



Outcome of laparoscopic ventral mesh rectopexy for full-thickness external rectal prolapse: a systematic review, meta-analysis, and meta-regression analysis of the predictors for recurrence

Sameh Hany Emile¹ · Hossam Elfeki^{1,2} · Mostafa Shalaby^{1,3} · Ahmad Sakr^{1,4} · Pierpaolo Sileri³ · Steven D. Wexner⁵

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Abstract

Background Laparoscopic ventral mesh rectopexy (LVMR) has proved effective in the treatment of internal and external rectal prolapse. The present meta-analysis aimed to determine the predictive factors of recurrence of full-thickness external rectal prolapse after LVMR.

Methods An organized, systematic search of electronic databases including PubMed/Medline, Embase, Scopus, and Cochran library was conducted in adherence to PRISMA guidelines. Studies that reported the outcome of LVMR in patients with full-thickness external rectal prolapse were included according to predefined criteria. A meta-regression analysis and sub-group meta-analyses were performed to recognize the patient and technical factors that were associated with higher recurrence rates.

Results Seventeen studies comprising 1242 patients of a median age of 60 years were included. The median operation time was 122.3 min. Conversion to open surgery was required in 22 (1.8%) patients. The weighted mean complication rate across the studies was 12.4% (95% CI 8.4–16.4) and the weighted mean rate of recurrence of full-thickness external rectal prolapse was 2.8% (95% CI 1.4–4.3). The median follow-up duration was 23 months. Male gender (SE=0.018, $p=0.008$) and length of the mesh (SE=−0.007, $p=0.025$) were significantly associated with full-thickness recurrence of rectal prolapse. The weighted mean rates of improvement in fecal incontinence and constipation after LVMR were 79.3% and 71%, respectively.

Conclusion LVMR is an effective and safe option in treatment of full-thickness external rectal prolapse with low recurrence and complication rates. Male patients and length of the mesh may potentially have a significant impact on recurrence of rectal prolapse after LVMR.

Keywords Laparoscopic ventral mesh rectopexy · External · Full thickness · Rectal prolapse · Recurrence · Meta-analysis

Rectal prolapse is protrusion of the mucosal layer or full thickness of the rectum through the anal canal. When the prolapsed segment of the rectum remains confined within the anal canal it is called internal rectal prolapse or

intussusception, whereas when it protrudes through the anal orifice it becomes an external prolapse [1].

Surgical treatment of rectal prolapse in adults is subdivided into two main categories: abdominal and perineal.

✉ Sameh Hany Emile
sameh200@hotmail.com

Hossam Elfeki
hossamelfeki@gmail.com

Mostafa Shalaby
mostafashalaby@mans.edu.eg

Ahmad Sakr
ahmadsakr1987@gmail.com

Pierpaolo Sileri
piersileri@yahoo.com

Steven D. Wexner
wexners@ccf.org

¹ Colorectal Surgery Unit, Department of General Surgery, Mansoura Faculty of Medicine, Mansoura University Hospitals, PO: 35516, 60 Elgomhuoria Street, Mansoura, Egypt

² Department of Surgery, Aarhus University Hospital, Aarhus, Denmark

³ Department of General Surgery, University of Rome Tor Vergata, Rome, Italy

⁴ Colorectal Surgery Department, Yonsei University College of Medicine, Seoul, South Korea

⁵ Department of Colorectal Surgery, Cleveland Clinic Florida, Weston, FL, USA

While the perineal resection procedures may be associated with low complication rates, the recurrence rate after these procedures is usually higher than the abdominal procedures [2].

Laparoscopic ventral mesh rectopexy (LVMR) is one of the most popular abdominal procedures for internal and external rectal prolapse. The procedure was first described by D’Hoore et al. [3] in 2004 and soon gained popularity as a treatment of choice for patients with rectal prolapse.

Several studies have assessed the efficacy and safety of LVMR for rectal prolapse. Cumulative evidence proved the effectiveness of the procedure as a systematic review [4] of 12 studies that applied ventral rectopexy for full-thickness rectal prolapse that reported a mean recurrence rate of 4.7% and complication rate of 4.8%. Another meta-analysis [5] of 14 studies that evaluated LVMR for internal rectal prolapse concluded that the weighted mean recurrence and complication rates of the procedure were 6.5% and 13.6%, respectively, and the weighted mean rates for improvement in constipation and fecal incontinence (FI) were 76.6% and 62.5%, respectively.

Although recurrence rates after LVMR are quite low, less than 10% on long-term follow-up [6], recurrence and management of recurrent cases are still challenging to colorectal surgeons. Causes of recurrence usually involve inadequate anterior rectal dissection, inadequate fixation of the mesh to the anterior rectal wall or to the sacral promontory, and incorrectly positioned staples to the upper sacrum [7].

This systematic review aimed to analyze the current literature on the use of LVMR for full-thickness external rectal prolapse in order to determine the mean recurrence and complication rates of LVMR with special emphasis on the predictive factors for recurrence which was not thoroughly

investigated in previous systematic reviews on the outcome of LVMR for rectal prolapse.

