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Surgical techniques for repair of abdominal rectus diastasis: a scoping review

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ABSTRACT

Rectus diastasis is characterized by widening and laxity of the linea alba, causing the abdominal content to bulge. Rectus diastasis is treated either conservatively with physiotherapy, or surgically, surgical treatment showing especially convincing results. The primary aim of this study was to describe surgical techniques used to correct abdominal rectus diastasis. Secondary, we wished to assess postoperative complications in relation to the various techniques. A systematic scoping review was conducted and reported according to the PRISMA-ScR statement. PubMed, Embase, and Cochrane Library were searched systematically. Studies were included if they described a surgical technique used to repair abdominal rectus diastasis, with or without concomitant ventral hernia. Secondary outcomes were recurrence rate and other complications. A total of 61 studies were included: 46 used an open approach and 15 used a laparoscopic approach for repair of the abdominal rectus diastasis. All the included studies used some sort of plication, but various technical modifications were used. The most common surgical technique was classic low abdominoplasty. The plication was done as either a single or a double layer, most commonly with permanent sutures. There were overall low recurrence rates and other complication rates after both the open and the laparoscopic techniques. We identified many techniques for repair of abdominal rectus diastasis. Recurrence rate and other complication rates were in general low. However, there is a lack of high-level evidence and it is not possible to recommend one method over another. Thus, further randomized controlled trials are needed in this area.

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Abdominal rectus diastasis; abdominoplasty; laparoscopic repair; surgery; plication technique; sutures; complications; recurrence

Introduction

Rectus diastasis is a condition in which the rectus abdominis muscles are separated by an abnormal distance due to widening of the linea alba. Rectus diastasis can be congenital but is most commonly acquired due to laxity of the linea alba [1]. The main risk factors are pregnancy and obesity leading to the two most common profiles: men with central obesity and small, fit women who carried a large fetus or twins to term [2]. The incidence in pregnancy's third trimester is as high as 66%, and 30–60% have rectus diastasis postpartum [3,4]. The symptoms and discomforts associated with rectus diastasis are a debated area [2]. Nevertheless, rectus diastasis may be associated with negative body image, musculoskeletal pain, and urogynecological symptoms [5]. The condition is not to be confused with a hernia, as the rectus fascia is intact. There are different treatment options including conservative treatment with physiotherapy, surgical repair, or both [2]. A systematic review stated that physiotherapy was unable to reduce the diastasis in a relaxed state, but some reduction during muscle contraction was described [6]. It seems like the only convincing results with complete normalization of the distance between the rectus muscles is seen after surgical treatment. Various surgical methods are described in the literature. However, an overview of different surgical techniques is lacking.

The primary aim of this study was to describe surgical techniques used to correct abdominal rectus diastasis. Secondly, we

wished to investigate recurrence rates and other postoperative complications in relation to the different surgical techniques.

Materials and methods

This systematic scoping review was reported according to PRISMA Extension for Scoping Reviews (PRISMA-ScR) [7]. A protocol was registered at OSF Home prior to data extraction (DOI 10.17605/OSF.IO/VNS9B).

The following criteria were used to select studies: patients had to be ≥ 18 years old and having had a repair of an abdominal rectus diastasis. Both male and female patients were included. Abdominal rectus diastasis can occur simultaneously with other conditions, and these patients were included when describing the surgical repair techniques but not when assessing other secondary outcomes than recurrence rate. The primary outcome was to describe the different surgical techniques used to correct abdominal rectus diastasis, and this had to be reported for a study to be included. In terms of mesh use, it is assumed that no mesh is used, if the study did not mention a mesh. Secondary outcomes were recurrence rate and other postoperative complications in relation to the different surgical techniques, but a study could be included without this information. When assessing recurrence rates, studies needed to have at least six months of follow up to be included in this study. There were no formal requirements for a comparison group. Conference abstracts, systematic reviews, and narrative reviews were excluded. There were no restrictions

Table 1. Overview of techniques used for repair of rectus diastasis.

