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Review

Onlay versus sublay mesh repair of open ventral incisional hernia: A meta-analysis of randomized controlled trials

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Abstract

Background: Incisional hernia treatment remains a major issue in abdominal wall surgery. Open onlay and sublay mesh repair are the most frequently used procedures. This meta-analysis aimed to compare the two techniques for open ventral incisional hernia repair in terms of wound infection, hematoma, seroma, and recurrence.

Methods: A search in electronic databases for randomized controlled trials (RCTs) published up to September 30, 2019 was performed. Review Manager Version 5.3 was used for pooled estimates. The eligibility criteria were as follows: RCTs comparing onlay mesh repairs performed according to Cheverel with sublay mesh repairs performed according to Rives-Stoppa and Schumpelick and including patients aged 18 or older.

Results: Of 22 relevant articles, 7 RCTs involving a total of 954 patients (487 onlay and 466 sublay mesh repairs) met the eligibility criteria. Sublay mesh repairs were found to require better results in terms of wound infection (odds ratio [OR]: 2.33, 95% CI: 1.09–4.94, $p = 0.03$) and seroma (OR: 3.71, 95% CI: 2.26–6.09, $p < 0.001$). There was no significant difference between the two techniques in terms of hematoma (OR: 2.53, 95% CI: 0.90–7.11, $p = 0.08$). Regarding recurrence, the forest plot showed no statistical difference (OR: 1.75, 95% CI: 0.55–5.55, $I^2 = 54\%$, $p = 0.34$); however, heterogeneity was high ($I^2 = 54\%$), and meta-regression showed a statistically significant difference in favor of sublay mesh repair.

Conclusions: This meta-analysis of RCTs shows that sublay mesh repair of open ventral incisional hernias is superior to onlay repair. Sublay mesh repair should probably be the first choice, and onlay repair should be reserved for more difficult cases, where sublay repair is not possible.

Keywords: Incisional hernia; onlay; sublay; recurrence; surgical site infection; wound complications; meta-regression

INTRODUCTION

An incisional hernia may occur within two years of a midline incision, with a rate ranging between 10% and 20% [1,2]. Incisional hernias are mainly caused by surgical errors during the closure of the abdominal wall. The incidence is higher in patients with risk factors such as obesity and steroid use [3]. Incisional hernias can impair patients' quality of life and can be life-threatening in case of strangulation. Mesh repair reduces the likelihood of incisional hernia recurrence [4,5]. The two most frequently used procedures are onlay and sublay mesh repair [6]. These procedures have advantages such as significantly reducing the likelihood of recurrence but also disadvantages such as chronic pain [6,7].

Some surgeons prefer onlay mesh repair to avoid extensive abdominal wall dissection, while others insist that sublay repair remains the best mesh placement even for incisional hernias. Onlay repair is known to be easier and faster but has a slightly higher wound complication rate [8]. Sublay repair is believed by many to carry a lower recurrence risk. Incisional hernia recurrence and post-

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operative wound complications depend on the abdominal wall mesh site. Then, the best mesh location is still debated among surgeons [9–11].

This meta-analysis aimed to compare open onlay with sublay mesh repair of ventral incisional hernias in terms of wound infection, hematoma, seroma, and recurrence.

METHODS

Electronic database searches

An extensive electronic search of the relevant literature, with no language restrictions, was performed on September 30, 2019, using the following databases: the Cochrane Library's Controlled Trials Registry and Database of Systematic Reviews, PubMed/MEDLINE of the United States National Library of Medicine, National Institutes of Health, Excerpta Medica Database (Embase), Scopus, and Google Scholar. The keywords used were "onlay," "sublay," "retromuscular," "preperitoneal," "open," "surgery," "incisional hernia," "abdominal wall," "repair," "retrorectus," "prefascial," "retrofascial," "Rives-Stoppa," and "mesh placement." This meta-analysis was performed in accordance with the 2010 Preferred Reporting Items for Systematic Review and Meta-analysis guidelines [12].

