

## Current status of laparoscopic and robotic ventral mesh rectopexy for external and internal rectal prolapse

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### Abstract

External and internal rectal prolapse with their affiliated rectocele and enterocele, are associated with debilitating symptoms such as obstructed defecation, pelvic pain and faecal incontinence. Since perineal procedures are associated with a higher recurrence rate, an abdominal approach is commonly preferred. Despite the description of greater than three hundred different procedures, thus far no clear superiority of one surgical technique has been demonstrated. Ventral mesh rectopexy (VMR) is a relatively new and promising technique to correct rectal prolapse. In contrast to the abdominal procedures of past decades, VMR avoids posterolateral rectal mobilisation and thereby minimizes the risk of postoperative constipation. Because of a perceived acceptable recurrence rate, good functional results and low mesh-related morbidity in the short to medium term, VMR has been popularized in the past decade. Laparoscopic or robotic-assisted VMR is now being progressively performed internationally and several articles and guidelines propose the procedure as the treatment of choice for rectal prolapse. In this article, an outline of the current status of laparoscopic and robotic ventral mesh rectopexy for the treatment of internal and external rectal prolapse is presented.

**Key words:** Laparoscopic ventral mesh rectopexy; Robot; Rectal prolapse; External rectal prolapse; Internal rectal prolapse; Rectocele; Mesh erosion; Obstructed defecation; Faecal incontinence; Biological mesh

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**Core tip:** Globally, there is no uniformity for the treatment of internal and external rectal prolapse. Laparoscopic or robotic-assisted ventral mesh rectopexy is being progressively performed internationally for correcting rectal prolapse. This abdominal approach

avoids posterolateral rectal mobilization and the risks of an anastomosis, corrects the middle compartment, improves anorectal function and shows acceptable recurrence rates. In this article, a synopsis of the current status of laparoscopic and robotic ventral mesh rectopexy for the treatment of internal and external rectal prolapse is presented.

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## INTRODUCTION

Prolapse of the posterior compartment of the pelvic floor, including rectal prolapse (RP) and its affiliated rectocele and enterocele, is associated with socially debilitating symptoms such as obstructed defecation, pelvic pain and faecal incontinence<sup>[1-3]</sup>. In the past decades, multiple surgical techniques have been described for RP. There is consensus that perineal procedures are associated with a higher recurrence rate and therefore, an abdominal approach, when possible, is preferred<sup>[4,5]</sup>. The majority of the abdominal procedures, however, include posterolateral mobilization of the rectum resulting in new-onset or worsening postoperative constipation<sup>[6]</sup>.

In the search to reduce postoperative constipation, ventral mesh rectopexy (VMR) was developed<sup>[6]</sup>. In this procedure, the rectum is mobilized ventrally and attached to the sacral promontory with a mesh. By avoiding posterolateral rectal mobilization, autonomic nerves are spared and the risk of postoperative constipation is minimised. By lifting the middle compartment of the pelvic floor, correction of other frequently accompanying pelvic prolapses and celes is achieved.

Laparoscopic or robotic-assisted VMR is being progressively performed internationally and several articles and guidelines propose the procedure as the treatment of choice for RP<sup>[7-10]</sup>. This topic highlight summarises and assesses current evidence on laparoscopic and robotic ventral mesh rectopexy (LVMR/RVMR) for the treatment of internal and external rectal prolapse (IRP/ERP).

## SELECTION OF USED LITERATURE

Studies presenting a homogeneous group of patients with rectal prolapse syndromes treated with VMR (laparoscopic or robotic) as described by D'Hoore *et al.*<sup>[6]</sup>, avoiding posterolateral mobilization and using a synthetic mesh were selected. Laparoscopic and robotic outcomes had to be displayed separately. Studies describing a heterogeneous group were

excluded. Articles using a biological mesh are described separately.

## COMPLICATIONS

### Laparoscopic

Since the introduction of laparoscopic surgery, complications following rectopexy have reduced significantly<sup>[11]</sup>. Over the years, many studies have been published investigating surgical complications after LVMR. Most were small case series, but recently a large cohort of 919 patients with a median follow-up of 33.9 mo was published<sup>[12]</sup>. For this topic highlight, we have included 24 studies showing postoperative complication rates from 0% to 23.5% (Table 1). This extensive variation can be explained by the different ways in scoring morbidity between studies, especially for minor complications. Therefore, we have divided complications in minor and major groups according to the Clavien-Dindo (CD) classification<sup>[13]</sup>. Major complications, requiring surgical intervention (CD  $\geq 3$ ), are more relevant and in most cases directly ascribed to the VMR. Such complications were demonstrated from 0% to 7.7% of patients, which is acceptable and comparable to other minimal-invasive abdominal pelvic floor procedures<sup>[14]</sup>. Perioperative mortality is very low and occurred from 0% to 1.1%. Conversion is rare and was described from 0% to 5.9% with one study reporting a rate of ten percent. The majority of the conversions were due to extensive intra-abdominal adhesions.

