia), 553.1 (umbilical and para umbilical hernia).

The primary outcome was the incidence proportion of recurrence determined with at least 6 months follow up from surgery and secondary outcomes included operative time, mesh infection, SSI within 30 days, and seroma formation.

SURGICAL TECHNIQUE

All surgeries were performed by the same consultant surgeon with uniform surgical technique and protocol

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for both procedures. Patients who were operated on an elective basis were kept nil per oral at least six hours before surgery. After anaesthesia administration, the operative field was hand scrubbed and then painted with the pyo-iodine solution in a circular manner, from the centre to the periphery. Draping with sterilized sheets The prophylactic antibiotic was administered at the time of induction. The incision was given in the midline or transverse as appropriate with a scalpel.

Sub-lay Repair

The skin incision was carried down through the subcutaneous tissue until the anterior rectus sheath was reached. The hernia sac was identified and dissected away from the surrounding tissues and sheath till the defect was reached. After opening the sac, the contents were examined and reduced. The rectus sheath was incised 1 cm lateral to the edge of the defect to enter the retrorectus space between the posterior lamina of the rectus sheath and the rectus muscle on both sides up to linea semilunaris. Superiorly, the fusion of anterior and posterior lamina at the linea alba was divided. Inferiorly the peritoneum was separated from the rectus muscle. A space was created at least 5 cm all around the defect. If the defect in the posterior lamina could not be closed primarily at this point, transversus abdominis release was performed by separating the transversus abdominis from the peritoneum till the defect in the posterior lamina could be closed primarily without tension using Prolene 2-0. A 30x30 cm size Polypropylene mesh, trimmed to fit the created space, was placed over the closed posterior rectus sheath/peritoneum. Superiorly and inferiorly the mesh was fixed under the surface of linea alba with proline 1 suture. Laterally, the mesh was anchored with the Posterior rectus sheath lamina/peritoneum using Prolene 3-0. The anterior rectus sheath was sutured together with Prolene 1 to reconstruct the linea alba.

On-lay Mesh Repair

Initial steps were similar to sub-lay mesh repair, however after reducing the hernia sac contents and excising the sac, the defect in the rectus sheath was primarily closed with prolene 1-0 continuous sutures. Then the subcutaneous plane was created over the sheath at least 5cm all around the defect. A prolene mesh of appropriate size, covering 5 cm all around the defect, was placed above the defect and anchored on all sides and corners with prolene 3-0 interrupted sutures. Quilting with polypropylene continuous sutures was performed, 3-4cm from the closed defect in a circular fashion.

In both techniques, the drain was placed over the mesh. The subcutaneous tissue was closed in layers using vicryl 2-0 suture. The skin was closed with either staples or subcuticular non-absorbable sutures. The drain was kept till drain fluid became nil or <30ml/day. Patients were followed within three to five post-operative days and advised drain charting. Antibiotics were stopped after drain removal. The drain was

removed in the outpatient department by the consultant surgeon or resident. Sutures were removed around day 14 in almost all patients except for those who developed surgical site infections. In such patients, affected sutures were removed early to drain pus, and the wound was allowed to heal by secondary intention.

Data collection started on 1st August 2021. Data were collected by two surgical residents of the first year, who had assisted in both procedures and were capable of collecting the data as per operational definitions. Data collection took place in twophases: In the first phase; the files, online operative notes, and scanned OPD files were reviewed to collect the data on the demographic variables, operative details, post-operative medications, OPD follow ups and any documented complications. In the second phase, patients were contacted through their contact numbers obtained from records and were asked about any complications in the wound (including surgical site infection, and seroma formation), recurrence, and any other missing data. Patients who could not be reached and in whom critical data was still missing were labelled as lost to follow-up.

