

# Comparative Study Between 'Onlay' And 'Sublay' Mesh Repair Techniques For Ventral Hernia

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## Abstract

**Objective:** To compare 'Onlay' with 'Sublay' hernioplasty in the treatment of uncomplicated ventral hernia concerning operative time, postoperative seroma formation, drain duration, and postoperative hospital stay.

**Methods:** Seventy-eight patients diagnosed with uncomplicated ventral hernias were retrospectively recruited to a randomized study from October 2023 to November 2024. The patients have been divided into two equal groups: Group A underwent hernioplasty with onlay mesh repair, while Group B received a sublay mesh repair. The evaluation of both methods focused on safety, efficacy, operative time, and complications.

**Results:** Our study demonstrated no significant differences in demographic characteristics or preoperative comorbidities between the two groups. Moreover, no significant disparities were observed regarding the size of the defect [4.20±1.12 vs 4.20±1.13 cm, p=0.984] or the type of hernia [p=0.462]. Notably, operative time was significantly shorter in the Onlay Group than in the Sublay Group, with a mean duration of 49.25±11.76 minutes versus 58.90±10.10 minutes (p<0.001). Furthermore, a significant difference in drainage duration was observed: 8.08±1.77 days in the Sublay Group versus

6.56±1.37 days in the Onlay Group ( $p<0.001$ ), indicating a shorter drainage period in the Sublay Group. While the differences in complication rates were not statistically significant, the Sublay Group exhibited lower complication rates than the Onlay Group.

**Conclusion:** The Sublay technique, despite requiring longer operative time, offers significantly fewer wound complications and recurrence rates than the Onlay method, making it a more reliable and safer option for hernia repair.

**Keywords:** Mesh repair, ventral hernias, seroma, sublay, onlay.

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## Introduction

Ventral hernia [VH] affects approximately 25% of the global population and represents a prevalent surgical issue. The incidence of VH is increasing in Western countries, primarily attributed to the obesity epidemic and an aging population that experiences a higher frequency of abdominal surgeries [1]. Although the natural course of ventral hernia has not been fully clarified, ventral abdominal wall hernias are known to progress. It may result in acute complications and mortality in case of incarceration and strangulation of the abdominal contents. Additionally, ventral abdominal wall hernia is associated with pain, discomfort, impaired cosmesis, and impaired quality of life [2]. Repairing VH with mesh placement is becoming more popular and is considered the gold standard. Compared with the abdominal wall suture technique, mesh placement significantly reduces recurrence rates, as evidenced by numerous extensive studies, and is widely accepted worldwide. Taking advantage of Laplace's law, the mesh aims to reinforce or bridge the defect and distribute intra-abdominal pressure across the wide synthetic sheet, rather than just the defect [3]. However, ventral hernia repair is among the most common surgical procedures performed worldwide. The optimal surgical technique remains debatable, given a 10% to 40% recurrence rate. Onlay and sublay are the two popular approaches for mesh laying. Every method has benefits and drawbacks. Some surgeons use the onlay technique to reduce the need for extensive dissection. Thus, it is a faster and simpler technique; however, local wound complications are high. Therefore, it is believed that the sublay repair has a better outcome [4]. The initial description of the sublay technique was by Rene Stoppa and Jean Rives in France during the 1960s. Rives described the mesh placement as retromuscular [posterior to the rectus muscle but anterior to the posterior rectus sheath]. Despite the added dissection required to establish the retromuscular space, there is increasing evidence that sublay mesh placement has the lowest recurrent hernia rate, with some studies reporting rates as low as 5% [5]. This retrospective study was conducted to compare 'onlay' and 'sublay' hernioplasty in uncomplicated ventral hernias regarding operative time, duration of drainage, incidence of seroma, wound infection rates, length of postoperative hospital stay, and recurrence rates.