Eligibility criteria

Studies. All randomized controlled trials (RCTs) reporting comparisons between onlay and sublay mesh repairs of ventral incisional hernias published in peer-reviewed journals were considered for the analysis. Non-random-

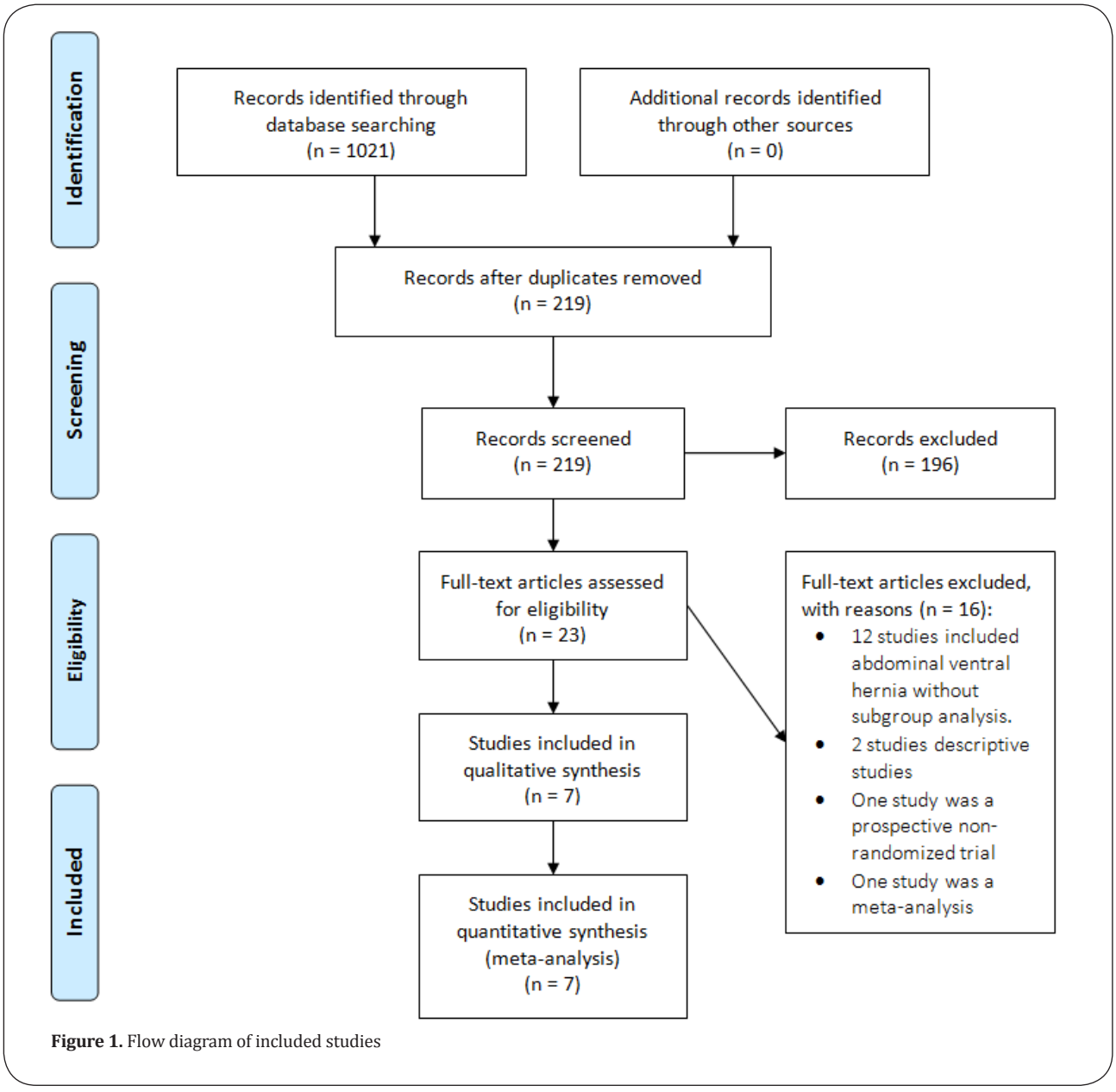

Figure 1. Flow diagram of included studies

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Table 1: Details of the included studies