SSI was determined according to the United States Centre for Disease Control and Prevention [12] within at least 30 days postoperatively or until complete healing of the surgical site by reviewing the clinic notes. Recurrence of hernia was labelled if it was documented in the file during regular clinic visits or the patient reported a persistent or increasing swelling that bulged out on coughing or the patient reported a hernia repair elsewhere. Seroma was labelled when fluid retention in the surgical field (between the mesh and the anterior abdominal wall) was documented in clinic notes during regular visits or the patient reported a swelling that was aspirated elsewhere [13]. Operative time was taken from skin incision to dressing of the wound as written in post-operative notes.

STATISTICAL ANALYSIS

Data were analysed using SPSS version 21. Continuous variables were reported as mean and standard deviation if normally distributed, otherwise, medians with Inter Quartile Range if the data was skewed. Normality assumption was assessed using the Shapiro-Wilk test. Categorical variables were reported as frequencies and percentages. The chi-square test was applied to compare categorical outcomes among the groups. An Independent t-test was applied to compare normality distributed numerical variables among the two groups whereas non-normally distributed tables among the two study groups were compared using the Mann-Whitney U test. A P-value less than or equal to 0.05 was taken as statistically significant.

Missing data (other than main exposure or outcome variables) was less than 5% and was dealt with by imputation technique based on the data available for that variable.

RESULTS

During the period of this retrospective cohort, 187 patients underwent ventral hernia repair after running ICD codes in the system and 69 were included *i.e.* 35 in the sub-lay and 34 in the on-lay group (Fig. 1).

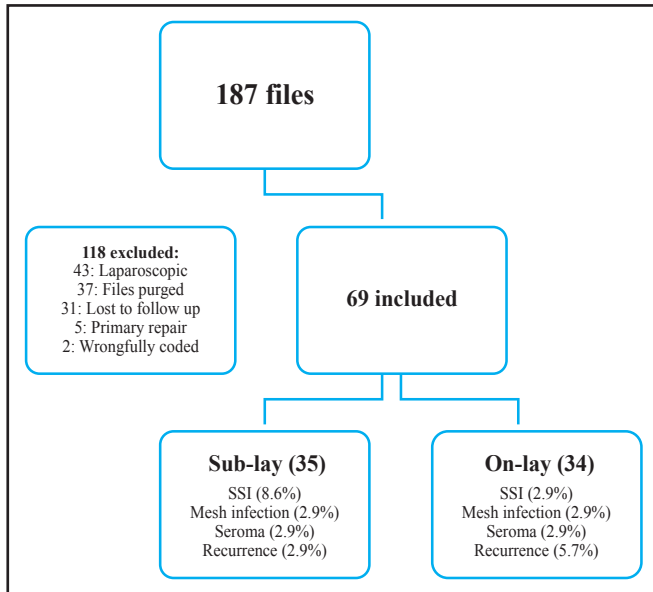


Fig. (1): Flow diagram of the participants assessed, included, and followed for the outcomes.

The Comparison of demographical characters of the two groups revealed mean age for the Sub-lay group and the the on-lay group were 48.89 +/- 15.32 and 52.70 +/- 12.3 respectively. On-lay mesh was observed to be a preferred approach in patients with obesity or small defect <5 cm. Most of the patients in the Sub-lay group received Cefazolin (77.1%), whereas in the on-lay group, the most common antibiotic prescribed was Amoxicillin/Clavunic acid (50%) and antibiotics were continued after surgery in the majority of patients. The median follow-up duration in the on-lay group was 5 years (IQR: 2-5) and 2 years in the sub-lay group (IQR: 0.5-2 years). Asian cut-off for BMI was used [14] (Table 1).