## Patients and methods:

This study was a retrospective comparative cohort evaluating the clinical outcomes of 78 patients who underwent hernioplasty for uncomplicated ventral hernias between October 2023 and November 2024. Patients were assigned to either onlay mesh repair (Group A) or sublay mesh repair (Group B). The study protocol received Institutional Review Board in accordance with the Declaration of Helsinki, and written informed consent was obtained from all participants. Patients aged over eighteen years diagnosed with an uncomplicated ventral hernia were included in the study. Patients with recurrent, strangulated, or giant ventral hernia that require particular attention before surgical intervention, such as component separation technique or tissue expansion-assisted closure, were excluded from the study. Experienced surgeons performed all procedures with over 10 years of experience. A thorough history and clinical examination were performed for all participants. For diagnostic confirmation, abdominal ultrasonography was routinely performed, and abdominal computed tomography with contrast was requested only when complications were suspected. Methods were evaluated for safety, efficacy, operative time, and complications.

## Hernioplasty technique:

The surgical procedure followed a standardized protocol. Before starting anesthesia, patients received a single dose of antibiotics [ceftriaxone 1 gm i.v. And metronidazole 500 milligrams i.v. The initial steps of both techniques were the same. First, a skin incision was made, followed by the dissection of subcutaneous tissues until the hernia sac was identified. The sac was then carefully opened, ensuring it

was free of surrounding tissues. After assessing the contents of the sac, adhesiolysis was conducted, followed by excision of the sac. In Group A [onlay technique], the mesh of appropriate size was secured to the anterior fascia after closing the hernia defect with zero polypropylene continuous sutures. The mesh was extended across the anterior fascia in all directions, 5 cm from the hernia defect margins, and fixed with 2/0 polypropylene sutures. Subcutaneous suction drains were used for all patients [Figure 1]. We used the Rives-Stoppa retromuscular technique for the sublay group [Group B]. The rectus sheath was split on both sides of the wound. The retromuscular space was dissected in all directions. This dissection continued until at least 5-6 cm overlap in all directions was achieved. A continuous Vicryl 0 suture was used to seal the peritoneum and posterior fascia. An adequately sized mesh was placed over the closed posterior fascia in the area between the fascia and the rectus muscle and fixed with 2-0 polypropylene sutures. A suction drain was then inserted above the mesh, and the anterior fascia was closed using continuous zero polypropylene [Figure 2]. If necessary, a second subcutaneous drain was added. When secretion was less than 30 mL/day, the drains were removed.

### Statistical analysis:

Recorded data have been analyzed using the Statistical Package for the Social Sciences (SPSS) version 26.0 [SPSS Inc., Chicago, Illinois, USA]. Quantitative data were presented as mean  $\pm$  standard deviation and ranges when their distributions were parametric [normal]; non-normally distributed variables [non-parametric data] were presented as median with interquartile range [IQR]. Also, qualitative variables were presented as numbers and percentages. Data were examined for normality using the Kolmogorov-Smirnov and Shapiro-Wilk Tests. The subsequent tests have been performed. An independent-samples t-test has been used to assess the significance of the difference between the two means. The comparison of groups with qualitative information has been conducted using the Chi-square test and Fisher's exact test, the latter serving as an alternative when the expected count in any cell is less than 5. The confidence interval was established at 95% with an accepted margin of error of 5%. The p-value was deemed significant as follows: P-value under 0.05 was classified as substantial, P-value under 0.001 as highly significant, and P-value above 0.05 as insignificant.

