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Minimally Invasive Surgery for Rectal Procidentia, Is there a Preferred Approach?

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Abstract

Purpose: Rectal procidentia can be repaired with multiple different minimally invasive (laparoscopic and robotic) approaches, though it is unclear if any one approach is preferred. Herein, we have systematically reviewed the literature in an attempt to clarify if one minimally invasive approach is superior to another.

Methods: Utilizing Google Scholar and PubMed a systematic review of the English literature was carried out using the terms minimally invasive, laparoscopic, robotic, and rectopexy, resection rectopexy, mesh, suture, rectal procidentia, and rectal prolapse. Inclusion criteria for our study included all studies strictly evaluating minimally invasive repairs, which provided a total of 32 studies for review.

Results: No significant differences were found between different minimally invasive approaches in regards to recurrence, operative time, estimated blood loss, morbidity, mortality, length of stay, or improvement in preoperative constipation and incontinence.

Conclusion: To our knowledge the literature on minimally invasive repairs of rectal procidentia is sparse and inundated by heterogeneity; with no one approach having significantly better outcomes than another. Prospective randomized controlled trials comparing different minimally invasive repairs are needed.

Keywords: Rectal procidentia / prolapsed; Laparoscopic; Robotic; Repair

Introduction

Rectal procidentia is defined as full thickness circumferential intussusceptions of the rectum through the anal canal. It affects females six times more than males [1]. Common complaints include bleeding, mucous discharge, discomfort, incontinence, and constipation, all of which can significantly affect quality of life.

Laparoscopic rectopexy was introduced by Berman et al. in 1992, and since then numerous studies have reported minimally invasive (laparoscopic and robotic) approaches as being safe and feasible [2-6]. In addition to equivalent recurrence rates, minimally invasive surgery for rectal procidentia has been shown to result in decreased lengths of stay, analgesic requirements, and earlier tolerance of diet when compared to open repairs [7-13].

There are five commonly performed minimally invasive procedures for rectal prolapse. Anterior mesh rectopexy (Orr-Loygue procedure) involves anterolateral mesh fixation of either side of the rectum to the sacral promontory after anterior rectal mobilization. Posterior mesh rectopexy (modified Wells procedure) consists of posterior rectal dissection, typically with preservation of the lateral stalks, and mesh fixation to the sacral promontory and lateral rectum. Suture rectopexy with (Frykman-Goldberg procedure) or without segmental sigmoid resection involves suture fixation of the rectum to the sacral promontory. Ventral mesh rectopexy (D'Hoore procedure), a variant of anterior mesh rectopexy, secures the anterior rectum to the sacral promontory, and is frequently coupled with colpopexy. By avoiding posterolateral rectal dissection the rectum remains in its normal anatomic configuration preventing the potential disruption of the autonomic nervous system and subsequently postoperative constipation.

Herein the existing literature is reviewed in order to clarify whether one minimally invasive approach is superior to another in terms of operative time, estimated blood loss, conversion to open, morbidity, mortality, length of stay, recurrence, and rates of constipation and incontinence pre and postoperatively since in the literature there is a lack of systematic reviews comparing minimally invasive approaches for rectal prolapse.

Methods

Utilizing Google Scholar and PubMed a systematic review of the English literature was carried out using the terms minimally invasive, laparoscopic, robotic, and rectopexy, resection rectopexy, mesh, suture, rectal procidentia, and rectal prolapse. A total of 48 articles were identified including 26retrospective [5,6,9,11,12,14-34] and 17 prospective studies [8,10,35-49], 3 meta-analyses [1,50,51], and 2 randomized controlled trials [7,13]. Inclusion criteria for our study included all studies strictly evaluating minimally invasive repairs, which provided a total of 32 studies for review. Study and patient demographic information is outlined in Table 1.

Patient demographics

Of the 32 studies we evaluated, patients were predominantly female (1,648 / 94.3%) with ages ranging from 44 to84 years old.

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Table 1: Study and patient demographic information.