References	Year	Country	Mean age (years)	Nb of onlay repair	Nb of Sublay repair	Hernia size	Mesh type	Prophylactic antibiotics	Follow up (months)	Quality assessment
Gondal et al [20]	2012	Pakistan	44.9	32	32	NF	NF	NF	6	10/25
Demetrashvili et al [21]	2017	Georgia	60.4	78	77	Onlay: 62.7 cm^2 Sublay: 100.4 cm^2	Polypropylene	Yes (Cefuroxime 1.5g)	26	21/25
Sevinc et al [22]	2018	Turkey	55.4	50	50	73.4 cm^2	Polypropylene	No	37	19/25
Venclauskas et al [23]	2010	Lithuania	55	57	50	Onlay: 114.5 cm^2 Sublay: 110 cm^2	Polypropylene	Yes (Oxacillin 1g)	12	15/25
Natarajan et al [8]	2017	India	56.3	13	11	≥ 4 cm	Polypropylene	NF	6	16/25
Wéber et al [24]	2010	Hungary	NF	235	224	> 25 cm^2	Polypropylene	Yes (cephazolin)	60	14/25
Ahmed et al [25]	2019	Pakistan	39.13	23	22	≥ 3 cm	NF	Yes	6	14/25

Nb: number, NF: Not Found

ized trials, non-comparative studies, editorials, letters to editors, review articles and case series (fewer than ten cases) were excluded.

Participants. Adults (aged 18 or older) of either gender undergoing open onlay or sublay mesh repair of ventral incisional hernia were included.

Interventions. The following surgical procedures were included:

(1) Sublay mesh repair according to Rives-Stoppa [13] and Schumpelick [14], with the mesh placed in the retrorectus muscles (prefascial or preperitoneal and retrofascial space).

(2) Onlay mesh repair according to Cheverel [15], with the mesh placed in the anterior rectus fascial after dissection of the fascia from the subcutaneous plane.

Outcome measures

The main outcome measure was recurrence. Secondary outcome measures were wound infection, seroma, and hematoma.

Data collection and analysis

Study selection. Two authors (MAC and MWD) independently reviewed all abstracts. The full texts of all studies that met the inclusion criteria were retrieved. Disagreements were resolved by discussion after consulting a third member of the review team (IB).

Assessment of the studies' quality. All studies that met the selection criteria were independently appraised by two authors (MAC and MAD) according to the CONSORT Statement [16].

Data extraction. Each author independently extracted the data from each study. Disparities were settled after discussion with two senior authors (MWD and CD).

Assessment of heterogeneity. We used Cochran's Q test to assess heterogeneity and the I^2 statistic to estimate the degree of heterogeneity [17]. We used the Cochrane Chi^2 test (Q-test) to assess heterogeneity and we calculated the variance TAU2, between studies and the I^2. An I^2 between 0% and 50% was considered a low level and between 51% and 100% a high level of heterogeneity [18].