### Results

In our study, there were no significant differences in demographic characteristics between the Onlay and Sublay groups. Age [39.85 $\pm$ 12.99 vs 38.08 $\pm$ 14.06,  $p=0.565$ ], sex distribution [female: 87.2% vs 79.5%,  $p=0.362$ ], and BMI [26.03 $\pm$ 3.59 vs 25.27 $\pm$ 4.94,  $p=0.445$ ] were comparable between groups, indicating that these baseline characteristics were well matched. Similarly, comorbidity data revealed no significant differences between groups in rates of cardiac insufficiency [0.0% vs 5.1%,  $p=0.152$ ], hypertension 10.3% vs 10.3%,  $p=1.000$ ], and diabetes [12.8% vs 7.7%,  $p=0.455$ ]. The prevalence of cardiac insufficiency was higher in Group B, while the prevalence of diabetes was higher in Group A. Overall, these findings suggest that the onlay and sublay groups were balanced and comparable in demographic and comorbidity profiles at baseline. No significant differences were found between groups regarding the size of the defect [4.20 $\pm$ 1.12 vs 4.20 $\pm$ 1.13 cm,  $p=0.984$ ] and type of hernia [ $p=0.462$ ] [Table 1]. Operative time, from skin incision to wound closure, was significantly shorter in Group A than in Group B [mean  $\pm$  SD: 49.25 $\pm$ 11.76 vs 58.90 $\pm$ 10.10 minutes,  $p<0.001$ ]. These results suggest that the Onlay method may be associated with shorter operating times, potentially reducing the risk of anesthesia-related complications and improving patient outcomes. Postoperative outcomes revealed a significant difference in drainage duration [8.08 $\pm$ 1.77 vs 6.56 $\pm$ 1.37 days,  $p<0.001$ ], with Group B having a shorter duration. However, there was no significant difference in hospital stay [2.67 $\pm$ 0.74 vs 2.44 $\pm$ 0.64 days,  $p=0.144$ ] between the two groups. The results suggest that the Sublay method may be associated with shorter drainage duration, potentially reducing the risk of complications and improving patient outcomes. No significant differences were found between groups regarding postoperative seroma after drain removal [15.4% vs 7.7%,  $p=0.288$ ], wound infection [5.1% vs 0.0%,  $p=0.152$ ], and recurrence [7.7% vs 2.6%,  $p=0.305$ ]. Although the differences were not statistically significant, Group B [Sublay] had lower complication rates than Group A [Onlay]. The results suggest that both methods are relatively safe, but the Sublay method may be associated with a lower risk of complications [Table 2].

**Table 1: Comparison between group A and group B according to demographic data.**

Demographic data	Group A Only [n=39]	Group B Sublay [n=39]	Test value	P-value
Age "years Mean±SD	39.85±12.99	38.08±14.06	0.577	0.565
Sex				
Female	34 [87.2%]	31 [79.5%]	0.831	0.362
Male	5 [12.8%]	8 [20.5%]		
BMI [Mean±SD]	26.03±3.59	25.27±4.94	0.768	0.445
Cardiac insufficiency	0 [0.0%]	2 [5.1%]		0.152
Hypertension	4 [10.3%]	4 [10.3%]		1.000
Diabetes	5 [12.80%]	3 [7.70%]		0.455
Type of hernia				
Epigastric H	16 [41.0%]	11 [28.2%]	1.545	0.462
Incisional hernia	4 [10.3%]	6 [15.4%]		
Paraumbilical	19 [48.7%]	22 [56.4%]		

Using: t-Independent Sample t-test for Mean±SD; Using: x<sup>2</sup>: Chi-square test for Number [%]. Using: Fisher's exact test, when appropriate.

P-value >0.05 is insignificant; \*p-value <0.05 is significant; \*\*p-value <0.001 is highly significant

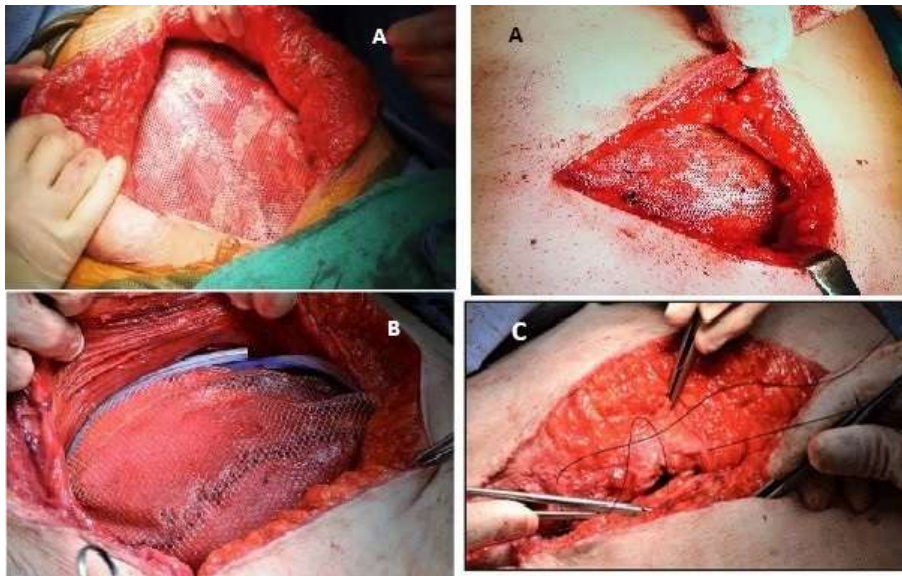
**Table 2: Comparison between group A and group B regarding operative data.**