Author	Year	Country	Study Type	Repair	Patients (n / % female)	Mean Age	Procidentia (n / %)
Faucheron et al	2012	France	Pro	LAMR	175 / 90.2	58	175/ 100
Cuschieri et al	1994	UK	Retro	LPMR	5 / 100	64-81^^	5 / 100
Darzi et al	1995	UK	Retro	LPMR	29 / 93.1	71	27 / 93.1
Poen et al	1996	Netherlands	Retro	LPMR	12 / 91.6	73*	12 / 100
Solomon et al	1996	Australia	Retro	LPMR	21 / 76.1	61	21 / 100
Himpens et al	1999	Belgium	Pro	LPMR	37 / 97.2	62.5*	37 / 100
Zittel et al	2000	Germany	Retro	LPMR	20 / 90	55	12 / 60
Dulucq et al	2007	France	Pro	LPMR	77 / 98.7	69	77 / 100
Bryne et al	2008	Australia	Retro	LPMR	126 / NR	56.2	126 / 100
Stevenson et al	1998	Australia	Pro	LRSR	30 / 96.6	61*	30 / 100
Ashari et al	2005	Australia	Pro	LRSR	117 / 99.1	60*	117 / 100
Laubert et al	2010	Germany	Retro	LRSR	152 / 94.7	64.1	75 / 49.3
Graf et al	1995	Sweden	Retro	LSR	5 / 100	44	5 / 100
Heah et al	2000	UK	Pro	LSR	25 / 88	72	25 / 100
Hsu et al	2007	USA	Pro	LSR	12 / 66.7	45.8	12 / 100
Foppa et al	2014	USA	Pro	LSR	179 / 97.2	62*	179 / 100
D'Hoore et al	2004	Belgium	Retro	LVMR	42 / NR	49.7	42 / 100
Wijffels et al	2011	UK	Retro	LVMR	80 / 97.5	84*	80 / 100
Formijine-Jonkers et al	2013	Netherlands	Retro	LVMR	233 / 96.1	62	36 / 15.4
Powar et al	2013	Austrailia	Pro	LVMR	120 / 100	62.5	53 / 44.1
Maggiori et al	2013	France	Pro	LVMR	33 / 87.8	64	33 / 100
Haahr et al	2014	Denmark	Retro	RPMR	24 / 95.8	72*	24 / 100
Munz et al	2004	UK	Retro	RSR	6 / NR	NR	6 / 100
Draaisma et al	2007	Netherlands	Pro	RVMR	15 / 93.3	62	15 / 100
Kessler et al	1999	USA	Retro	LSR	28 / 90.6 +	51.5*	32 / 100
				LRSR	4 / 90.6 +		
Kellokumpu et al	2000	Finland	Pro	LSR	17 / 91.1+	64*	16 / 94.1

				LRSR	17 / 91.1+	55*	12 / 70.5
Bruch et al	1999	Germany	Pro	LSR	32 / 94.4+	62	57 / 79.1
				LRSR	40 / 94.4+		
Benoist et al	2001	UK	Retro	LPMR	14 / 85.7	66.3	14 / 100
				LSR	16 / 100	76.2	16 / 100
				LRSR	18 / 94.4	53.5	18 / 100
Kairaluoma et al	2003	Finland	Pro	LSR	26 / 88.6+	64	50 / 89.2
				LRSR	27/ 88.6+		
Madbouly et al	2003	USA	Retro	LPMR	11 / 90.9	63.9	11 / 100
				LRSR	13 / 84.6	48.6	13/ 100
Perrenot et al	2013	France	Retro	RVMR	77 / 92.2	59.9	77 / 100
				RAMR			
				RRSR			
Buchs et al	2013	Switzerland	Retro	RSR	1 / 100	74*	5 / 100
				RVMR	4 / 100		

* - denotes median rather than mean; ^^ - denotes range rather than mean; + - did not specify % gender between different approaches
LAMR: Laparoscopic Anterior Mesh Rectopexy; LPMR: Laparoscopic Posterior Mesh Rectopexy; LRSR: Laparoscopic Resection Suture Rectopexy; LSR: Laparoscopic Suture Rectopexy; LVMR: Laparoscopic Ventral Mesh Rectopexy; n: Number; NR: Not Recorded; Pro: Prospective; RAMR: Robotic Anterior Mesh Rectopexy; Retro: Retrospective; RPMR: Robotic Posterior Mesh Rectopexy; RRSR: Robotic Resection Suture Rectopexy; RSR: Robotic Suture Rectopexy; RVMR: Robotic Ventral Mesh Rectopexy; UK: United Kingdom; USA: United States of America

All studies presented patients with rectal procidentia; however a small number also included patients with symptomatic rectal intussusceptions, rectocele, enterocele, and/or solitary rectal ulcer syndrome [8,15,20,32,34,36,41,47]. Twenty-four studies described a single minimally invasive approach, while 8 presented more than one. Study and patient demographic information is outlined in Table 1.