Table 1: Showing demographics.

| | Sub-lay (%) | On-lay (%) | p-value |
|----------------------------------|------------------|------------------|---------|
| Gender | | | |
| Male | 14 (40.0) | 15 (44.1) | 0.729 |
| Female | 21 (60.0) | 19 (55.9) | |
| Age | 48.89 (+/-15.32) | 52.79 (+/-12.30) | 0.254 |
| BMI Asian Cut-off | | | |
| Underweight | 2 (5.7) | 0(0) | 0.075 |
| Normal BMI | 9 (25.7) | 4 (11.7) | |
| Overweight | 5(14.3) | 2 (5.9) | |
| Obese | 19 (54.3) | 28 (82.4) | |
| Charles Comorbidity Index | | | |
| 0 | 15 (42.8) | 9 (26.6) | 0.155 |
| 1 | 4 (11.4) | 8 (23.6) | |
| 2 | 7 (20.2) | 8 (23.6) | |

| | | | |
|--|-----------|-----------|-------|
| 3 | 9 (25.6) | 5 (14.8) | 0.299 |
| 4 | 0(0) | 3 (8.8) | |
| 5 | 0(0) | 1 (2.9) | |
| Procedure | | | |
| Emergency | 4 (11.4) | 7 (20.6) | 0.299 |
| Elective | 31 (88.6) | 27 (79.4) | |
| Type of Hernia | | | |
| Para-umbilical | 17 (48.6) | 18 (52.9) | 0.460 |
| Incisional | 18 (51.4) | 16 (47.1) | |
| Content in Hernial Sac | | | |
| Empty | 3 (8.6) | 2 (5.9) | 0.129 |
| Bowel | 10 (28.6) | 7 (20.6) | |
| Omentum and ligaments | 21 (60.0) | 19 (55.9) | |
| Missing | 1 (2.8) | 6 (17.6) | |
| Size of Hernial Defect | | | |
| Small (<5cm) | 20 (57.1) | 25 (73.5) | 0.334 |
| Medium (5-10cm) | 4 (11.4) | 4 (11.8) | |
| Large (10-15cm) | 6 (17.2) | 3 (8.8) | |
| Giant (>15cm) | 5 (14.3) | 2 (5.9) | |
| Drain Placement | | | |
| Yes | 30 (85.7) | 33 (97.1) | 0.095 |
| No | 5 (14.3) | 1 (2.9) | |
| Skin Closure | | | |
| Suture | 28 (80.0) | 21 (61.8) | 0.095 |
| Staples | 7 (20.0) | 13 (38.2) | |
| Antibiotics (Post-Operative) | | | |
| None | 3 (8.6) | 6 (17.6) | 0.001 |
| Amoxicillin/Clavulanic acid | 4 (11.4) | 17 (50.0) | |
| Ceftriazone | 1 (2.9) | 1 (2.9) | |
| Cefazolin | 27 (77.1) | 10 (29.4) | |
| Follow-up duration in years (median + IQR) | 2 (0.5-2) | 5 (2-5) | |

The comparison of study outcomes between the two surgical groups show that there was no statistically significant difference was observed between sub-lay and on-lay groups for recurrence (2.9% vs. 5.7%, p-value 0.51), SSI (8.6% vs. 2.9%, p-value: 0.31), Mesh infection (2.9% vs. 2.9% p-value: 0.74), duration of surgery (median: 120 vs. 121 minutes, p-value 0.36) and seroma formation (2.9% vs. 2.9%, p-value 0.74), respectively (Table 2).

Table 2: Comparison of outcomes between sub-lay and on-lay mesh repair.

| Variable/Endpoint | Sub-lay (%) | On-lay (%) | p-value |
|--------------------------------|--------------|--------------|---------|
| Duration (minutes) | 120 (86-203) | 121 (74-146) | 0.369 |
| Less than two hours | 18 | 15 | |
| 2 hours or more | 17 | 19 | |
| Surgical Site Infection | 3 (8.6) | 1 (2.9) | 0.318 |
| Mesh Infection | 1 (2.9) | 1 (2.9) | 0.746 |
| Seroma | 1 (2.9) | 1 (2.9) | 0.746 |
| Recurrence | 1(2.9) | 2 (5.7) | 0.511 |

DISCUSSION

In this study, 69 patients were included to determine whether the outcomes of sub-lay repair were superior to on-lay repair and we did not find any statistically significant difference between both techniques.