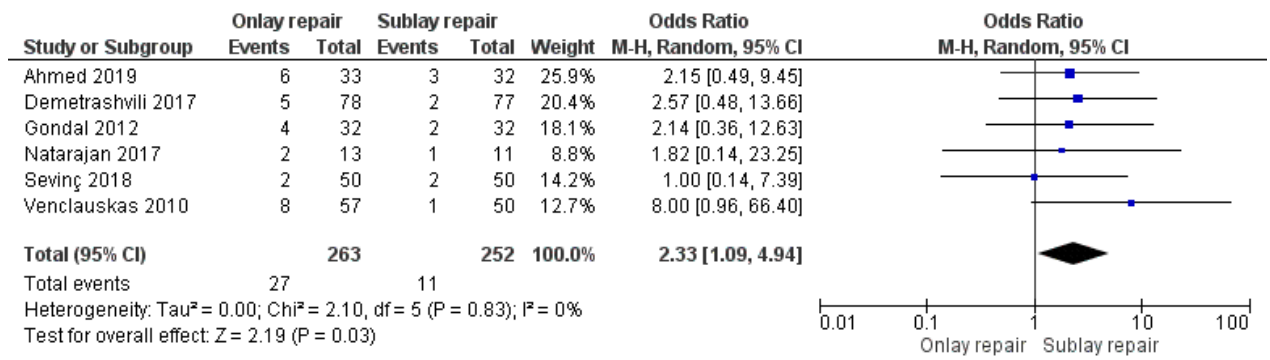

Figure 2. (A) Meta-analysis of studies on wound infections

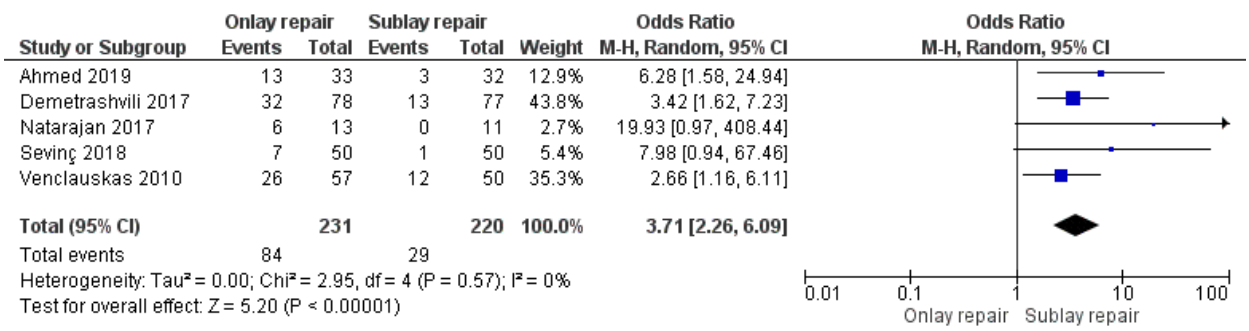

Figure 2. (B) Meta-analysis of studies on seroma

Funnel plots were used to identify the studies responsible for heterogeneity.

Evaluation of effect size. For the meta-analysis, we used Cochrane's Review Manager statistical package version 5.3.5 [19]. We selected the mean difference (MD) as an effective measure for continuous data. For dichotomous variables, we calculated odds ratios (OR) with 95% confidence intervals (CI). We used the random-effects model and set the threshold of statistical significance at 0.05. When I^2 was between 51% and 100%, we tested for interactions between relevant factors and effect size estimates. We performed meta-regression using the natural log (OR) as the dependent variable and the explored factor as the independent variable [17], as determined by the Comprehensive Meta-Analysis software. Meta-regression concerned interactions between treatment effects and the main outcome measure of recurrence. The covariate used was the global rate of recurrence.

RESULTS

Literature search results

We retrieved seven potentially relevant articles (Figure 1). They were published between 2010 and 2018 [8,20–25]. Sixteen studies were excluded for the following reasons: one study [26] was a prospective non-randomized trial, two [27,28] were descriptive studies, one was a meta-analysis [29], and twelve concerned onlay and sublay mesh repair of abdominal ventral hernias or included abdominal ventral hernias and abdominal ventral incisional hernias without subgroup analysis [30–41].

The seven identified studies involved a total of 954 patients (487 onlay and 466 sublay mesh repairs). They were fully matched in terms of year of publication, country, mean age, hernia size, mesh type, numbers of patients undergoing sublay and onlay mesh repairs, prophylactic antibiotic use, and follow-up duration. Six studies were published in English [8,20–23,25] and one in Hungarian [24]. The quality assessment and details of the included studies are summarized in Table 1.