Methods

Registration

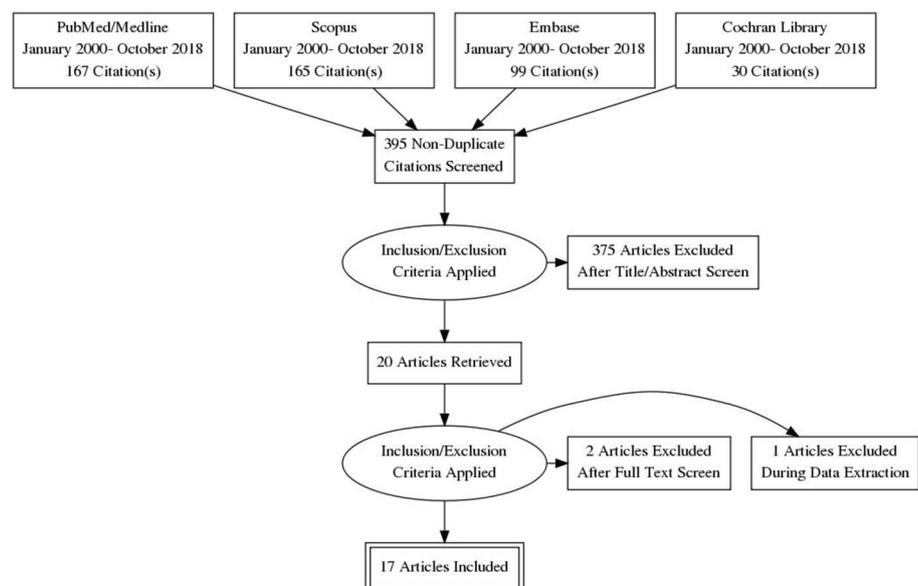
The protocol of this systematic review was registered a priori in the PROSPERO register under the registration number of CRD42018116050. Institutional Review Board (IRB) approval and informed patients’ consent were not needed for this type of studies.

Search strategy

We conducted an organized, systematic review of the literature to assess the recurrence and complication rates of LVMR in patients with full-thickness external rectal prolapse. The present review is reported in adherence to the screening guidelines established by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Fig. 1) [8]. Electronic databases including PubMed/Medline, Scopus, Embase, and Cochrane library were searched for published and ahead-of-publication studies from January 2000 through October 2018. In order to extend the search process, the PubMed function-“related articles” were used.

Keywords used in the search process included “*rectopexy*,” “*ventral rectopexy*,” “*laparoscopic rectopexy*,” “*ventral mesh rectopexy*,” “*anterior rectopexy*,” “*external rectal prolapse*,” “*complete rectal prolapse*,” “*total rectal prolapse*,” “*full-thickness rectal prolapse*,” “*obstructed defecation*,” and “*fecal incontinence*.” In addition, the

Fig. 1 PRISMA flow chart illustrating the search strategy of the review



following medical subject headings (MeSH) terms were used: (rectal prolapse), (constipation), (fecal incontinence), and (rectopexy).

The reference section of each publication was searched for relevant articles. After excluding duplicate reports and conference abstracts with no full-text version, the remaining publications were screened and filtered by title and abstract, then subsequently by full text. The full text of each article was independently reviewed by one of four authors (S.E, H.E, M.S, and A.S) under the guidance and supervision of the senior author (S.D.W.) to verify eligibility for inclusion.

Eligibility criteria

Studies that included at least 10 patients with full-thickness external rectal prolapse who underwent LVMR with a minimum follow-up of 12 months were included. External rectal prolapse was defined as extrusion of the full thickness of the rectal wall beyond the anal verge as diagnosed by physical examination. Case series, cohort observational studies, case-controlled studies, and randomized controlled trials (RCTs) were eligible for inclusion to the review. Only English-language articles were included.

We excluded irrelevant articles, editorials, case reports, reviews, meta-analyses, animal, and ex vivo studies. Studies with a follow-up duration of less than 12 months were excluded. Articles that comprised patients with internal rectal prolapse in addition to patients with external rectal prolapse in the same context without clear reporting of the results for each entity were considered confounding and were excluded. Articles that did not report the aim, methodology, demographic data of patients, final results, and conclusion clearly were also excluded.

Assessment of methodological quality and bias within the included studies

The methodological quality and risk of bias in each study were independently assessed by three investigators (H.E, M.S, A.S.) and any discrepancies in interpretation were resolved by discussion and mutual agreement.

The checklist for the quality of case series of the National Institute for Health and Clinical Excellence (NICE) [9] was used for the assessment of the studies included and each study was given a score. Quality of the studies was defined as good (score = 7–8), fair (score = 4–6), and poor (score = 0–3). The revised grading system of the Scottish Intercollegiate Guidelines Network (SIGN) [10] was used to assess comparative studies, a score of less than 8 indicated poor quality; a score of 8–14 implied fair quality, and a score of more than 14 indicated good quality.

Data collected

Data collection objectives included the following items:

- Type, country, and duration of each study.
- Patients' characteristics including number, age, gender distribution, body mass index (BMI), duration and type of symptoms, and previous surgery for rectal prolapse.
- Technical details of the procedure that involve operation time, conversion to open surgery, number of surgeons, type and size of mesh used, methods of fixation to the rectal wall and sacral promontory, and closure of Douglas pouch.
- Recurrence which was defined as extrusion of the full thickness of the rectal wall beyond the anal verge.
- Number and type of postoperative complications and follow-up duration.

Outcomes of the review

The primary outcome of this review was the recurrence rate after LVMR and the predictors for recurrence, whereas secondary endpoints comprised operation time, complication rate, conversion to open surgery, and postoperative improvement in symptoms as constipation and FI.

Assessment of publication bias across the included studies

A funnel plot of the standard error of the recurrence rates against the recurrence rates of the studies included was used to assess the publication bias across the studies of this review. Straight vertical line in the plot indicates the zone in which 95% of points (studies) should exist if there was no publication bias. In addition, publication bias was assessed using the Begg and Mazumdar Rank Correlation Test.

Statistical analysis

Data were analyzed using SPSS version 23 (IBM corp, Chicago, USA). Continuous variables were expressed as mean \pm standard deviation (SD), or median and normal range. Categorical variables were expressed as number and percentage. *p* value less than 0.05 was considered significant.