Surgical Characteristics	Group A Only [n=39]	Group B Sublay [n=39]	Test value	P-value
Size of Defect [CM] Mean±SD	4.20±1.12	4.20±1.13	0.02	0.984
Operation time "min." Mean±SD	49.25±11.76	58.90±10.10	3.888	<0.001**
Duration of drainage [days] Mean±SD	8.08±1.77	6.56±1.37	4.221	<0.001**
Hospital stay [days] Mean±SD	2.67±0.74	2.44±0.64	2.177	0.144
Seroma after drain removal	6 [15.4%]	3 [7.7%]		0.288
Wound infection	2 [5.1%]	0 [0.0%]		0.152
Recurrence	3 [7.7%]	1 [2.6%]		0.305

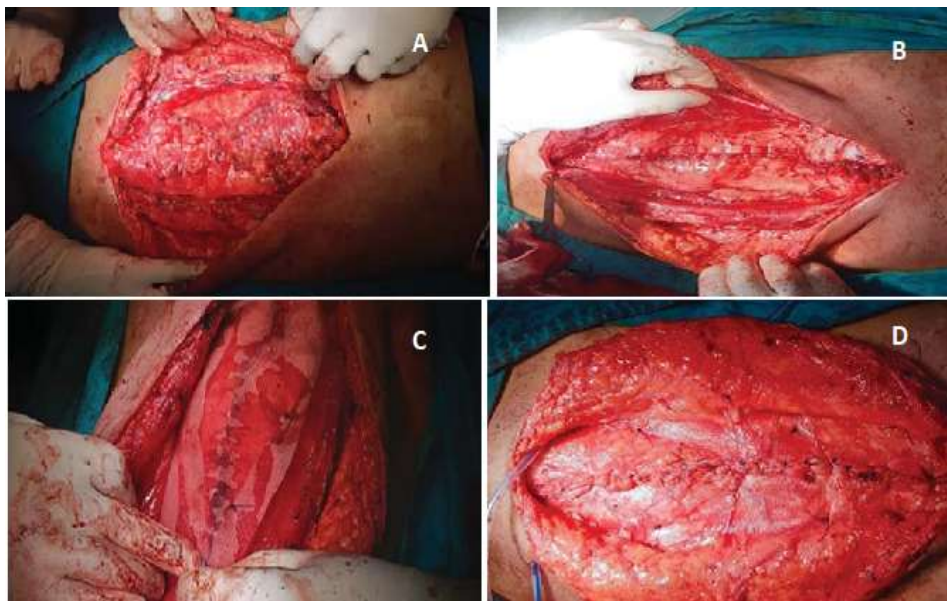
Using: t-Independent Sample t-test for Mean±SD; Using: x<sup>2</sup>: Chi-square test for Number [%]. Using: Fisher's exact test, when appropriate.

P-value >0.05 is insignificant; \*p-value <0.05 is significant; \*\*p-value <0.001 is highly significant

**Fig. 1: A) Suturing the mesh to the anterior wall of rectus sheath. B). Suction drain over the mesh. C). Suturing subcutaneous plane**



**Fig. 2: A) The preperitoneal plane between the posterior rectus sheath and rectus muscle. B). Closure of the posterior rectus sheath. C). Application of the mesh into the created preperitoneal plane. D). The anterior rectus sheath is closed, and the drain is inserted over it**