Outcome measures

Wound infection. Wound infections were reported in six studies [8,20–23,25] (Figure 2.A), which included a total of 515 patients. They were detected in 27 of 263 patients undergoing onlay repair and 11 of 252 patients undergoing sublay repair. There was a significantly lower rate of

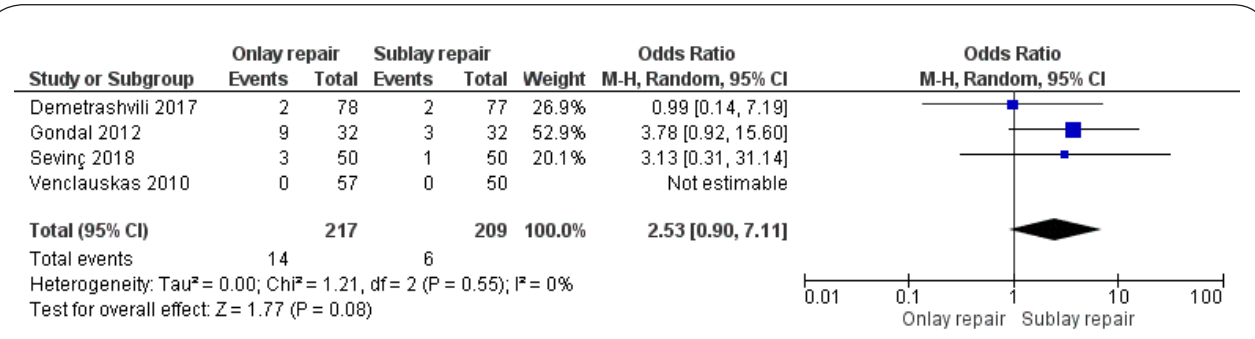

Figure 2. (C) Meta-analysis of studies on hematoma

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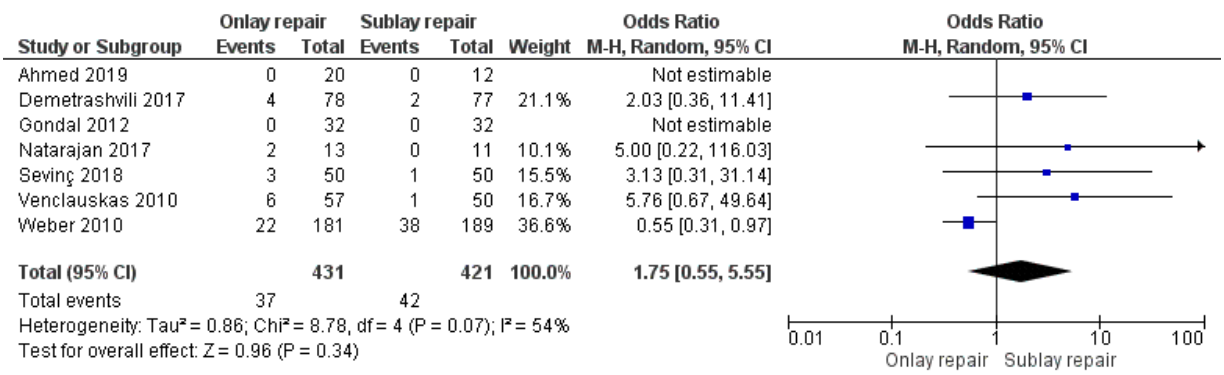

Figure 3. (A) Meta-analysis of studies on recurrence

wound infections in sublay repair patients (OR: 2.33, 95% CI: 1.09–4.94, $p = 0.03$] with no heterogeneity among the studies (Tau^2 =0 and I^2 = 0%).

Seroma. Seromas were reported in five studies [8,21–23,25] (Figure 2.B), which included a total of 451 patients. They were detected in 84 of 231 patients undergoing onlay repair and 29 of 220 patients undergoing sublay repair. There was a significantly lower seroma rate in sublay repair patients (OR: 3.71, 95% CI: 2.26–6.09, $p < 0.00001$) with no heterogeneity among the studies (Tau^2 =0 and I^2 = 0%).

Hematoma. Hematomas were reported in four studies [20–23], which included a total of 426 patients (Figure 2.C). They were detected in 14 of 217 patients undergoing onlay repair and 6 of 209 patients undergoing sublay repair. There was no statistical difference between the two techniques (OR: 2.53, 95% CI: 0.90–7.11, $p = 0.08$) with no heterogeneity among the studies (Tau^2 =0 and I^2 = 0%).