Operative information	Open		Laparoscopy	
	Total patients= 2865 Patients (%)	Total studies = 43* Studies (%)	Total patients= 666 Patients (%)	Total studies = 15 Studies (%)
Abdominal incision				
<i>Reported</i>	2865 (100),	43 (100)	NR	NR
-Low abdominal	2707 (95)	39		
-Other incision	126 (4)	3		
-Combination of the above	32 (1)	1		
Plication—layers				
<i>Reported</i>	2318 (81)	31 (72)	238 (36)	10 (67)
-Single	788 (34)	13	96 (40)	5
-Double	1530 (66)	16	114 (48)	4
-Single or double	0 (0)	2	0 (0)	0
-Triple	0 (0)	0	28 (12)	1
Plication—material				
<i>Reported</i>	2385 (83)	36 (84)	428 (64)	12 (80)
-Permanent	901 (38)	22	381 (89)	11
-Slowly absorbable	82 (3)	2	0 (0)	0
-Absorbable	688 (29)	5	0 (0)	0
-Combination	714 (30)	7	47 (11)	1
Plication—technique				
<i>Reported</i>	2605 (91)	37 (86)	378 (57)	11 (73)
-Interrupted	494 (19)	9	50 (13)	2
-Continuous	1100 (42)	16	300 (79)	8
-Combination	1011 (39)	12	28 (8)	1
Mesh use				
<i>Reported</i>	2865 (100)	43 (100)	666 (100)	15 (100)
-Mesh was used	289 (10)	8 (19)	465 (70)	8 (53)
Mesh with hernia	89 (31)**	NR	447 (96)	NR
Mesh without hernia	168 (58)**	NR	18 (4)	NR

'Reported' is number of patients and studies that reported this parameter of the total number of patients/studies (in italic font). The subdivision under each headline presents number and per cent that used the technique of the total number of patients/studies that 'reported' on this parameter.

*Number of studies with a unique patient population.

**Number of patients did not correspond to the total count since not all studies specified the number of patients with hernia. NR: not relevant.

in other study types or number of patients. Studies reported in English, German, Danish, Swedish, or Norwegian were included.

Systematic searches were conducted in PubMed, Embase, and Cochrane Library. The search strategy was developed for PubMed and adapted to the other databases: (((((((('Rectus Abdominis'[Mesh]) OR 'Diastasis, Muscle'[Mesh])) OR ((rectus diastasis[Text Word] OR diastasis recti[Text Word] OR diastasis rectus abdominis[Text Word] OR abdominal separation[Text Word])) OR separation recti)) AND (((('General Surgery'[Mesh]) OR 'Surgery, Plastic'[Mesh])) OR ((surg*[Text Word] OR plication[Text Word] OR repair[Text Word])))) OR ((('Rectus Abdominis/surgery'[Mesh]) OR 'Diastasis, Muscle/surgery'[Mesh])). The final search was performed on 4th October 2019 in PubMed, Cochrane and Embase. The search strategy was developed together with a professional research librarian.

After retrieving titles and abstracts, Mendeley® was used to exclude duplicates. Then two reviewers screened title and abstracts independently, and disagreements were discussed until consensus was reached. Studies potentially fulfilling the eligibility criteria were full-text screened in the same way as titles and abstracts. The literature search was supplemented with relevant articles from the reference lists of the included studies and from reviews on the subject, a so-called snowball search.

Data extraction was performed in an Excel® sheet created by the authors and tested for five studies. Thereafter, data were extracted twice by one reviewer to the preformed Excel® sheet. The following variables were extracted: author, study design, number of patients, age, sex, conditions repaired, duration of operation, type of repair (open or laparoscopic), details of the suture technique and material, mesh material and size and

placement, follow up (time, type, and completion), and postoperative complications including recurrence, pain, hematoma, seroma, and infection. The complications, besides recurrence, were only considered if they were reported specifically to the rectus diastasis repair and not included if they were reported in relation to a combined hernia and rectus diastasis procedure.