A meta-analysis of recurrence and complication rates across the studies was conducted using open-source, cross-platform software for advanced meta-analysis "openMeta[Analyst]TM" version 12.11.14. Data were pooled and the weighted mean rates with 95% confidence interval (CI) were calculated. Statistical heterogeneity was determined by the Cochrane Q test and the Inconsistency (I^2) statistics. I^2 is the proportion of total variation observed between the studies attributable to differences between

studies rather than sampling error. Heterogeneity was considered low if $I^2 < 25\%$ and high if $I^2 > 75\%$. If no significant statistical heterogeneity was present, a fixed-effect model was used to pool data, whereas in the case of significant ($p < 0.1$) statistical heterogeneity, the binary random-effect model was utilized for pooling of data.

A random-effect meta-regression model was used weighing the studies by their within-study variance and the degree of heterogeneity. The heterogeneity between the studies was explored in relation to differences in patients' age, gender, BMI, history of surgery for rectal prolapse, number of surgeons, operation time, type and size of mesh used, method of fixation of mesh to sacral promontory, and conversion to open surgery. The statistical significance of each examined variable was determined using slope coefficient (SE) and p value.

Results

Patient and study characteristics

Seventeen studies [6, 11–26] published between 2010 and 2018 were included to the present review. Twelve studies were conducted in European countries, two in India [19, 26], two in Egypt [22, 25], and one in Australia [24]. Thirteen studies were retrospective, three were RCTs [15, 21, 22], and one was a prospective cohort study [4]. According to quality assessment scale, five studies [6, 12, 21, 22, 24] were of good quality and 12 were of fair quality.

The studies included a total of 1242 patients of a median age of 60 (range 34.7–84) years and female-to-male ratio of 5.8:1. The median BMI of patients was 25 (range 22–29) kg/m². One hundred and sixty-two (13%) patients had undergone previous surgical treatment of external rectal prolapse (Table 1).

Ten studies [6, 11, 14, 17–19, 22, 23, 25, 26] including 704 patients reported FI in 463 (65.7%) patients and ten studies [6, 11, 14, 16, 19, 21–23, 25, 26] including 557 patients reported constipation in 237 (42.5%) patients. The median duration of symptoms was 60 (range 15.6–120) months.

Technical details

Eleven studies used synthetic meshes (Polypropylene, Polyester, Hi-Tech®, Marlex), one [15] used biologic mesh (Bio-design®), one [16] used semi-absorbable synthetic mesh (Vypro®), two [20, 24] used synthetic or biologic meshes, and two studies [23, 25] did not specify the type of mesh used.

All studies placed one strip of mesh except two studies [13, 16] that used two mesh strips. Six studies [11–13, 15, 17, 18] used a 20-cm-long mesh, six used [6, 19, 22–24, 26] a 17-cm-long mesh, one [14] used a 15-cm-long mesh, whereas in four studies [16, 20, 21, 25] the length of mesh was not disclosed.

Tackers (Protack™) were used to fixate the mesh to the sacral promontory in 12 studies. One study [14] used either tacks or single titanium screw, one study [6] used either

Table 1 Characteristics of the patients and studies included

Study	Type	Country	Number	Males (%)	Age	Previous surgery for rectal prolapse	Quality
Boons et al. [11]	Retrospective	UK	65	5 (7.7)	72	0	5 (fair)
Wijffels et al. [12]	Retrospective	UK	80	2 (2.5)	84	33 (41.2)	7 (good)
Faucheron et al. [13]	Prospective	France	175	17 (9.7)	58	6 (3.4)	6 (fair)
Formijne Jonkers et al. [14]	Retrospective	Multicenter	40	4 (10)	67	NA	12 (fair)
Mehmood et al. [15]	Randomized trial	UK	34	3 (8.8)	58	19 (55.9)	14 (fair)
Bjerke and Mynster [16]	Retrospective	Denmark	46	0	83	14 (30.4)	6 (fair)
Randall et al. [17]	Retrospective	UK	190	24 (12.6)	69	46 (24.2)	5 (fair)
Gosselink et al. [18]	Retrospective	UK	41	3 (7.3)	63	NA	6 (fair)
Conseten et al. [6]	Retrospective	Multicenter	242	NA	50.1	NA	7 (fair)
Chandra et al. [19]	Retrospective	India	15	6 (40)	50	2 (13.3)	5 (fair)
Rautio et al. [20]	Retrospective	Finland	52	52 (100)	46.2	4 (7.7)	6 (fair)
Lundby et al. [21]	Randomized trial	Denmark	38	3 (7.9)	60	NA	18 (good)
Emile et al. [22]	Randomized trial	Egypt	25	8 (32)	34.7	0	17 (good)
Luglio et al. [23]	Retrospective	Italy	20	0	68	NA	8 (fair)
Fu and Stevenson [24]	Retrospective	Australia	113	0	65.3	38 (33.6)	7 (good)
Madbouly and Youssef [25]	Retrospective	Egypt	41	5 (12.2)	57.5	NA	10 (fair)
Chandra et al. [26]	Retrospective	India	25	15 (60)	38	0	6 (fair)

tacks or sutures, and one study [24] used either absorbable sutures, non-absorbable sutures or tacks.

Fourteen studies used non-absorbable sutures (Ethibond = 11, polypropylene = 3) to secure the mesh to the anterior rectal wall, whereas one study [24] used absorbable or non-absorbable sutures and another study [13] used five 4-mm titanium staples (Table 2).

The median operation time was 122.3 (range 85–200) min. Nine studies reported the number and level of experience of the operating surgeons. LVMR was performed by single experienced surgeon in two studies [15, 16], by two experienced surgeons in one study [25], and by more than two experienced surgeons in six studies [11, 20–22, 24]. Conversion to open surgery was required in 22 (1.8%) patients.