Short term outcomes

Short term outcomes including operative time, conversion to open, estimated blood loss, morbidity, mortality, and length of stay are outlined in Table 2.

Operative time

Operative times for all approaches ranged from 68 to 270 minutes, with no significant differences noted between the different types of repairs. Only one study evaluated laparoscopic anterior mesh rectopexy, with a mean operative time of 112 minutes documented [46]. Operative times for laparoscopic posterior mesh rectopexy ranged from 68 to 270 minutes [14,44] and resection suture rectopexy from 128.5 to 258 minutes [24,36]. Suture rectopexy ranged from 96 to 227 minutes [36,38], and ventral mesh rectopexy was completed between 97 and 223 minutes [26,47]. In the 5 studies evaluating robotic approaches operative times were not significantly different from laparoscopic repairs and ranged from 112 to 223 minutes [5,6,26,29,30].

Conversion rate

Twenty-four studies documented conversion rates, which ranged from 0-20% and were primarily the result of presacral bleeding and pelvic adhesions from prior surgery [5,15-18,22,24-26,32-37,41-44,46-48]. The highest rates were appreciated in early studies, rates decreased with increased experience, and no one approach was significantly higher than another.

Estimated Blood Loss (EBL)

Estimated blood loss ranged from 11 - 100 milliliters, though was only recorded in 7 studies [5,8,19,24,37,43,44]. Of the approaches reported no one had a significantly higher blood loss than another.

Morbidity

Complications recorded included postoperative hemorrhage, port site hernia, abdominal wall hematoma, deep vein thrombosis, urinary tract infection, urinary retention, pneumonia, erectile dysfunction, surgical site infection, pseudomembranous colitis, small bowel obstruction, ureteral or small bowel injury, and anastomotic leak [5,6,15-19,22,24-26,31-37,41-44,46-48]. Morbidity for laparoscopic approaches ranged from 0 - 41.1%, and robotic from 0 - 20%.No one approach had a significantly higher morbidity than another.

Mortality

Mortality rates were low with most studies reporting none and only 3 studies reporting one each [32,35,42]. All recorded mortalities occurred in patients undergoing laparoscopic resection suture rectopexy and were due to aspiration pneumonia.

Table 2: Short term outcomes.