Results

A study flow chart is illustrated in Figure 1. The systematic search identified 3323 studies, and a total of 61 studies [8–68] met the eligibility criteria and were included for this review: eight randomized controlled trials (RCTs) [8–15], 23 prospective cohort studies [16–30,54–61], 20 retrospective cohort studies [31–47,62–64], one case-control study [48], and nine case reports [49–53,65–68]. Study characteristics are presented in eTable 1. The total study population consisted of 3531 patients, ranging from 1 to 673 in the individual studies. All included patients had abdominal rectus diastasis, and 17 studies included patients with a midline ventral hernia as well [22,23,30,31,37,41,47,48,52,54,55,58–61,63,65,67]. Open surgical techniques are presented in eTable 2 and laparoscopic techniques are presented in eTable 3.

The rectus diastasis width was reported in 24 studies [8,9,12–15,17,19,22,24,26–28,31,38,44,49–51,56,58–60,67]. The median of the reported means was 2.8 cm ranging from 2.1 cm¹³ to 11 cm [56]. Twelve studies used a classification for the diagnosis, whereof seven studies [9,13,14,24,25,28,50] used the classification by Nahas [69], three studies [29,51,59] used the Beer classification [70], and one study [44] used the Rath classification [71]. The diagnostics used was reported in 21 studies. Ten studies

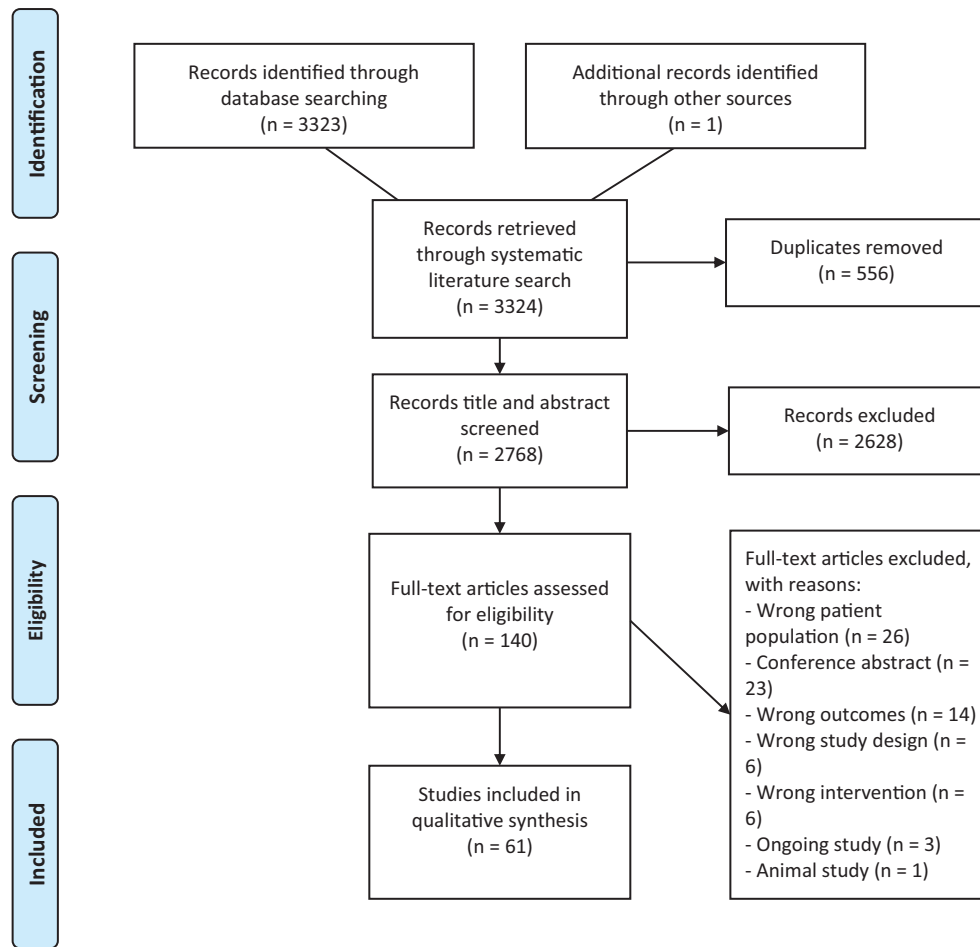


Figure 1. Flowchart of inclusion and exclusion of studies.