Recurrence. Recurrence was reported in seven studies [8,20–25]. After excluding patients lost of follow-up in these studies, we found a total of 852 patients (Figure 3.A). It was reported in 37 of 431 patients undergoing onlay repair and 42 of 421 patients undergoing sublay repair. There was no statistical difference between the two groups (OR: 1.75, 95% CI: 0.55–5.55, $p = 0.34$). There was a high level of heterogeneity between the studies (Tau^2 = 0.86 and I^2 = 54%). Random-effects meta-regression (Figure 3.B) favored sublay repair ($p = 0.007$).

DISCUSSION

This is the first meta-analysis of RCTs comparing onlay and sublay mesh repair of incisional hernias. Our results show that sublay mesh repair yields better results than onlay repair in terms of wound infection and seroma.

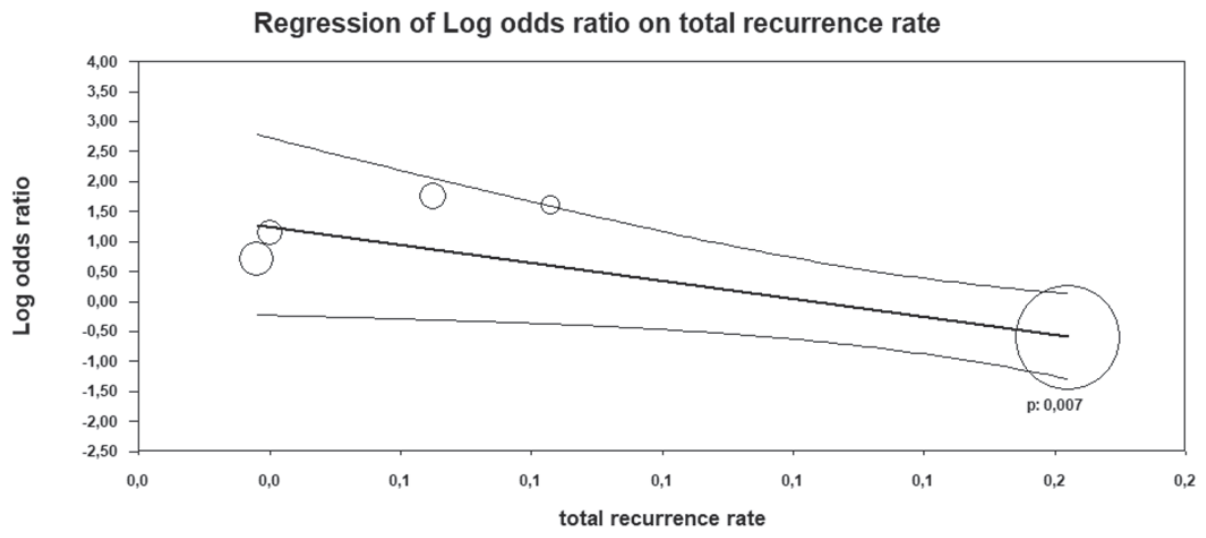

Figure 3. (B) Meta-regression of studies on recurrence

We found no significant difference between the two techniques in terms of hematoma. Regarding the recurrence rate, meta-regression favored sublay repair. We conclude that sublay mesh repair should probably be the first choice, and onlay mesh repair should be reserved for more difficult cases, where sublay is not possible.

Mesh placement affects tissue incorporation, tissue reaction, and tensile strength of the abdominal wall [11,42–44]. In the case of incisional hernia, mesh bedding dissection is challenging, especially in cases of previous wound infection, hostile abdomen, multiple retromuscular repairs, and adhesions. A wide dissection with a large mesh overlap is preferable in terms of tissue incorporation. However, this could be associated with an increased risk of postoperative wound complications and recurrence.

Wound complications present a problem following mesh repair of incisional hernia and pose a higher risk of secondary recurrence [45]. Many studies have recommended sublay mesh repair for incisional hernias [44,46,47]. The placement of the mesh on the posterior rectus fascia benefits from a more vascularized area compared with the onlay position [46]. Moreover, it is widely recognized that dissection of subcutaneous suprafascial space for onlay mesh placement promotes wound infection and seroma [47].