Complications

A total of 174 (14%) complications and four (0.3%) mortalities were recorded (Table 3). The weighted mean complication rate across the studies was 12.4% (95% CI 8.4–16.4, $I^2 = 80%$) (Fig. 2).

Urinary complications were the most frequent complications ($n = 28$; 2.2%) and included urinary tract infection ($n = 17$), urine retention ($n = 7$), ureteral injury ($n = 2$), urinary bladder injury ($n = 1$), and vas deferens injury ($n = 1$). Mesh-related complications occurred in 12 (0.96%) patients, port site infection in nine (0.7%) patients, port site hernia in nine (0.7%) patients, ileus in six (0.5%), and small bowel injury in three (0.2%) patients.

Table 2 Technical details of laparoscopic ventral mesh rectopexy in the studies reviewed

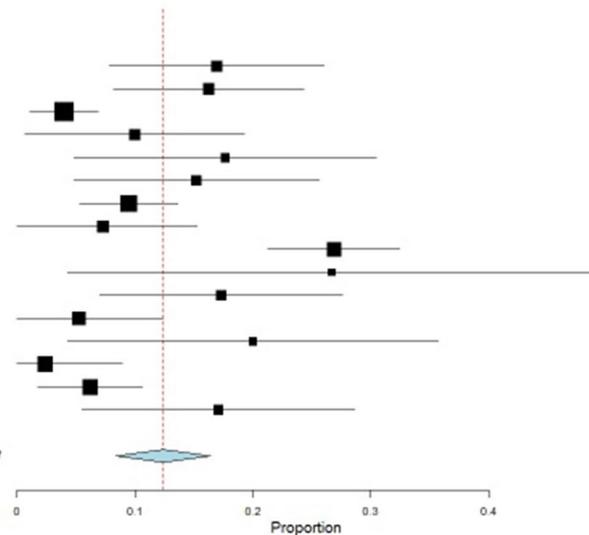
Study	Type of mesh	Length of mesh	Method of fixation to promontory	Method of fixation to the rectum	Operation time	Number of surgeons
Boons et al. [11]	Polypropylene	20 cm	Protack	Two rows of Ethibond 0 sutures	140	Multiple
Wijffels et al. [12]	Polypropylene or polyester	20 cm	3 Protack staples	Interrupted Ethibond 0	NA	NA
Faucheron et al. [13]	Synthetic	20 cm	3 Protack staples	Five 4-mm titanium staples	NA	NA
Formijne Jonkers et al. [14]	Hi-TEC or Polypropylene	15 cm	Protack or one titanium screw	At least 6 sutures	NA	NA
Mehmood et al. [15]	Biodesign® biologic mesh	20 cm	Protack	2/0 Ethibond interrupted sutures	115	Single
Bjerke and Mynster [16]	Synthetic semi-absorbable mesh (Vypro)	NA	Protack	Sutures	135	Single
Randall et al. [17]	Polypropylene or polyester	20 cm	Protack	Sutures	NA	NA
Gosselink et al. [18]	Polypropylene	20 cm	3 Protack staples	Three Ethibond 0 sutures	NA	NA
Conseten et al. [6]	Malrex, Hi-Tech, polypropylene	17 cm	Titanium tacks, stapler, sutures	Sutures	NA	Multiple
Chandra et al. [19]	Polypropylene	17 cm	Tackers	Polypropylene sutures	200	NA
Rautio et al. [20]	Polypropylene or polyester or biologic	NA	Protack	At least 3 sutures	114	Multiple
Lundby et al. [21]	Polypropylene	NA	Tackers	Ethibond sutures	125	Multiple
Emile et al. [22]	Polypropylene	17 cm	2–3 Protack staples	Polypropylene sutures 2/0	114	Multiple
Luglio et al. [23]	NA	17 cm	NA	1–2 non-absorbable sutures	NA	NA
Fu and Stevenson [24]	Synthetic or biologic (Biodesign/Permacol)	17 cm	Absorbable or non-absorbable sutures, tacks, colposuspension	Non-absorbable + absorbable sutures	85	Multiple
Madbouly and Youssef [25]	NA	NA	NA	NA	122.3	Two
Chandra et al. [26]	Polypropylene	17 cm	Tackers	Polypropylene sutures	142.3	NA

Table 3 Outcomes of laparoscopic ventral mesh rectopexy in the studies reviewed

Study	Recurrence (%)	Mucosal prolapse (%)	Complications (%)	Improvement in continence (%)	Improvement in constipation (%)	Follow-up in months
Boons et al. [11]	1 (1.5)	2 (3.1)	11 (16.9)	85.1	71.8	19
Wijffels et al. [12]	2 (2.5)	3 (3.75)	13 (16.2)	NA	NA	23
Faucheron et al. [13]	2 (1.1)	0	7 (4)	NA	NA	74
Formijne Jonkers et al. [14]	0	0	4 (10)	72.7	59.1	42
Mehmood et al. [15]	0	0	6 (17.6)	NA	NA	12
Bjerke and Mynster [16]	2 (4.3)	NA	7 (15.2)	NA	33.3	18
Randall et al. [17]	1 (0.5)	5 (2.6)	18 (9.3)	92.6	NA	29
Gosselink et al. [18]	1 (2.4)	0	3 (7.3)	48.8	NA	12
Conseten et al. [6]	13 (5.4)	0	65 (26.8)	63.3	61	33.9
Chandra et al. [19]	0	0	4 (26.6)	91.7	NA	22
Rautio et al. [20]	9 (17.3)	11 (21.1)	9 (17.3)	NA	NA	56.1
Lundby et al. [21]	0	2 (5.2)	2 (5.2)	NA	NA	12
Emile et al. [22]	2 (8)	2 (8)	5 (20)	75	100	18
Luglio et al. [23]	0	1 (5)	0	97.6	100	12
Fu et al. [24]	16 (14.1)	8 (7.1)	7 (6.2)	NA	NA	47
Madbouly and Youssef [25]	1 (2.4)	NA	7 (17.1)	66.7	59.3	46
Chandra et al. [26]	1 (4)	0	6 (24)	92.6	84.6	33.5