Author	Repair	Mean operation time (min)	Conversion to open (n / %)	EBL (mL)	Morbidity (n / %)	Mortality (n / %)	LOS (days)
Faucheron et al	LAMR	112	3 / 1.7	NR	9 / 5.1	0 / 0	2.2
Cuschieri et al	LPMR	120-270^^	NR	NR	1 / 20	0 / 0	<4
Darzi et al	LPMR	95	1 / 3.4	NR	3 / 10.3	0 / 0	5
Poen et al	LPMR	195	0 / 0	NR	0 / 0	0 / 0	7 *
Solomon et al	LPMR	198	3 / 14.2	NR	4 / 19	0 / 0	6.3
Himpens et al	LPMR	130	1 / 2.7	75	2 / 5.4	0 / 0	7
Zittel et al	LPMR	NR	NR	NR	4 / 20	0 / 0	NR
Dulucq et al	LPMR	68	1 / 1.3	35	3 / 3.9	0 / 0	4.9
Stevenson et al	LRSR	185	0 / 0	NR	4 / 13.3	1 / 3.3	5
Ashari et al	LRSR	110-180^^	1 / 0.85	NR	10 / 8.5	1 / 0.85	4-5^^
Laubert et al	LRSR	204.1	1 / 0.7	NR	35 / 23	1 / 0.7	11.3
Graf et al	LSR	225	1 / 20	NR	0 / 0	0 / 0	5
Heah et al	LSR	96	4 / 16	NR	4 / 16	NR	7*
Hsu et al	LSR	NR	NR	NR	4 / 33.3	NR	4
Foppa et al	LSR	NR	NR	NR	7 / 3.9	0 / 0	NR
D'Hoore et al	LVMR	115-140^^	2 / 4.7	NR	2 / 4.7	0 / 0	5.8
Wijffels et al	LVMR	NR	1 / 1.2	NR	10 / 12.5	0 / 0	3
Formijine-Jonkers et al	LVMR	NR	6 / 2.5	NR	11 / 4.6	0 / 0	5
owar et al	LVMR	97	0 / 0	NR	13 / 10.8	NR	1
Maggiori et al	LVMR	NR	1 / 3	NR	0 / 0	0 / 0	5
Haahr et al	RPMR	124	NR	NR	1 / 4.1	NR	4.1
Munz et al	RSR	156	0 / 0	NR	0 / 0	0 / 0	6
Draaisma et al	RVMR	160	0 / 0	50	2 / 13.3	0 / 0	4*
Kessler et al	LSR LRSR	150	NR	100	3 / 9.3	0 / 0	5
Kellokumpu et al	LSR LRSR	LSR- 150* LRSR- 255*	0 / 0	NR	LSR- 7 / 41.1 LRSR- 1 / 5.8	0 / 0	LSR- 5 LRSR- 5

Bruch et al	LSR LRSR	LSR- 227 LRSR- 258	1 / 1.4	NR	7 / 9.7	0 / 0	15
Benoist et al	LPMR LSR LRSR	LPMR- 113.5 LSR- 106.5 LRSR- 133	LPMR- 0 / 0 LSR- 0 / 0 LRSR- 0 / 0	NR	LPMR- 2 / 14.2 LSR- 3 / 18.7 LRSR- 2 / 11.1	LPMR- 0 / 0 LSR- 0 / 0 LRSR- 0 / 0	LPMR- 5.6 LSR- 5.7 LRSR- 6.7
Kairaluoma et al	LSR LRSR	LSR- 127.5 LRSR- 210	NR	LSR- 15 LRSR- 35	12 / 22.6	0 / 0	LSR- 4.5 LRSR- 5
Madbouly et al	LPMR LRSR	LPMR- 69.9 LRSR- 128.5	LPMR- 1 / 9 LRSR- 1 / 7.6	LPMR- 69.9 LRSR- 87.7	LPMR- 0 / 0 LRSR- 3 / 23	LPMR- 0 / 0 LRSR- 0 / 0	LPMR- 2.2 LRSR- 3.6
Perrenot et al	RVMR RAMR RRSR	223	5 / 6	NR	8 / 10.4	0 / 0	6.5
Buchs et al	RSR RVMR	170	0 / 0	11	1 / 20	0 / 0	3.6

***** - denotes median instead of mean; **^^** -denotes range rather than mean

EBL: Estimated Blood Loss; LAMR: Laparoscopic Anterior Mesh Rectopexy; LOS: Length of Stay; LPMR: Laparoscopic Posterior Mesh Rectopexy; LRSR - Laparoscopic Resection Suture Rectopexy; LSR: Laparoscopic Suture Rectopexy; LVMR: Laparoscopic Ventral Mesh Rectopexy; min: minutes; n: Number; NR - Not Recorded; RAMR: Robotic Anterior Mesh Rectopexy; RPMR: Robotic Posterior Mesh Rectopexy; RRSR: Robotic Resection Suture Rectopexy; RSR: Robotic Suture Rectopexy; RVMR: Robotic Ventral Mesh Rectopexy

Length of stay

The majority of studies reported a length of stay between 5-7 days, with no significant differences noted between the different types of repairs. Powar et al. reported the shortest mean length of stay of 1 day [47], and their prospective study design focused on laparoscopic ventral rectopexy being performed as a same-day procedure. Bruch et al. reported the longest mean length of stay at 15 days, which was attributed to social arrangements in the elderly patient population and financial aspects of the German healthcare system [36].

Long term outcomes

Long term outcomes including follow up, recurrence, and rates of pre and postoperative constipation and incontinence are outlined in Tables 3 and 4.