Regarding wound infection, our results favor sublay mesh repair. This does not seem to be directly related to the mesh or to hernioplasty, but rather to poor skin antisepsis [46,47]. Adequate sterilization of the skin before the procedure is therefore essential. Some studies have attributed the higher rate of mesh infections in patients undergoing onlay repair to the more superficial position of the mesh, which leaves it more exposed to bacterial colonization [29,48]. In contrast, in sublay mesh repair, the placement of the mesh on the retrorectus prefascial space offers the body's immune system a better chance of fighting infections [11,49]. Mesh infections occur in 5% to 10% of mesh repairs [50,51]. Their management is complicated due to several factors, such as medical history, causal germs, and type and location of the prosthesis in the abdominal wall [52].

Seroma is related to a tight contact of any subcutaneous foreign body (mesh). A meta-analysis of Timmermans et al. [29] found no statistical difference between the onlay and sublay techniques in terms of seroma frequency. Other studies have reported a higher frequency associated with the onlay technique [53,54]. Our results also show a higher seroma rate in onlay mesh repair. This complication could be reduced by using low-thrombin fibrin sealant, as well as by wearing an abdominal binder postoperatively [55,56]. Overall, the postoperative complication rate (seroma, hematoma, and wound infection) has been reported to be higher after onlay mesh repair [49,57].

Regarding recurrence, many factors, such as wound complications, tensile strength of the abdominal wall, and mesh shrinkage, can affect this outcome [43,45,58]. In sublay repair, the hernia sac is introduced to the abdominal cavity. The wall defect is closed, and the mesh prevents a new displacement. In onlay repair, the hernia defect is not closed, and the mesh recovers the hernia. Nevertheless, it is only justified when the surgeon lacks of skills or assistance from an experienced surgeon. Many studies have reported contradictory results [23,24,29,53,59,60]. Some have reported a lower recurrence rate after the sublay technique [53,61], whereas Wéber et al [54] found a lower rate after the onlay method. Other studies have reported similar rates associated with both procedures [23,60]. However, other factors were not taken into consideration in the included studies, such as mesh overlap, mesh fixation, and the surgeon's experience are missed. Moreover, this high degree of heterogeneity can be explained to some extent by the small number of patients and the different follow-up periods included in these studies. Surgical care of patients with recurrent hernias may best be provided in referral centers with expertise in the management of complex abdominal hernias [62].

All the studies included in this meta-analysis had comparable study populations and similar interventions. Our main result concerning incisional hernia recurrence is worthy of special attention. This outcome is characterized by a high level of heterogeneity. In the forest plot, Wéber et al's study [24], which included almost half of all patients (370 of 852), was the only study to report a lower recurrence rate after onlay mesh repair and was thus a source of asymmetry and heterogeneity. Furthermore, the study was judged as of mediocre quality and as potentially subject to location bias by Timmermans et al [29]. This study did differ somewhat from the other studies in that it only included larger hernias, which explains the heterogeneity. To compensate for heterogeneity, we used meta-regression, which is an extension of subgroup analysis (Figure 3.B). When this study was removed, the heterogeneity (I^2) was reduced to 0%, and the results became statistically significant in favor of sublay repair. However, this uncertainty regarding the recurrence rates makes it difficult to draw solid conclusions. Therefore, more multi-center RCTs with longer follow-ups are recommended.

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This meta-analysis has several limitations. We did not assess hospital stay durations, postoperative pain scores, chronic pain, long-term discomfort, and the time of returning to everyday activities. These criteria were not clearly defined in the included studies. Moreover, the reference articles provided no data as to the types of ventral incisional hernias and surgical wound characterizations, such as recurrent, infected, reoperated, and previous mesh. The heterogeneity caused by Wéber et al's study [24] represents another limitation.

In summary, the available literature suggests that the sublay technique for open ventral incisional hernia repair is superior to the onlay technique in terms of wound complications and recurrence rate. Sublay mesh repair should probably be the first choice for open incisional hernia repair, and onlay repair should be reserved for more difficult cases, where sublay is not possible.

DECLARATION

Conflicts of interest

The authors declare that they have no conflict of interest.

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