Random-Effect Model

Studies	Complications	95% C.I	Ev/TrT
Boons	0.169	(0.078, 0.260)	11/65
Wijffels	0.163	(0.082, 0.243)	13/80
Faucheron	0.040	(0.011, 0.069)	7/175
Formijne Jonkers	0.100	(0.007, 0.193)	4/40
Mehmood	0.176	(0.048, 0.305)	6/34
Bjerke	0.152	(0.048, 0.256)	7/46
Randall	0.095	(0.053, 0.136)	18/190
Gosselink	0.073	(0.000, 0.153)	3/41
Conseten	0.269	(0.213, 0.324)	65/242
Chandra	0.267	(0.043, 0.490)	4/15
Rautio	0.173	(0.070, 0.276)	9/52
Lundby	0.053	(0.000, 0.124)	2/38
Emile	0.200	(0.043, 0.357)	5/25
Luglio	0.024	(0.000, 0.089)	0/20
Fu	0.062	(0.018, 0.106)	7/113
Madbouly	0.171	(0.056, 0.286)	7/41
Overall ($I^2=80.02\%$, $P<0.001$)	0.124	(0.084, 0.164)	168/1217

**Fig. 2** Forest plot for recurrence of rectal prolapse**Recurrence**

Fifty-one (4.1%) patients presented with recurrent full-thickness external rectal prolapse and 34 (2.7%) presented with mucosal prolapse after surgery (Table 3). The weighted mean rate of recurrence of full-thickness external rectal prolapse was 2.8% (95% CI 1.4–4.3, $I^2=60.4\%$) (Fig. 3) at a median follow-up of 23 (range 12–74) months.

Predictive factors for recurrence

Random-effect meta-regression analysis revealed that the factors that were significantly associated with full-thickness recurrence of rectal prolapse were male gender (SE=0.018, 95% CI –0.008–0.044, $p=0.008$) and length of the mesh (SE=–0.007, 95% CI –0.01 to –0.001, $p=0.025$).

Random-Effect Model

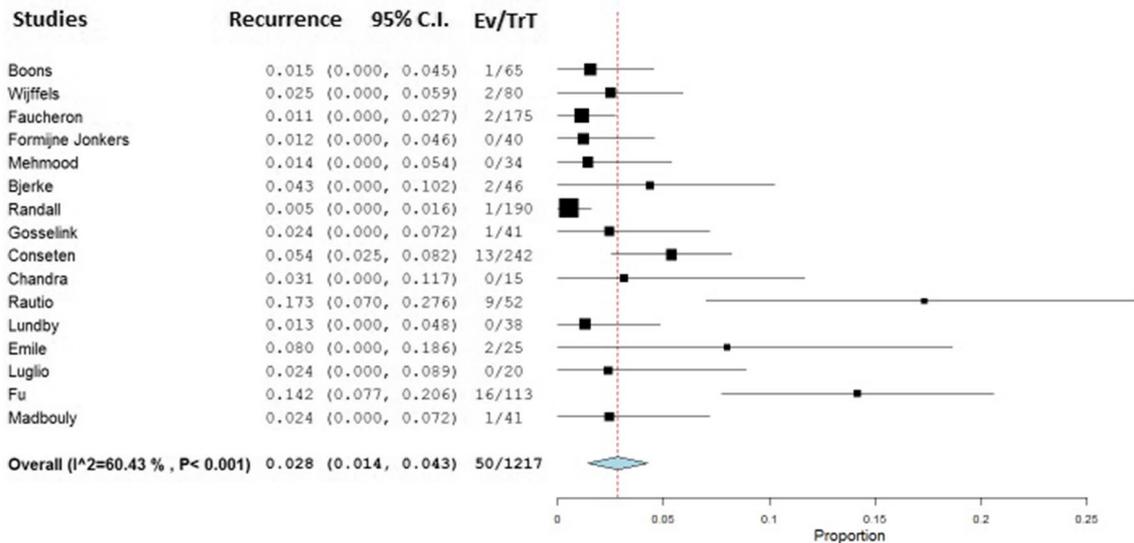


Fig. 3 Forest plot for complications of laparoscopic ventral mesh rectopexy

Factors that were not predictive of recurrence of full-thickness rectal prolapse were:

- Age (SE = -0.001, 95% CI -0.002–0.0001, $p=0.185$).
- BMI (SE = -0.005, 95% CI -0.02–0.011, $p=0.55$).
- Previous surgery for rectal prolapse (SE = -0.0001, 95% CI -0.002–0.001, $p=0.944$).
- Type of mesh (SE = 0.012, 95% CI -0.007–0.031, $p=0.214$).
- Operation time (SE = -0.001, 95% = -0.002–0.001, $p=0.08$).
- Number of surgeons (SE = -0.02, 95% CI -0.09–0.03, $p=0.404$).
- Conversion to open surgery (SE = -0.008, 95% CI -0.01–0.001, $p=0.072$).

Sub-group meta-analysis of the recurrence rates according to study variables

A sub-group meta-analysis of the recurrence rate of rectal prolapse according to the gender, age, and BMI of patients and according to the type and length of the mesh used was performed.