used CT scan [9,12,17,19,31,49–51,56,67], seven studies used ultrasound scan [13,26,29,33,44,55,58], two studies used MRI [16,53], one study used either ultrasound or CT scan [54]. The remaining studies diagnosed with clinical examination [24,25,27,38,43,45,47,52,65,66,68]. Further details about diagnostics are presented in eTable 4.

In general, repairs were initiated with the patient under either epidural or general anesthesia usually including muscle relaxants. All techniques included plication of the anterior or the posterior rectus sheath or both. The surgeons using an open abdominoplasty usually plicated the anterior rectus sheath while surgeons using a laparoscopic approach usually plicated the posterior rectus sheath. The surgical techniques and postoperative complications are described below.

Open repair

Surgical technique

A total of 46 studies used an open technique to visualize the rectus muscles and the linea alba [8–53]. Table 1 shows an overview of the used techniques. All but four [22,31,47,52] of the 46 studies used a classic abdominoplasty approach with a suprapubic transverse incision extended laterally bilateral to the anterior iliac crests. The remaining four studies used a combination of low abdominal transverse incision and midline incision [31], a midline supraumbilical incision [47,52], and a suprapubic incision on the left side extended 2–3 cm cranially [22]. Three studies consisted of the same patient population having received the same surgical

technique and they are referred to as one study in the following paragraphs [9–11]. The same applies to two other studies, which also included the same patient population [17,18].

A total of 31 studies [8,9,12–14,16,17,19,21,24–30,32,35,36,39,41–48,50–52] reported whether they used a single or double layer suture: 13 studies used a single layer [8,14,16,21,29,30,32,36,39,42,44,46,48], 16 studies used a double layer [12,17,19,24–28,35,41,43,45,47,50–52], and two studies used both types [9,13].

In 36 studies, the suture material was reported [8,9,12–17,19,20,22,24,25,27–35,37–41,43–47,49–51,53]. Permanent sutures were used in 22 studies [14–17,19,20,24,28–34,38–40,45,46,49,50,53], slowly absorbable sutures were used in two studies [22,43], and five studies used absorbable sutures [35,37,41,44,47]. In three studies that used a double layer technique, one layer was sutured with an absorbable material and the other layer with a permanent material [25,27,51]. Four RCTs compared different types of sutures [8,9,12,13]: absorbable versus permanent sutures, with no differences in inter-recti distance in the two groups after six months [8]; absorbable versus slowly absorbable sutures, with no difference regarding early complications including recurrence and pain three months postoperatively [9]; absorbable versus permanent sutures, with no difference in recurrence six months post-surgery [12]; and three types of permanent sutures, with no differences in tensile force or recurrence in the three groups after six months [13].

Suture technique for the plication was reported in 37 studies [8,9,12–14,16,17,19,21,22,24–36,38–49,51,52]. Interrupted sutures were used in eight studies [8,21,30–32,34,42,46,49], of which three used figure-of-eight sutures [31,32,42] and two used mattress

sutures [21,30]. Continuous suture was used in 16 studies [9,16,22,29,33,35–37,39–41,43,44,47,48,52], two of which used horizontal mattress suture [35,52]. In ten of the studies that used a double layer technique, one layer was done with interrupted sutures and one with a continuous layer of sutures [12,17,19,24–28,45,51]. Two RCTs compared different types of suturing techniques [13,14]: one study compared a double layer technique, one interrupted layer and one continuous layer, with two groups plicated with continuous sutures and found no differences regarding tensile force and recurrence [13]; and the other study compared triangular mattress sutures with continuous sutures but did not report on postoperative complications [14].