### Robotic

Three studies using synthetic mesh discussed the complication rate following RVMR (Table 1). Robotic surgery showed a non-significant minimal advantage in terms of intra- and postoperative complications compared to LVMR, described in a meta-analysis of these three studies<sup>[15]</sup>. However, studies were small and follow-up was short. Very recently, a randomised controlled trial (RCT) comparing the two techniques demonstrated a non-significant equality in complication rates<sup>[16]</sup>.

## SYNTHETIC MESH-RELATED COMPLICATIONS

### Laparoscopic

The use of mesh in pelvic floor surgery has been subject for debate in recent years. Considerable commotion arose in response to the US Food and Drug Administration (FDA) report in 2011 where a high number of mesh-related adverse events associated with transvaginal pelvic organ prolapse repair were described<sup>[17]</sup>. The systematic review of Abed *et al.*<sup>[18]</sup>, showing a mesh erosion rate of 10.3% (110 studies, range 0%-29.7%) within 12 mo after transvaginal pelvic organ prolapse repair, confirmed these concerns.

**Table 1** Conversion, intra- and postoperative complications following laparoscopic and robotic ventral mesh rectopexy with synthetic mesh *n* (%)

	<i>n</i>	Median FU (mo)	Intra- operative complications	Conversion	Postoperative complications			
					Total	Minor (CD 1-2)	Major (CD 3-4)	Mortality (CD 5)
Laparoscopic studies								
D'Hoore <i>et al</i> <sup>[6]</sup> , 2004	42	61	0	2 (4.8)	2 (4.8)	2 (4.8)	0	0
D'Hoore <i>et al</i> <sup>[84]</sup> , 2006	109	-	0	4 (3.7)	8 (7.3)	8 (7.3)	0	0
Slawik <i>et al</i> <sup>[62]</sup> , 2008	80	54	-	1 (1.3)	7 (8.8)	7 (8.8)	0	0
van den Esschert <i>et al</i> <sup>[54]</sup> , 2008	17	38 <sup>1</sup>	0	1 (5.9)	4 (23.5)	3 (17.6)	1 (5.9)	0
Boons <i>et al</i> <sup>[44]</sup> , 2010	65	19	-	1 (1.5)	11 (16.9)	6 (9.2)	5 (7.7)	0
Collinson <i>et al</i> <sup>[51]</sup> , 2010	75	12	0	1 (1.3)	4 (5.3)	3 (4)	0	0
Wijffels <i>et al</i> <sup>[85]</sup> , 2011	80	23	-	1 (1.3)	10 (12.5)	9 (11.3)	1 (1.3)	0
Wong <i>et al</i> <sup>[36]</sup> , 2011	40	6	0	4 (10.0)	5 (12.5)	5 (12.5)	0	0
Wong <i>et al</i> <sup>[52]</sup> , 2011	84	29	4 (4.8)	3 (3.6)	3 (3.6)	2 (2.4)	1 (1.2)	0
Lauretta <i>et al</i> <sup>[24]</sup> , 2012	30	13.9 <sup>1</sup>	-	0	2 (7.7)	0	2 (7.7)	0
Faucheron <i>et al</i> <sup>[86]</sup> , 2012	175	74/60 <sup>2</sup>	0	3 (1.7)	8 (4.6)	5 (2.9)	3 (1.7)	0
Formijne Jonkers <i>et al</i> <sup>[23]</sup> , 2013	233	30	0	6 (2.6)	11 (4.7)	7 (3.0)	4 (1.7)	0
Badrek-Amoudi <i>et al</i> <sup>[25]</sup> , 2013	48	33	-	0	9 (18.8)	8 (16.7)	1 (2.1)	0
Maggiori <i>et al</i> <sup>[26]</sup> , 2013	33	42 <sup>1</sup>	0	1 (3.0)	0	0	0	0
Mantoo <i>et al</i> <sup>[38]</sup> , 2013	74	16	0	3 (4.1)	15 (20.0)	15 (20.0)	0	0
Mäkelä-Kaikkonen <i>et al</i> <sup>[37]</sup> , 2014 <sup>3</sup>	20	3	0	0	1 (5.0)	0	1 (5.0)	0
Mackenzie <i>et al</i> <sup>[32]</sup> , 2014	953	21	-	8 (1.3)	63 (6.6)	53 (5.6)	8 (0.8)	2 (0.2)
Ogilvie <i>et al</i> <sup>[30]</sup> , 2014	29	15.4	1 (3.4)	0	3 (10.3)	2 (6.9)	1 (3.4)	0
Randall <i>et al</i> <sup>[31]</sup> , 2014	190	29	1 (0.5)	5 (2.6)	22 (11.6)	11 (5.7)	8 (4.2)	2 (1.1)
Owais <i>et al</i> <sup>[53]</sup> , 2014	68	42	0	0	11 (16.2)	10 (14.7)	1 (1.5)	0
Gosselink <i>et al</i> <sup>[29]</sup> , 2015	91	12	0	0	5 (5)	4 (4.4)	0	0
Tsunoda <i>et al</i> <sup>[33]</sup> , 2015	26	16	0	0	2 (7.7)	2 (7.7)	0	0
Consten/van Iersel <i>et al</i> <sup>[12]</sup> , 2015	919	33.9/120 <sup>2</sup>	3 (0.3)	20 (2.2)	203 (23.4)	153 (19.3)	50 (4.1)	1 (0.1)
Tsunoda <i>et al</i> <sup>[34]</sup> , 2016	31	25	0	0	2 (6.5)	2 (6.5)	0	0
Robotic studies								
Wong <i>et al</i> <sup>[36]</sup> , 2011	23	6	0	1 (4.3)	1 (4.3)	0	0	0
Mantoo <i>et al</i> <sup>[38]</sup> , 2013	74	16 <sup>4</sup>	0	1 (2.3)	5 (11.0)	5 (11.0)	0	0
Mäkelä-Kaikkonen <i>et al</i> <sup>[37]</sup> , 2014 <sup>3</sup>	20	3	1 (5.0)	0	1 (5.0)	1 (5.0)	0	0