In six studies [17, 19, 20, 22, 25, 26], male patients represented more than 10% of the number of patients included and had a weighted mean recurrence rate of 4.2% (95% CI 0.3–8, $I^2=62.4\%$). On the other hand, male patients represented less than 10% of patients included in the remaining 11 studies which had a weighted mean recurrence rate of 2.9% (95% CI 1.1–4.6, $I^2=57.7\%$).

Four studies [19, 20, 22, 26] had a mean age of 50 years or less and had a weighted mean recurrence rate of 7.5% (95% CI 1.4–13.6, $I^2=43.1\%$) and 13 studies had a mean age above 50 years and had a weighted mean recurrence rate of 2.5% (95% CI 1.1–3.9, $I^2=59.7\%$).

Three studies [16, 21, 24] had a mean BMI of 25 or less kg/m^2 and a weighted mean recurrence rate of 0.7% (95% CI 0.3–1.7, $I^2=0$), whereas three studies [15, 20, 25] had a mean BMI of more than 25 kg/m^2 and a weighted mean recurrence rate of 5.3% (95% CI 1.3–11.9, $I^2=75.3\%$).

Six studies [11–13, 15, 17, 18] used a 20-cm-long mesh and had a weighted mean recurrence rate of 0.9% (95% CI 0.2–1.7, $I^2=0$) and seven studies [6, 14, 19, 22–24, 26] used a 15–17-cm-long mesh and had a weighted mean recurrence rate of 5.1% (95% CI 1.8–8.3, $I^2=56\%$).

Twelve studies used synthetic meshes only and had a weighted mean recurrence rate of 1.8% (95% CI 0.8–2.8, $I^2=21.5\%$) and three studies [15, 20, 24] used either biologic or synthetic meshes and had a weighted mean recurrence rate of 10.3% (95% CI 0.3–20.9, $I^2=87.5\%$).

Twelve studies used tackers only to fixate the mesh to the sacral promontory and had a weighted mean recurrence rate of 1.7% (95% CI 0.6–2.9, $I^2=28.2\%$) and three studies [6, 14, 24] used either tackers, Titanium screw or sutures to fixate the mesh to the promontory and had a weighted mean recurrence rate of 6.2% (0.6–11.9, $I^2=84.2\%$) (Table 4).

Improvement in bowel functions

Significant improvement in FI after LVMR was reported in 369 (79.6%) of 463 patients with preoperative FI. Significant

Table 4 Sub-group meta-analysis of the recurrence rates according to study variables

Variable		Number of studies	Weighted mean recurrence rate (%)	95% CI	I^2 (%)
Male gender	> 10% of total	6	4.2	0.3–8	62.4
	< 10% of total	11	2.9	1.1–4.6	57.7
Age	≤ 50 years	4	7.5	1.4–13.6	43.1
	> 50 years	13	2.5	1.1–3.9	59.7
BMI	≤ 25 kg/m ²	3	0.7	0.3–1.7	0
	> 25 kg/m ²	3	5.3	1.3–11.9	75.3
Length of mesh	20 cm	6	0.9	0.2–1.7	0
	15–17 cm	7	5.1	1.8–8.3	56
Type of mesh	Synthetic only	12	1.8	0.8–2.8	21.5
	Synthetic or biologic	3	10.3	0.3–20.9	87.5
Fixation to promontory	Tackers only	12	1.7	0.6–2.9	28.2
	Tackers, screw, or sutures	3	6.2	0.6–11.9	84.2

CI confidence interval, BMI body mass index

improvement in constipation after LVMR was reported in 156 (65.8%) of 237 patients with preoperative constipation (Table 3).

The weighted mean rates of improvement in FI and constipation after LVMR were 79.3% (95% CI 69.4–89.1, $I^2=87.8%$) and 71% (95% CI 55.2–86.9, $I^2=91.2%$), respectively (Figs. 4, 5).

Publication bias assessment

The funnel plot (Fig. 6) demonstrates no significant publication bias in the studies reviewed. According to the Begg and Mazumdar Rank Correlation Test, the Kendall's tau b (corrected for ties, if any) was -0.05 , with a one-tailed p value of 0.38 and two-tailed p value of 0.77 indicating no significant publication bias.

Discussion

LVMR is currently considered one of the cornerstone treatments of internal and external rectal prolapse. The safety and excellent outcomes of the procedure contributed to increasing its popularity and use among colorectal surgeons across the world. However, there remain some concerns about the mesh-related complications, suitability of the technique in certain patient groups as male patients, and long-term recurrence of rectal prolapse [20, 27].

The present review focused on the outcome of LVMR for full-thickness external rectal prolapse. We elected to analyze the predictors of recurrence of the homogeneous group of patients with external rectal prolapse after LVMR. We deliberately excluded patients with internal

Random-Effect Model

Studies	Incontinence	95% C.I.	Ev/TrT
Boons	0.851	(0.749, 0.953)	40/47
Formijne Jonkers	0.727	(0.541, 0.913)	16/22
Randall	0.926	(0.889, 0.963)	176/190
Gosselink	0.488	(0.335, 0.641)	20/41
Conseten	0.633	(0.537, 0.728)	62/98
Chandra	0.917	(0.696, 1.000)	5/5
Emile	0.750	(0.538, 0.962)	12/16
Luglio	0.976	(0.911, 1.000)	20/20
Madbouly	0.667	(0.449, 0.884)	12/18
Chandra 2	0.929	(0.738, 1.000)	6/6
Overall ($I^2=87.8%$, $P<0.001$)	0.793	(0.694, 0.891)	369/463