Follow up (Table 3)

Thirty one studies reported follow up with 28 describing a mean ranging from 6 - 70 months, 2 reporting a range from 4 - 48 months, and one defining a median of 23 months [5,6,8,14-20,22,24-26,30-37,42-48].

Recurrence (Table 3)

There was no significant difference in recurrence between the various repairs, which overall ranged from 0 to 12.8%. One study evaluating laparoscopic anterior mesh rectopexy revealed a recurrence rate of 3% [46]. Laparoscopic recurrence rates were 0 - 3.8% for posterior mesh rectopexy, 0 - 11.1% for resection suture rectopexy, 0 - 11.7% for suture rectopexy, and 2.5 - 6.6% for ventral mesh rectopexy. Robotic approaches did not differ significantly from laparoscopic approaches with rates ranging from 0 - 12.8%. Haahr et al. reported that 11.1% of their robotic posterior mesh rectopexy patients noted a recurrence. However, that was subjective and determined by telephone follow up instead of being found objectively on examination or with imaging [6].

Constipation and incontinence (Table 4)

A total of 22 studies compared pre and postoperative constipation and incontinence. All studies evaluating laparoscopic posterior mesh rectopexy, except one [24], revealed a worsening of constipation postoperatively, while incontinence improved [6,14,17,20,22,37,44]. Preoperative constipation ranged from 0-40% and increased to 16.6-64.2% postoperatively. Preoperative incontinence ranged from 32.4-100%, improving to 2.7-42.8% postoperatively. Laparoscopic resection suture rectopexy consistently reduced constipation and incontinence rates, and some studies preferentially performed resection rectopexy on patients with severe constipation [22,24,41]. Preoperatively constipation ranged from 53.8 - 100% compared to 0 - 44.4% postoperatively. Preoperative and postoperative incontinence were 0 - 69.2% and 0 - 27.7%, respectively. Laparoscopic suture rectopexy improved incontinence from 33.3-64.7% preoperatively to 11.7-31.2% postoperatively. Preoperative and postoperative constipation ranged between 0-58.8% and 16.6-62.5%, respectively, and improved [8,41] as well as worsened [22,38,45] in equal numbers of patients. In the studies evaluating laparoscopic ventral mesh rectopexy constipation and incontinence both improved [25,26,34,48]. Preoperative constipation ranged from 52.7-60% compared to 16.6-23.3% postoperatively. Preoperative and postoperative incontinence rates were 59.2-73.8% and 10-35.7%, respectively. Only one study evaluating robotic repairs reported on pre and postoperative constipation and incontinence, which showed improvement in both categories.

Discussion

This review of 32 studies evaluating minimally invasive repairs of rectal procidentia revealed no significant differences between the various approaches utilized.

Numerous studies comparing minimally invasive and open repairs for rectal prolapse have shown improved short term outcomes with laparoscopic approaches including length of hospital stay,

Table 3: Follow up and recurrence.

Author	Repair	Mean follow up (months)	Recurrence (n / %)
Faucheron et al	LAMR	70	5 / 3
Cuschieri et al	LPMR	4-27^^	0 / 0
Darzi et al	LPMR	8	0 / 0
Poen et al	LPMR	18	0 / 0
Solomon et al	LPMR	NR	NR
Himpens et al	LPMR	6-48^^	0 / 0
Zittel et al	LPMR	22	1 / 3.8
Dulucq et al	LPMR	34	1 / 1.2
Bryne et al	LPMR	60	5 / 3.6
Stevenson et al	LRSR	18	0 / 0
Ashari et al	LRSR	62	2 / 2.5
Laubert et al	LRSR	47.7	10 / 11.1
Graf et al	LSR	10	0 / 0
Heah et al	LSR	26	0 / 0
Hsu et al	LSR	32	0 / 0
Foppa et al	LSR	120	20 / 11.1
D'Hoore et al	LVMR	61	2 / 4.7
Wijffels et al	LVMR	23*	2 / 2.5
Formijine-Jonkers et al	LVMR	30	6 / 2.6
Powar et al	LVMR	7.6	3 / 2.5
Maggiori et al	LVMR	42	2 / 6.6
Haahr et al	RPMR	10	2 / 11.1**
Munz et al	RSR	6	0 / 0
Draaisma et al	RVMR	61	1 / 6.6
Kessler et al	LSR LRSR	33	2 / 6.2
Kellokumpu et al	LSR LRSR	24	LSR- 2 / 11.7 LRSR- 0 / 0
Bruch et al	LSR LRSR	30	0 / 0
Benoist et al	LPMR LSR LRSR	LPMR- 47 LSR- 24 LRSR- 20	LPMR- 0 / 0 LSR- 0 / 0 LRSR- 0 / 0
Kairaluoma et al	LSR LRSR	12	3 / 5.6
Madbouly et al	LPMR LRSR	18.1	LPMR- 0 / 0 LRSR- 0 / 0
Perrenot et al	RVMR RAMR RRSR	19.5	9 / 12.8
Buchs et al	RSR RVMR	6	0 / 0