Literature shows that the most common complication following hernia repair is the formation of a Seroma

which can lead to significant morbidity. Saber *et al.*, Servinc *et al.*, Ahmed *et al.*, and Ismail *et al.* reported seroma to be 6%, 14%, 20% and 3% in on-lay group versus 2%, 2%, 4.61%, and 5% in sub-lay groups, respectively [11, 15-19]. However, among these, the results of Saber *et al.*, and Ahmed *et al.* were the only ones statistically significant. This may be due to the larger sample size in these studies. In contrast, our data showed Seroma formation to be equal in both on-lay and sub-lay repair (**Table 2**).

Ismail *et al.* reported 10% SSI in sub-lay mesh repair and 7% in on-lay and it was statistically insignificant [16]. Saber *et al.*, Sevinç *et al.* and Ahmed *et al.* concluded wound infection to be 4%, 4%, and 9.23% in the on-lay group versus 8%, 4%, and 4.6% in the sub-lay group respectively [11, 15, 19]. SSI in sub-lay vs. onlay repair in our study was 8.6% vs. 2.9% and the difference was statistically insignificant. This could be due to a smaller sample size.

Operative time was shown to be less in the on-lay group in some studies with all results statistically significant [11, 15, 17]. In the present study, however, the operative time was similar in both groups. In the case of hernia repair, recurrence of the hernia is thought to be one of the distressing complications which could lead to re-intervention [17]. Recurrence of hernia has been reported to be 8%, 6%, and 9.5% in on-lay as compared to 3%, 2%, and 17.4% in the sub-lay group [11, 15, 16], respectively. In the present study, recurrence in on-lay repair is 5.7% as compared to 2.9% in sub-lay repair. The higher frequency of recurrence may be attributed to the preference of the sub-lay technique in patients with larger defects (**Table 1**). However, some studies report recurrence after ventral hernia repair to be 10% after long follow-up regardless of the technique used [20] (**Table 3**).

There is no standard of choice of one technique over the other. Other studies also demonstrate insignificant differences [21-24] however, there may be some difference between operative times [22].

Table 3: Comparison of outcomes with other studies.

| Seroma | On-lay(%) | Sub-lay(%) | p-value |
|---------------------------|--------------|--------------|---------|
| Saber (2015) | 6 | 2 | <0.001 |
| Sevinç (2018) | 14 | 2 | 0.027 |
| Ahmed (2019) | 20 | 4.61 | 0.005 |
| Ismail (2021) | 3 | 5 | 0.648 |
| Present study | 2.9 | 2.9 | 1.101 |
| Operative time in minutes | | | |
| Ali (2013) | 49.35±8.29 | 63.15±15 | <0.001 |
| Saber (2015) | 67.04±13.19 | 93.26±24.94 | <0.001 |
| Sevinç (2018) | 56.7±13.7 | 73.9±14.2 | <0.001 |
| Present study | 121 (74-146) | 120 (86-203) | 0.369 |
| Wound infection | | | |
| Saber (2015) | 4 | 8 | 0.231 |
| Sevinç (2018) | 4 | 4.5 | 1.00 |

| Ahmed (2019) | 9.23 | 4.61 | 0.157 |
|---------------|------|------|-------|
| Ismail (2021) | 7 | 10 | 0.509 |
| Present study | 2.9 | 8.6 | 1.029 |
| Recurrence | | | |
| Saber (2015) | 8 | 3 | >0.05 |
| Sevinç (2018) | 6 | 2 | 0.307 |
| Ismail (2021) | 9.5 | 17.4 | 0.192 |
| Present study | 5.7 | 2.9 | 1.029 |

LIMITATIONS

This study is limited with small sample size and retrospective nature. A significant part of the sample size could not be assessed for outcomes as the files were purged or follow-up was not possible (contact number changed or inaccessible) which may have led to inconclusive results. The on-lay mesh was observed to be a preferred approach in patients with obesity or small defect <5 cm, warranting less dissection and fewer chances of SSI. The limitations of Saber *et al.* and Ismail *et al.* were that they excluded infra-umbilical hernias and those that presented with strangulation at presentation. Sevinç *et al.* excluded patients with BMI >40. Ahmed *et al.* excluded patients with co-morbid and emergency cases. In the present study, all these groups were included.