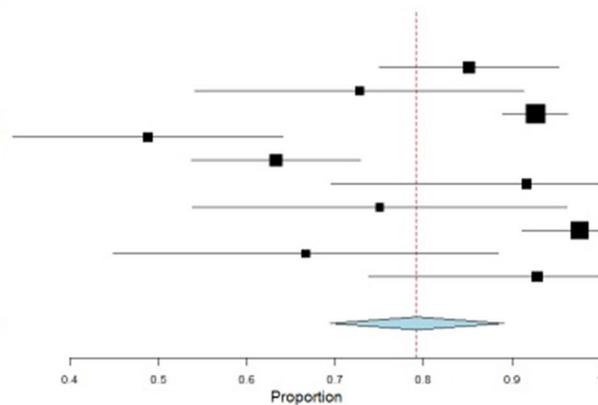


Fig. 4 Forest plot for improvement in fecal incontinence after ventral mesh rectopexy

Random-Effect Model

Studies	Constipation	95% C.I.	Ev/TrT
Boons	0.718	(0.577, 0.859)	28/39
Formijne Jonkers	0.591	(0.385, 0.796)	13/22
Bjerke	0.333	(0.145, 0.522)	8/24
Conseten	0.610	(0.504, 0.715)	50/82
Emile	0.955	(0.831, 1.000)	10/10
Luglio	0.976	(0.911, 1.000)	20/20
Madbouly	0.593	(0.407, 0.778)	16/27
Chandra 2	0.846	(0.650, 1.000)	11/13
Overall ($I^2=91.25\%$, $P<0.001$)	0.710	(0.552, 0.869)	156/237

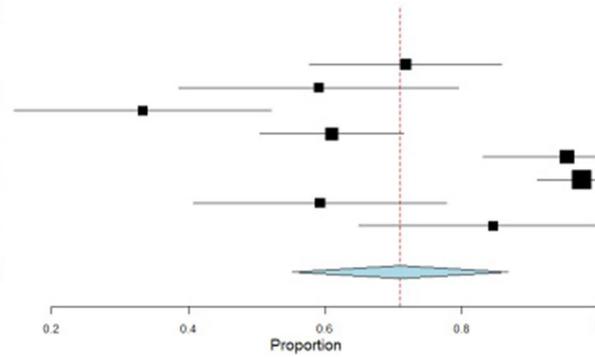
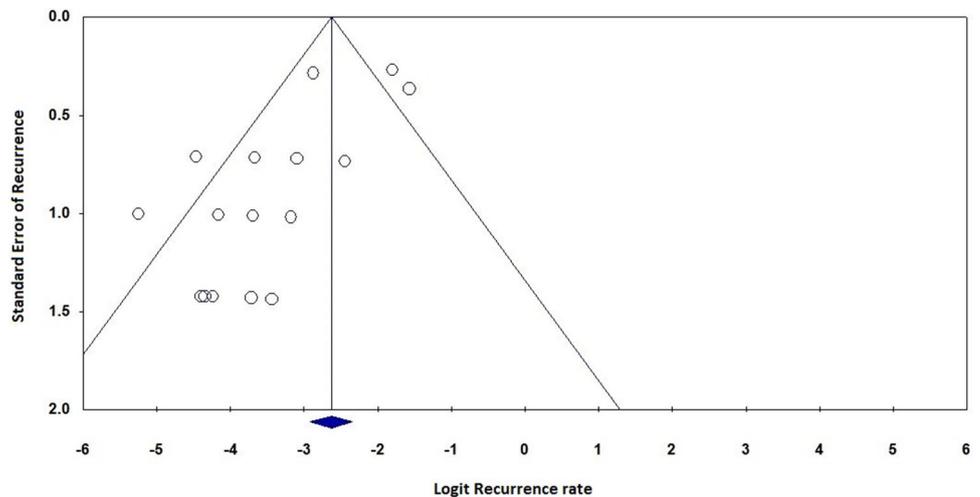


Fig. 5 Forest plot for improvement in constipation after ventral mesh rectopexy

Fig. 6 Funnel plot demonstrating the publications bias among the studies reviewed



prolapse due to the low incidence of progression to external prolapse. Furthermore, investigators have described different rectal wall biomechanics between internal and external rectal prolapse, suggesting that these conditions are two separate entities [28, 29].

The review included 17 studies comprising more than 1200 patients which is more than twice the number of patients included in a similar previous review [4] on anterior rectopexy for full-thickness rectal prolapse. The weighed mean recurrence rate reported by the present review is lower than the previous systematic review by Faucheron et al. [4] (2.8% vs 4.7%) which may reflect improved outcome of the procedure as more experience has been gained.

We aimed to determine the main predictors for recurrence of full-thickness rectal prolapse after LVMR in an attempt to reduce the recurrence rates of the procedure by understanding and avoiding the causes of recurrence and standardizing the technique. Hence, we explored the studies in terms of various patient and technical factors that may impact the recurrence rate of rectal prolapse postoperatively.

On performing meta-regression analysis, male gender and the length of the mesh were found to be significantly associated with higher recurrence rate. It is known that rectal prolapse has a specific female predominance with women accounting for around 90% of the diagnosed cases [30]. Although male patients represented 10% or less of the number of patients included in each study, in the studies based in Egypt and India [19, 22, 25, 26] male patients accounted for a greater percent (12–60%), and in one study [20] from Finland all patients studied were male.

A sub-group meta-analysis of the recurrence rate according to the percent of male patients in each study showed that the studies that involved more male patients had higher recurrence rates than those that involved fewer male patients (4.2% vs 2.9%). Furthermore, the highest rate of recurrence (17%) was reported by the study that included all male patients [20]. However, in complete discordance with these results, another study [31] on 69 men with internal or external rectal prolapse reported excellent results of LVMR with no recurrent external rectal

prolapse and significant improvement in symptoms in 82% of patients.