<sup>1</sup>Mean instead of median; <sup>2</sup>Percentages are Kaplan-Meier estimates at 60 and 120 mo of follow-up; <sup>3</sup>The results of Wong, Mantoo and Mäkelä-Kaikkonen *et al* are displayed per technique; <sup>4</sup>Not specified whether mean of median was used. FU: Follow-up; -: Not specified or not applicable.

The contemporary literature present a low incidence of mesh-related morbidity following VMR, but studies discussing this issue are limited. A pooled analysis of 11 observational studies (*n* = 767) demonstrated a 0.7% rate for mesh-related complications after LVMR in 2012<sup>[19]</sup>. Recently a multicentre study, including 2203 patients from databases of five hospitals over a 14-year period, described 45 patients (2%) developing mesh erosion (42 synthetic, 3 biologic) after a median of 23 mo<sup>[20]</sup>. However, underestimation is probable because of the retrospective character and a lack of systematic follow-up of this study. In general, mesh complication rates from 0% to 6.7% with mesh erosion percentages between 0 and 3.7% are described<sup>[12,19-34]</sup>. Most articles report vaginal mesh erosions, but intrarectal mesh migration following LVMR is not uncommon. The study of Evans *et al*<sup>[20]</sup> showed approximately half of the mesh erosions were rectal (17/45, 0.8%) and a similar percentage was described in other articles<sup>[20,27,31,35]</sup>. Recognized risk factors for developing mesh erosion are smoking, steroids, poorly regulated diabetes mellitus, pelvic hematoma, pelvic infection and a history of pelvic irradiation or pelvic surgery<sup>[19,35]</sup>. The multicentre study also suggested that mesh erosions were more frequently associated with LVMR for IRP (*P* = 0.02) and

polyester mesh (*P* = 0.00006)<sup>[20]</sup>.

### Robotic

Only four studies mentioned examination for synthetic mesh-related complications following RVMR and all reported a rate of zero percent<sup>[36-39]</sup>. The follow-up, however, was short varying from 3 to 23 mo.