* - denotes median rather than mean; ^^ - denotes range rather than mean: ** - denotes subjective recurrence

LAMR: Laparoscopic Anterior Mesh Rectopexy; LPMR: Laparoscopic Posterior Mesh Rectopexy; LRSR: Laparoscopic Resection Suture Rectopexy; LSR: Laparoscopic Suture Rectopexy; LVMR: Laparoscopic Ventral Mesh Rectopexy; n: Number; NR: Not Recorded; RAMR: Robotic Anterior Mesh Rectopexy; RPMR: Robotic Posterior Mesh Rectopexy; RRSR: Robotic Resection Suture Rectopexy; RSR: Robotic Suture Rectopexy

RVMR: Robotic Ventral Mesh Rectopexy

intraoperative blood loss, analgesic requirement, and early tolerance of diet [7-13]. Two meta-analyses comparing laparoscopic to open rectopexy noted a decreased length of stay and longer operative times in the laparoscopic group [50,51]. Total operation time is typically longer with laparoscopic rectopexy [7,11], however, Tevlin et al. and Carpelan-Holmstrom et al. revealed no difference [12,28].

Xynos et al. showed decreased morbidity with laparoscopic compared to open rectopexy, specifically surgical site infection and postoperative atelectasis, however, others have shown no difference [10,28,50,51]. In a meta-analysis by Sajid et al. they reported a significant heterogeneity between studies with regards to morbidity [50].

In a multicenter study evaluating 643 patients undergoing minimally invasive and open rectopexy for rectal procidentia the 1, 5, and 10 year recurrence rates were noted to be 1.06%, 6.61%, and 28.9%, respectively [23]. The minimally invasive studies in this review were comparable, and 2 meta-analyses comparing laparoscopic to open rectopexy found no difference in recurrence rates [50,51].

There are few studies comparing the different minimally invasive approaches and early reports have shown comparable morbidity, conversion rates, length of hospital stay and recurrence [39,40]. Mehmood et al. showed shorter operative times in the laparoscopic group compared to robotic (115 *vs.* 137.5 min, P=0.013), as did de Hoog et al. (119 *vs.* 154 min, P=0.02) [21]. Rondelli et al., in a meta-analysis, revealed no difference in terms of recurrence, conversion rates, or postoperative complications. However, there was not enough data to analyze operative time, blood loss, or length of stay [1].

In a retrospective study comparing long term outcomes in elderly patients with complete rectal prolapse, Germain et al. revealed that

Table 4: Constipation and incontinence.