LVMR can be more technically difficult in male patients owing to different anatomic factors compared to female patients. The narrow android pelvis and tedious dissection in the rectovesical pouch may cause inadvertent injury to the prostate or seminal vesicles. In addition, injury of the autonomic nerves is another caveat that may lead to sexual dysfunction presenting as retrograde ejaculation or impotence [32]. These factors may explain possibly the higher recurrence rates of LVMR in the studies that included more male patients, nonetheless, LVMR can be a safe and effective treatment of rectal prolapse in males when performed by surgeons who passed the learning curve as Owais et al. implied [31, 33].

The studies that included patients of median age of less than 50 years had a weighted mean recurrence rate of 7.5%, higher than the studies with a median age of more than 50. This finding is in contrast to what has been published before that younger patients tend to have better outcome than the elderly owing to the good state of their pelvic floor musculature [34]. However, since the studies that included younger patients also involved more male patients, the higher recurrence rate may be attributed to the gender, rather than the age of the patients as aforementioned. This unique pattern of patients being young or middle-aged males warrants further detailed investigation to determine the cause of external rectal prolapse in this age group and whether LVMR is a suitable therapeutic option for them. Perhaps an insight toward collagen disease could be the potential cause of rectal prolapse in the young patients as Shalaby et al. [35] implied.

The studies including patients of a mean BMI greater than 25 kg/m² had higher recurrence rate than studies with lower BMI. This observation is consistent with previous studies in which obesity was related to pelvic floor disorder and pelvic organ prolapse in females [36]. It has been also reported that BMI reduction of 10 kg/m² could reduce the prevalence of pelvic floor dysfunction to 48%, and improve the rates of pelvic organ prolapse by 74% [37]. In concordance with our finding, the consensus statement on ventral rectopexy for rectal prolapse [38] recognized obesity as a risk factor for higher recurrence rate after ventral mesh rectopexy owing to difficult pelvic dissection.

The length of mesh used in LVMR appears to be an important factor for the development of recurrence as the studies that used a 20-cm-long mesh had a mean recurrence of less than 1% compared to 5% in the studies that used shorter meshes. While no previous explanation of this observation was given, we assume that a 20-cm-long mesh provides more convenient fixation of the rectum to the sacral promontory without much tension, whereas shorter meshes may be placed under tension during bowel movements

which carries higher risk of detachment of the mesh from the promontory.

The type of mesh may as well have an impact on the risk of recurrence after LVMR. The studies that used only synthetic mesh had lower mean recurrence rate than those that used either synthetic or biologic mesh or only biologic mesh. This finding is in disagreement with Fu et al. [24] who found biologic meshes confer lower recurrence rate than synthetic mesh; however, the authors attributed the better outcome of biologic mesh to concurrent modifications in their surgical technique across the study period that had improved the technical results of LVMR over time, rather than because of the type of mesh per se. On the other hand, biologic meshes may offer a safer option for LVMR with lower incidence of mesh-related erosion compared to synthetic mesh [39].

Finally, the method of fixation of the mesh to the promontory plays a pivotal role in the success of LVMR. The studies that exclusively used tacks for fixation of the mesh to the promontory in all patients had lower mean recurrence rate than the studies that used different methods of mesh fixation (tacks in some patients, screw in some patients, and sutures in other patients) within the same study. A study compared the three methods of fixation in an ex vivo experimental model and concluded that the screw and tacks offer similar fixation strengths, whereas Ethibond sutures provided significantly weaker fixation [40].

In addition to the predictors for recurrence reported by the present review, Fu and colleagues [24] conducted detailed univariate and multivariate analyses of the risk factors for recurrence after LVMR for external rectal prolapse and documented that prolonged pudendal nerve terminal motor latency, the use of synthetic mesh, age > 70 years, and poorer preoperative continence were significantly associated with recurrence of rectal prolapse.

The present review has some limitations including the average quality of the studies included and the medium duration of follow-up across the studies as higher rates of long-term recurrence of rectal prolapse have been reported as compared to the rates reported in this meta-analysis. Furthermore, in most of the studies, some technical details such as the number of tacks and sutures used for mesh fixation, management of the Douglas pouch, and presence of concomitant genital prolapse were not reported. The method of mesh fixation is a crucial factor for the success of the technique. Similarly, coexisting genital prolapse may affect the outcome of LVMR because uncorrected anterior and middle compartment prolapse may factor in the development of recurrence of rectal prolapse after LVMR. Finally, one of the most important factors that determine the outcome of any surgical procedure is the level of experience, training, and case volume of the operating surgeon which was not clearly described in the majority of the studies reviewed, thus was not possible to analyze its impact on the recurrence

of rectal prolapse. The learning curve for LVMR includes 25–30 cases according to Pucher et al. [41] and approximately 50 cases according to the position statement by the pelvic floor society in 2017 [42].

Conclusion

LVMR is an effective and safe option for the treatment of full-thickness external rectal prolapse. Our review suggests that it has low recurrence and complication rates. Patient factors including male gender and higher BMI along with technical factors such as the length and type of mesh and method of its fixation to the sacral promontory may affect the outcome of the procedure, hence further trials are required to elucidate the actual impact of these factors on recurrence after LVMR.

Author contributions SHE designed the study. SHE, HE, MS, and AS participated in data collection and analysis, writing, and drafting of the manuscript. PS participated in data interpretation, drafting, and critical revision of the manuscript. SDW reviewed the collected results on regular basis and participated in drafting and critical revision of the manuscript.

Compliance with ethical standards

Disclosures Sameh Emile, Hossam Elfeki, Mostafa Shalaby, Ahmad Sakr, Pierpaolo Sileri, and Steven D Wexner do not have any relevant financial conflicts of interests to declare.

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