### Discussion

Ventral abdominal wall hernias are a common surgical issue in clinical practice. Hernias are associated with reduced quality of life and high socioeconomic costs. Although various surgical techniques for the repair of hernias are available, the best method for providing a durable repair has not been determined. The outcome of the surgery depends not only on the technique utilized but also on the operator's experience, precise dissection, and tension-free repair [6]. Onlay mesh repair is technically easier to perform as it involves dissection down to the anterior abdominal fascia, on which the mesh is secured. Placing the mesh superficially increases the risk of seroma formation and surgical site infection. Potential dead space that develops following dissection and plane raising provides a space for seroma formation. Invariably, this space is greater in the onlay dissection, where the overlying layer is the subcutaneous fat and skin [7]. Sublay techniques are infrequently used in clinical practice due to the

complexity of the surgical procedure, the need for highly skilled surgeons, and the longer operative time. Sublay dissection creates a space between the rectus muscle and the posterior rectus sheath, which may be narrower compared to the space created during onlay dissection. Our findings showed that seroma formation was more prevalent in the onlay group than in the sublay group. Furthermore, Perletti et al. [8] concluded that the onlay procedure is associated with a significantly higher risk of seroma compared to sublay ventral hernia repair. Most hernia repair complications are wound complications and seroma, which are thought to be caused by the more extensive dissection of the abdominal wall for exposure of the anterior rectus sheath and the anterior abdominal wall fascia for mesh placement in the onlay position; thus, surgical experience, selective indications, and smaller defects appear to reduce the post-operative complication rate. Ibrahim et al. [12] concluded that seroma formation was significantly less frequent in patients who underwent sublay repair than in those who underwent onlay mesh repair. In contrast, Jairan et al. [13] reported that the onlay mesh repair method was more effective for hernia repair. They noted that although seroma formation was more prevalent in the onlay repair group, wound infection rates were almost equal between the two repair methods. Furthermore, Venclauskas et al. followed patients with an incisional hernia for 1 year and observed that the wound complication rate was significantly higher in the onlay technique group [14]. Also, Köckerling et al. [15] concluded that the onlay technique was associated with a higher postoperative complication rate 33.5% (range 5-76%) than the sublay technique 18.6% (range 8-26%). Furthermore, sublay repair entails dissection in the retrorectus plane to create adequate space for mesh application. This anatomical region is characterized by increased vascularity, which elevates the risk of bleeding during dissection and prolongs the time to control bleeding compared to onlay dissection, which tends to be less vascular. Consequently, the likelihood of hematoma formation and operative time is notably higher in sublay mesh repair. [9]. Several factors affect recurrence after hernia repair; Common patient-related factors are age, high BMI, chronic illnesses, diabetes mellitus, and early physical exertion following surgery [10]. Technical factors contributing to recurrence include the size of the defect, type of procedure [i.e., suture versus mesh repair], wound infection, and type and plane of mesh placement [11]. Our study did not show any significant differences in recurrence rates between the sublay and onlay techniques. Timmerman et al. [9] conducted a meta-analysis that revealed the sublay technique is associated with a reduced incidence of surgical site infections and recurrences compared with the onlay technique. Additionally, the onlay technique demonstrated a higher overall postoperative complication rate, with a mean of 33.5% [ranging from 5% to 76%]. Conversely, the sublay technique had a mean complication rate of 18.6% (range, 8% to 26%). Our study revealed a statistically significant difference in intraoperative time between the onlay and sublay techniques, with the sublay method requiring more time. This observation supports the findings of Hassan et al. [14], who also reported a significant difference in operative time between the two methods. Additionally, Shah et al. [16] reported that the average operative time was longer with the sublay method, at 61 minutes, compared to 46 minutes with the onlay method. This difference is likely due to the extra time required to create the retro-rectus plane and ensure adequate hemostasis. Our study revealed a statistically significant difference between onlay and sublay techniques in terms of postoperative drainage duration. Specifically, the onlay mesh group had a longer drainage duration. Heikal et al. [17] found that the utilization of sublay mesh in the treatment of ventral hernia significantly decreased the time required for drain removal, which was notably longer in the onlay mesh group [ $P = 0.001$ ]. Furthermore, the incidence of seroma formation following drain removal was significantly higher in the onlay mesh group [ $P = 0.010$ ], as was the rate of wound infection [ $P = 0.010$ ], and concluded that retromuscular [sublay] mesh repair is the ideal technique for ventral hernia repair. Köckerling [18] stated that the higher incidence of seroma may be attributed to the more extensive dissection of the abdominal wall, which is undertaken to adequately expose the anterior rectus sheath and the anterior abdominal wall fascia for mesh placement in the onlay position. Holihan et al. [19] showed that sublay repair performed better than onlay repair in terms of hernia recurrence and prevention of surgical site infection. Correspondingly, the 2020 Guidelines for the treatment of umbilical and epigastric hernias indicate that sublay mesh placement is associated with the lowest risk of surgical site infection and/or recurrence. However, the onlay technique may offer advantages in particular cases, such as small and lateral incisional hernias, without significant differences in complication rates [20].