In the 46 studies that used an open technique for the rectus diastasis repair, nine studies included patients with ventral hernias as well [22,23,30,31,37,41,47,48,52]. Mesh reinforcement in addition to the plication was used in eight of the studies [9,22,23,30,31,38,47,53], and mesh details are listed in eTable 2.

The procedure was typically completed with the placement of a suction drain and then closure of the skin. The mean or median duration of the procedure was reported in five studies [13,22,25,31,47], and the median value of these was 2.23 h ranging from 1.32 to 3.20 h.

Postoperative complications

Recurrence rate was reported in 18 studies [8,9,12,13,16,18,19,29,31,33,37–39,41,43,44,49,50], and it was overall very low with 14 studies reporting a 0% recurrence rate [8,12,16,18,19,29,31,37–39,41,43,49,50]. The remaining four studies reported recurrence rates between 4% and 40% [9,13,33,44]. Of the two RCTs [9,13] and one retrospective study [33] that compared groups with different plication techniques and reported recurrences above zero, none of the differences in recurrence rates were statistically significant. The overall completion of follow up was high, and the median of the mean/median follow up times was 20 months, ranging from six months to 64 months. Details about follow up time and type of assessment are listed in eTable 1.

Postoperative pain was reported in eight studies [10,12,13,17,34,38,39,53]. Even though pain prevalence in general was low after open repairs, the method of assessment was heterogeneous and of poor quality. Two studies reported 0% postoperative pain after 6 months [17] and 15 months [33] without specifying their method of assessment [17,33]. Four studies reported 'no other complications except the mentioned' but did not specify if these statements included pain [12,39,50,53]. One study reported that patients only took common painkillers and non-steroidal anti-inflammatory drugs in the first week, but did not specifically assess pain [13]. One study assessed pain before and one year after surgery by the validated Ventral Hernia Pain Questionnaire and showed a significant improvement in several of the pain parameters after surgery [10]. Another study assessed pain during clinical examination and 17% (1 patient) reported 'occasional left upper quadrant abdominal pain' and 17% (1 patient) reported 'lower left rectus ache' [38].

Regarding other complications, ten studies reported hematoma rates, which ranged from 0% to 7% with a median of 0% [9,17,19,22,25,30,34,38,43,46]. Seroma incidence was reported in 15 studies [9,12,17,19,22,25,30,34,36,38,41–45], and it ranged from 0% to 30% with a median of 6.3%. Local infection rates were reported in 14 studies [9,17,19,22,25,30,34,36,38,41–44,46], and it was between 0% and 18% with a median of 0%. Additionally, one study reported hematoma and seroma rates together, and it was 10% [37].

Laparoscopic repair

Surgical technique

A total of 15 studies [54–68] used a laparoscopic approach to repair the abdominal rectus diastasis. Table 1 shows an overview of the used techniques. The trocars were placed suprapubically and at the umbilicus in five studies [57,62,64–66], suprapubically and in both iliac fossae in six studies [55, 58–60,67,68], periumbilically in one study [63], caudally to the xiphoid process and in the upper left and right quadrants in one study [56], in the left upper, middle, and lower abdomen in one study [54], and above a hernia defect and laterally in both sides, 1 cm lateral of rectus muscles, in one study [61]. Four patients (8%) in one study were operated on with robot assistance [59].

The number of plication layers that had been used was reported in ten studies [54–57,62,64–68]: single-layer was used in five studies [54,56,57,65,68], double-layer was used in four studies [55,62,66,67], and one study used a triple-layer plication technique [64].

Twelve studies [54–58,62–68] reported which suture material had been used, and all of these twelve studies used permanent sutures, except from a proportion in one study where absorbable suture was used [58].