CONCLUSION

This study has shown that there are no significant differences in the outcomes of both groups; therefore, the choice of mesh placement may be left to the surgeon's preference and competency.

ETHICAL APPROVAL

Ethical approval was obtained from the Institutional Review Committee of Patel Hospital, Karachi (PH/IR-B/2021/122). All procedures performed in studies involving human participants were following the ethical standards of the institutional and or national research committee and with the Helsinki Declaration.

CONSENT FOR PUBLICATION

Consent was not required for reviewing the records of the hospital. When patients were contacted for the telephonic interview, verbal consent was obtained.

AVAILABILITY OF DATA

The data set may be acquired from the corresponding author upon a reasonable request.

FUNDING

Declared none.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHOR'S CONTRIBUTION

SAS: designing, data collection, result analysis and interpretation, manuscript drafting, critical review, and revision of the draft.

GM: study concept, designing, result analysis and interpretation, critical review.

OA: manuscript drafting, data collection, critical review, and revision of the draft.

REFERENCES

- Burcharth J, Pedersen MS, Pommergaard HC, Bisgaard T, Pedersen CB, Rosenberg J. The prevalence of umbilical and epigastric hernia repair: a nationwide epidemiologic study. *Hernia* 2015; 19(5): 815-9.
DOI: <https://doi.org/10.1007/s10029-015-1376-3> PMID: 25840852
- Luijendijk RW, Hop WC, 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 Engl J Med* 2000; 343(6): 392-8.
DOI: <https://doi.org/10.1056/nejm200008103430603> PMID: 10933738
- Schumpelick VC, Conze J, Klinge U. Preperitoneal mesh-plasty in incisional hernia repair. A comparative retrospective study of 272 operated incisional hernias. *Chirurg* 1996; 67(10): 1028-35.
DOI: <https://doi.org/10.1007/s001040050099> PMID: 9011422
- Clark JL. Ventral incisional hernia recurrence. *Journal of Surgical Research* 2001; 99(1): 33-9.
DOI: <https://doi.org/10.1006/jsre.2001.6093> PMID: 11421601
- Burger JW, Luijendijk RW, Hop WC, Halm JA, Verdaasdonk EG, Jeekel J. Long-term follow-up of a randomized controlled trial of suture *versus* mesh repair of incisional hernia. *Ann Surg* 2004; 240(4): 578-83.
DOI: <https://doi.org/10.1097/01.sla.0000141193.08524.e7> PMID: 5383785
- Arroyo A, Garcia P, Perez F, Andreu J, Candela F, Calpena R. Randomized clinical trial comparing suture and mesh repair of umbilical hernia in adults. *Br J Surg* 2001; 88(10): 1321-3.
DOI: <https://doi.org/10.1046/j.0007-1323.2001.01893.x> PMID: 1578284
- de VriesReilingh TS, van Geldere D, Langenhorst BL, de Jong D, van der Wilt GJ, van Goor H, *et al.* Repair of large midline incisional hernias with polypropylene mesh: comparison of three operative techniques. *Hernia* 2004; 8(1): 56-9.
DOI: <https://doi.org/10.1007/s10029-003-0170-9> PMID: 14586775
- Kokotovic D, Gögenur I, Helgstrand F. Substantial variation among hernia experts in the decision for treatment of patients with incisional hernia: a descriptive study on agreement. *Hernia* 2017; 21(2): 271-8.
DOI: <https://doi.org/10.1007/s10029-016-1562-y> PMID: 27915385