## Conclusion

The Sublay technique, although requiring a longer operative time, offers superior outcomes, including a reduced risk of complications such as seroma formation, shorter postoperative drainage duration, and lower recurrence rates, making it a more reliable and safer option for hernia repair than the onlay technique.

## Declarations

**Data Availability Statement:** The data that support the findings of this study are available on request from the corresponding author.

**Ethics Committee Approval:** Ethical committee approval was received from the Institutional Review Board of Al-Azhar University (Registration no: 2899/2025).

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**Author contributions:** SS, MO, TA, MW, IA, AF: manuscript preparation, protocol, data collection and management, manuscript editing. EF, AM, MS, SE: Data acquisition, data analysis and management, manuscript editing. MA, SA, AA, LS, AL: Manuscript editing, project development, data analysis, and project development. All the authors have read and approved the manuscript.

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## References

1. Tien, T. P. D., Huan, N. N., & Trung, L. V. Short-Term Outcomes of Sublay Mesh for Ventral Hernia Repair. *International Journal of Science and Research [IJSR]*. 2023; 12[11]: 258–260. <https://doi.org/10.21275/sr231102145803>.
2. Hartog, F. P. J. D., Sneiders, D., Darwish, E. F., Yurtkap, Y., Menon, A. G., Muysoms, F. E., Kleinrensink, G. J., Bouvy, N. D., Jeekel, J., & Lange, J. F. Favorable Outcomes After Retro-Rectus [Rives-Stoppa] Mesh Repair as Treatment for Noncomplex Ventral Abdominal Wall Hernia, a Systematic Review and Meta-analysis. *Annals of Surgery*. 2022; 276[1]: 55–65. <https://doi.org/10.1097/sla.0000000000005422>.
3. Issa M, Noureldin K, Elgadi A, Abdelaziz A, Badawi M, Makram M. Evaluation of the Sublay Mesh Repair Outcomes in Different Types of Ventral Hernia. *Cureus*. 2021; 13(12):e20590. doi: 10.7759/cureus.20590.
4. Shahdhar, M., & Sharma, A. Laparoscopic ventral hernia repair: extraperitoneal repair. *Annals of Laparoscopic and Endoscopic Surgery*. 2018; 3: 79. <https://doi.org/10.21037/ales.2018.09.07>.
5. Rhemtulla, I., & Fischer, J. Retromuscular Sublay Technique for Ventral Hernia Repair. *Seminars in Plastic Surgery*. 2018; 32[03]: 120–126. <https://doi.org/10.1055/s-0038-1666800>.
6. Liang, M. K., Holihan, J. L., Itani, K., Alawadi, Z. M., Gonzalez, J. R. F., Askenasy, E. P., Ballecer, C., Chong, H. S., Goldblatt, M. I., Harvin, J. A., Keith, J. N., Martindale, R. G., Orenstein, S., Richmond, B., Roth, J. S., Szotek, P., Towfigh, S., Tsuda, S., Berger, D. H. Ventral Hernia Management. *Annals of Surgery*. 2017; 265[1]: 80–89. <https://doi.org/10.1097/sla.0000000000001701>.
7. Pereira C, Gururaj S. Onlay Versus Sublay Mesh Repair for Incisional Hernias: A Systematic Review. *Cureus*. 2023; 15(1):e34156. doi: 10.7759/cureus.34156. PMID: 36713818; PMCID: PMC9879281.
8. Perletti, L. B., Spoelders, F., & Berrevoet, F. Association between surgical hernia repair techniques and the incidence of seroma: a systematic review and meta-analysis of randomized controlled trials. *Hernia*. 2021; 26[1]: 3–15. <https://doi.org/10.1007/s10029-021-02531-4>.
9. Ibrahim, R., Abounozha, S., Kheder, A., & Alshahri, T. Incidence of seroma in sublay versus onlay mesh repair of incisional hernia. *Annals of Medicine and Surgery*. 2021; 61: 155–157. <https://doi.org/10.1016/j.amsu.2020.12.029>.
10. Jairam AP, Timmermans L, Eker HH, Pierik REGJM, van Klaveren D, Steyerberg EW, et al. PRIMA Trialist Group. Prevention of incisional hernia with prophylactic onlay and sublay mesh reinforcement versus primary suture only in midline laparotomies (PRIMA): 2-year follow-up of a multicentre, double blind randomised controlled trial. *Lancet*. 2017 ; 390(10094):567-576. doi:

- 10.1016/S0140-6736(17)31332-6. Epub 2017 Jun 20. Erratum in: *Lancet*. 2017 Aug 5;390(10094):554. doi: 10.1016/S0140-6736(17)31759-2.
11. Hassan BHA, Kamel KAL, Awad PBA, Awad KBA, Maaty SA, Fawzi FS, El-Shayeb BH. A comparative study in elective repair of large incisional hernias using on-lay mesh vs. sub-lay mesh: a meta-analysis. *Updates Surg*. 2024; 76(5):1685-1697. doi: 10.1007/s13304-024-01755-0.
  12. Köckerling, F., Schug-Pass, C., & Scheuerlein, H. What Is the Current Knowledge About Sublay/Retro-Rectus Repair of Incisional Hernias? *Frontiers in Surgery*. 2018; 5. <https://doi.org/10.3389/fsurg.2018.00047>.
  13. Timmermans, L., De Goede, B., Van Dijk, S. M., Kleinrensink, G. J., Jeekel, J., & Lange, J. F. Meta-analysis of sublay versus onlay mesh repair in incisional hernia surgery. *The American Journal of Surgery*. 2014; 207[6]: 980–988. <https://doi.org/10.1016/j.amjsurg.2013.08.030>.
  14. Tarasova, N. K., Dynkov, S. M., Pozdeev, V. N., Teterin, A. Y., & Osmanova, G. S. [2019]. Analysis of the causes of recurrent postoperative ventral hernias. *Pirogov Russian Journal of Surgery*. 2019; 10: 36. <https://doi.org/10.17116/hirurgia201910136>.
  15. Baker, J. J., Öberg, S., & Rosenberg, J. Type of Mesh in Laparoscopic Ventral Hernia Repair affects reoperation for Recurrence. *Annals of Surgery*. 2023; 277[2]: 335–342. <https://doi.org/10.1097/sla.0000000000005206>.
  16. Shah, D. K., Patel, S. J., Chaudhary, S. R., & Desai, N. R. Comparative study of onlay versus sublay mesh repair in the management of ventral hernias. *Updates in Surgery*. 2023; 75[7]: 1991–1996. <https://doi.org/10.1007/s13304-023-01532-5>.
  17. Heikal, M. M., Ibrahim, A., & El-Gammal, A. Comparative study between 'onlay' and 'sublay' hernioplasty in the treatment of uncomplicated ventral hernia. *Menoufia Medical Journal*. 2015; 28[1]: 11. <https://doi.org/10.4103/1110-2098.155904>.
  18. Köckerling, F. Onlay Technique in Incisional Hernia Repair—A Systematic Review. *Frontiers in Surgery*. 2018; 5. <https://doi.org/10.3389/fsurg.2018.00071>.
  19. Holihan, J. L., Nguyen, D. H., Nguyen, M. T., Mo, J., Kao, L. S., & Liang, M. K. Mesh Location in Open Ventral Hernia Repair: A Systematic Review and Network Meta-analysis. *World Journal of Surgery*. 2015; 40[1]: 89–99. <https://doi.org/10.1007/s00268-015-3252-9>.
  20. Henriksen, N. A., Montgomery, A., Kaufmann, R., Berrevoet, F., East, B., Fischer, J., Hope, W., Klassen, D., Lorenz, R., Renard, Y., Urena, M. a. G., & Simons, M. P. Guidelines for treatment of umbilical and epigastric hernias from the European Hernia Society and Americas Hernia Society. *British Journal of Surgery*. 2020; 107[3]: 171–190. <https://doi.org/10.1002/bjs.11489>.