Author	Repair	Preoperative constipation (n / %)	Postoperative constipation (n / %)	Preoperative incontinence (n / %)	Postoperative incontinence (n / %)
Cuschieri et al	LPMR	0 / 0	2 / 40	5 / 100	1 / 20
Poen et al	LPMR	0 /0	2 / 16.6	9 / 75	2 / 16.6
Himpens et al	LPMR	2 / 5.4	12 / 32.4	12 / 32.4	1 / 2.7
Zittel et al	LPMR	8 / 40	10 / 50	11 / 55	7 /35
Dulucq et al	LPMR	22 / 28.5	28 / 36.3	38 / 49.3	19 / 24.6
Stevenson et al	LRSR	14 / 53.8	5 / 19.2	18 / 69.2	6 / 23
Ashari et al	LRSR	53 / 68.8	20 / 25.9	29 / 37.6	9 / 11.6
Heah et al	LSR	9 / 36	11 / 44	15 / 60	7 / 28
Hsu et al	LSR	0 / 0	2 / 16.6	4 / 33.3	2 / 16.6
D'Hoore et al	LVMR	23 / 54.7	7 / 16.6	31 / 73.8	15 /35.7
Formijine-Jonkers et al	LVMR	123 / 52.3	44 / 18.8	138 / 59.2	32 / 13.7
Powar et al	LVMR	41 / 34.1	NR	65 / 54.1	NR
Maggiori et al	LVMR	18 / 60	7 / 23.3	20 / 66.7	3 / 10
Haahr et al	RPMR	NR	NR	8 / 44.4	3 / 16.6
Munz et al	RSR	NR	0/ 0	NR	1 / 16.6
Kessler et al	LSR LRSR	NR	2 / 6.2	NR	5 / 15.6
Kellokumpu et al	LSR LRSR	LSR- 10 / 58.8 LRSR- 14 / 82.3	LSR- 4 / 23.5 LRSR- 7 / 41.1	LSR- 11 / 64.7 LRSR- 10 /58.8	LSR- 2 / 11.7 LRSR- 2 / 11.7
Benoist et al	LPMR LSR LRSR	LPMR- 5 / 35.7 LSR- 6 / 37.5 LRSR- 11 / 61.1	LPMR- 9 / 64.2 LSR- 10 / 62.5 LRSR- 2 / 11.1	LPMR- 6 / 42.8 LSR- 9 / 56.2 LRSR- 5 / 27.7	LPMR- 6 / 42.8 LSR- 5 / 31.2 LRSR- 5 / 27.7
Kairaluoma et al	LSR LRSR	LSR- 13 / 50 LRSR- 20 / 74	LSR- 7 / 26.9 LRSR- 12 / 44.4	LSR- 9 / 34.6 LRSR- 15 / 55.5	LSR- 4 / 15.3 LRSR- 1 / 3.7
Madbouly et al	LPMR LRSR	LPMR- 1 / 9 LRSR- 13 / 100	LPMR- 1 / 9 LRSR- 0 / 0	LPMR- 5 / 45.4 LRSR- 0 / 0	LPMR- 1 / 9 LRSR- 0 / 0
Perrenot et al	RVMR RAMR RRSR	24 / 34.2	19 / 27.1	65 / 92.8	56 / 80
Buchs et al	RSR RVMR	NR	0 / 0	NR	0 / 0

robot-assisted rectopexy could be performed safely [29]. They divided patients into two groups, one with an average age of 53 and the other 80 years. They found no difference in terms of morbidity, operative time, conversion rate, or length of stay. Recurrence rates were similar at 5-year follow up.

The PROSPER trial, published in 2013, is the largest randomized controlled trial to date comparing surgical approaches for the treatment of rectal prolapse [53]. Although this trial is not specific for minimally invasive repairs it does highlight the difficulty performing prospective randomized controlled trials for rectal prolapse. The trial had difficulty recruiting patients and trained surgeons, thus emphasizing the regionalization of surgical repairs for rectal procidentia.

Cost Analysis

Cost analysis was not included in our review secondary to a paucity of studies evaluating cost. One study evaluating cost analysis revealed the total cost for laparoscopic rectopexy was £357 less per patient than open rectopexy (P=0.042), which was primarily attributed to a decreased hospital length of stay in the laparoscopic group (3.9 *vs.* 6.6 days, P=0.001) [13]. Cost analysis by Heemskerk et al. revealed the robotic approach to be $745.09 more expensive per patient compared to a laparoscopic repair (P=0.012) [52].

Conclusion

Compared to open, minimally invasive surgery for rectal procidentia has been shown to be safe with improved short-term outcomes and comparable recurrence rates. In the right patient population it can be completed as a same day surgery and can also be safely performed in elderly patients. The literature on minimally invasive repairs of rectal procidentia is sparse and inundated by heterogeneity; with no one approach having significantly better outcomes than another. Prospective randomized controlled trials comparing different minimally invasive repairs are needed.

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