- Venclauskas L, Maleckas A, Kiudelis M. One-year follow-up after incisional hernia treatment: results of a prospective randomized study. *Hernia* 2010; 14(6): 575-82.
DOI: <https://doi.org/10.1007/s10029-010-0686-8> PMID: 0567989
- Gleysteen JJ. Mesh-reinforced ventral hernia repair: preference for 2 techniques. *Arch Surg* 2009; 144(8): 740-5.
DOI: <https://doi.org/10.1001/archsurg.2009.118> PMID: 19687378
- Sevinç B, Okuş A, Ay S, Aksoy N, Karahan Ö. Randomized prospective comparison of long-term results of onlay and sublay mesh repair techniques for incisional hernia. *Turk J Surg* 2018; 34(1): 17-20.
DOI: <https://doi.org/10.5152%2Fturkjsurg.2017.3712> PMID: 29756100
- Borchardt RA, Tzizik D. Update on surgical site infections: The new CDC guidelines. *JAAPA* 2018; 31(4): 52-4.
DOI: <https://doi.org/10.1097/01.jaa.0000531052.82007.42> PMID: 30973535
- Morales-Conde S. A new classification for seroma after laparoscopic ventral hernia repair. *Hernia* 2012; 16(3): 261-7.
DOI: <https://doi.org/10.1007/s10029-012-0911-8> PMID: 22527929
- Lim JU, Lee JH, Kim JS, Hwang YI, Kim TH, Lim SY, *et al.* Comparison of World Health Organization and Asia-Pacific body mass index classifications in COPD patients. *Int J Chron Obstruct Pulmon Dis* 2017; 12: 2465-75.
DOI: <https://doi.org/10.2147/COPD.S141295>
- Saber A, Emad KB. Onlay *versus* sub-lay mesh repair for ventral hernia. *J Surg* 2015; 4(1-1): 1-4.
- Ismail M, Khan S, Ali M, Bayazeed, Imran A, Ali A. Efficacy and safety between sub-lay and on-lay mesh repair for para-umbilical hernia in Mardan Medical Complex, Mardan. *Pak J Surg* 2021; 37(2): 70-5.
- Ali Q, Murad F, Awan TA, Khan A, Malik AZ. Onlay *versus* sub-lay technique of repairing ventral abdominal hernia. *JRMC* 2013; 17(2): 192-4.
- Ibrahim R, Abounozha S, Kheder A, Alshahri T. Incidence of seroma in sub-lay *versus* on-lay mesh repair of incisional hernia. *Ann Med Surg (Lond)* 2021; 61: 155-7.
DOI: <https://doi.org/10.1016%2Fj.amsu.2020.12.029> PMID: 33425349
- Ahmed M, Mehboob M. Comparisons of on-lay *versus* sub-lay mesh fixation technique in ventral abdominal wall incisional hernia repair. *J Coll Physicians Surg Pak* 2019; 29(9): 819-22.
DOI: <https://doi.org/10.29271/jcpsp.2019.09.819> PMID: 31455474
- Godara R, Garg P, Raj H, Singla SL. Comparative evaluation of sublay *versus* only meshplasty in ventral hernias. *Indian J Gastroenterol* 2006; 25(4): 222-3.
PMID: 16974052
- Magsi AM, Malik M, Anwar K, Rafi AU. A Comparison between Sub-lay and On-lay Mesh Repair in Incisional Hernia: A Randomized Controlled Trial. *Isra Med J* 2021; 13(4): 255-60.
- Awad P, Hassan BH, Kamel KA. A comparative study in elective repair of large incisional hernias using on-lay mesh vs. sub-lay mesh- A meta-analysis. *Res Square* 2023; 1-12.
DOI: <https://doi.org/10.21203/rs.3.rs-2511771/v1>
- Qureshi AB, Aslam N, Quershi MA. Outcome of open repair with on lay mesh hernioplasty in patients presenting with ventral hernia-a retrospective analysis. *Esculapio J SIMS* 2022; 18(3): 366-70.
DOI: <https://doi.org/10.51273/esc22.2518325>
- Saeed F, Khan K, Israr S, Khan A, Ahmed I, Khurshid M. A Comparison of the onlay and sublay mesh procedures for the repair of ventral hernias. *Pak J Med Health Sci* 2022; 16(11): 599-601.
DOI: <https://doi.org/10.53350/pjmhs20221611599>