The suturing technique was available in eleven studies [54–57,62–68]. In eight studies [54,55,62,63,65–68], a continuous suture was used, two of which used horizontal mattress suture [54,68]. In two studies, an interrupted suture technique was used [56,57] and in the last study, a triple-layer repair was used with two layers being interrupted and one layer continuous [64].

Of the 15 studies that used a laparoscopic approach for the rectus diastasis repair, nine studies included patients with ventral hernias as well [54,55,58–61,63,65,67]. A mesh was used for the repair in eight studies [55,56,58–61,63,67], and the details about the mesh placement and material is presented in eTable 2. The mean or median duration of the procedure was reported in six studies [54–56,59,61–63] and the median value of these was 1.65 h ranging from 1.38 to 2.17 h.

Postoperative complications

Recurrence rates was reported in eight studies [54–59,63,66], with seven studies reporting a 0% recurrence rate [54–58,63,66], the eighth study reporting a 2% recurrence rate [59]. The median of the mean/median follow up times was 12 months, ranging from 8 months to 48 months. The overall follow up completion rate was high; however, two studies followed an unknown number of patients for only a few months [54,63].

Postoperative pain was not reported in any of the studies, neither acute nor chronic pain. The incidence of hematoma was reported in four studies with a hematoma rate of 0% [57,59,62,66]. The same four studies reported a seroma rate of 3%, 16%, 25%, and 27% respectively [57,59,62,66]. Infection rate was reported in three studies and was 0%, 2%, and 25% [57,59,66].

Discussion

This systematic review provides an overview of surgical techniques used to repair rectus diastasis and postoperative complications in relation to the surgical technique. The most common repair was by the classic open low abdominoplasty with a transverse incision. Laparoscopic techniques were also used, and one study reported using robot-assisted laparoscopic repair in 8% of the patients. All repairs included a plication of the rectus sheath. In the open repairs, plication of the anterior rectus sheath was performed as either single- or double-layer and with either

permanent, slowly absorbable, or absorbable suture, with permanent suture being the most common. The RCTs comparing different open techniques showed no differences in complication or recurrence rates. In general, the studies on open repairs reported low recurrence and complication rates after all techniques. During the laparoscopic repairs, permanent sutures were used in all included studies. Recurrence rate was 0% in all identified studies but one, where it was 2%, and other complication rates were low.

The strength of this study was the systematic search in several databases and the use of snowballing to identify relevant data. PRISMA-ScR was followed, making the reporting transparent, and the review was registered at a public database. In addition, the completion of follow up was high and the length of the follow up was long enough for us to comment on the secondary outcomes. A limitation of this study includes a risk of language bias since there may have been studies in other languages that we did not identify with our search. As many of the included studies were not blinded RCTs with control groups, there is risk of performance bias and detection bias. Furthermore, there is a high risk of detection bias regarding the assessment of pain since only one study used a validated pain questionnaire. The diagnostic process was in general poorly reported and only few studies used a classification system. In addition, some variables such as other complications and plication details were poorly assessed or reported and with great variation between studies. We chose not to include more details about suture types other than absorbable, slowly absorbable, or permanent in order to keep the results section as homogenous as possible. Studies have described possible advantages of, e.g. barbed suture for plication [13,35,43,54], and our simplification of only dividing sutures into three groups may be a limitation as well.

In conclusion, many different techniques can be used in the correction of abdominal rectus diastasis. In the current literature, no evidence suggests that one technique is superior to another. Therefore, the choice of surgical approach may rely on the surgeon's expertise and preference, which can be influenced by factors such as the presence of loose abdominal skin and a concomitant hernia. There might be a higher risk of recurrence with the use of absorbable sutures, and this needs to be examined further. In general, more research needs to be conducted since the included studies often consisted of a very limited number of patients, and especially well designed RCTs with validated assessments of outcomes are lacking. The current literature indicates that surgical correction is a safe and effective treatment for symptomatic rectus diastasis.

Disclosure statement

MJ and SÖ report no potential conflicts of interest. JR received personal fee from MDS, outside the submitted work.

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