## FUNCTIONAL OUTCOME

### Laparoscopic - ERP

LVMR, with a limited anterior dissection, was introduced to avoid rectal denervation associated with damage to the parasympathetic fibres of the inferior hypogastric plexus. The RCT of Speakman *et al*<sup>[40]</sup> showed that preservation, rather than division, of the lateral ligaments is associated with less postoperative constipation. Meta-analyses confirmed this specific finding and demonstrate that VMR seems to be related to less constipation postoperatively as compared with other abdominal techniques (posterior mesh rectopexy, Ripstein, Orr-Loygue)<sup>[5,41]</sup>.

An ERP is a circumferential full-thickness protrusion of the rectum through the anal verge. A recent consensus report, by a panel of international experts,

**Table 2 Functional results following laparoscopic and robotic ventral mesh rectopexy with synthetic mesh**

Laparoscopic studies	n	Median FU (mo)	Improvement OD	P value	Improvement FI	P value	Median gain CCCS	P value	Median gain CCIS	P value
<b>Indication ERP</b>										
D'Hoore <i>et al</i> <sup>[6]</sup> , 2004	42	61	84.2%. <i>De novo</i> 4.8%	-	90.3%	-	-	-	13	< 0.001
Auguste <i>et al</i> <sup>[21]</sup> , 2006	54	12	70%. <i>De novo</i> 17.6%	-	72.4%	-	-	-	5.8 <sup>1</sup>	-
Verdaasdonk <i>et al</i> <sup>[42]</sup> , 2006 <sup>2</sup>	13	7	66%	-	69%	-	-	-	-	-
Cristaldi <i>et al</i> <sup>[43]</sup> , 2007	63	18	78%	-	90%. <i>De novo</i> 3.2%	-	5	< 0.0001	32 (FISI)	< 0.0001
Boons <i>et al</i> <sup>[44]</sup> , 2010	58 <sup>3</sup>	19	72%	-	83%. <i>De novo</i> 1.5%	-	5	< 0.0001	36 (FISI)	< 0.0001
Formijne Jonkers <i>et al</i> <sup>[23]</sup> , 2013 <sup>4</sup>	36	30	57.9%	0.01	76.2%	< 0.001	-	-	-	-
Randall <i>et al</i> <sup>[31]</sup> , 2014	190	29	-	-	93%	-	-	-	8	< 0.0001
Gosselink <i>et al</i> <sup>[29]</sup> , 2015 <sup>4</sup>	41	12	-	-	50%	< 0.01	4.8	< 0.01	12 (FISI)	< 0.01
Tsunoda <i>et al</i> <sup>[33]</sup> , 2015 <sup>4,5</sup>	19	12	52%	-	62%	-	7	< 0.0001	23 (FISI)	< 0.0001
Consten/van Iersel <i>et al</i> <sup>[12]</sup> , 2015 <sup>4</sup>	242	33.9	63.3%	< 0.0001	73.2%	< 0.0001	-	-	-	-
Tsunoda <i>et al</i> <sup>[34]</sup> , 2016	31	12	-	-	-	-	5	0.005	22 (FISI)	< 0.0001
<b>Indication IRP and/or rectocele</b>										
Collinson <i>et al</i> <sup>[50]</sup> , 2007	30	3	83%	-	92%	-	9	< 0.0001	25 (FISI)	< 0.0001
Collinson <i>et al</i> <sup>[51]</sup> , 2010	75	12	86%	-	85%	-	7	< 0.0001	20 (FISI)	< 0.0001
Wong <i>et al</i> <sup>[52]</sup> , 2011	84	29	45%	< 0.001	20%	> 0.05	-	-	-	-
Formijne Jonkers <i>et al</i> <sup>[23]</sup> , 2013 <sup>4</sup>	197	30	76.9%	< 0.001	65.4%	< 0.001	-	-	-	-
Gosselink <i>et al</i> <sup>[28]</sup> , 2013	72	12	-	-	-	-	5	< 0.001	16 (FISI)	< 0.01
Gosselink <i>et al</i> <sup>[29]</sup> , 2015 <sup>4</sup>	50	12	-	-	48%	< 0.01	3.1	< 0.01	17 (FISI)	< 0.01
Tsunoda <i>et al</i> <sup>[33]</sup> , 2015 <sup>4,5</sup>	25	12	55%	-	63%	-	6	< 0.0001	22 (FISI)	< 0.0001
Tsunoda <i>et al</i> <sup>[87]</sup> , 2015	26	16	-	-	-	-	7	< 0.01	24 (FISI)	< 0.01
Consten/van Iersel <i>et al</i> <sup>[12]</sup> , 2015 <sup>4</sup>	242	33.9	61%	< 0.0001	73.2%	< 0.0001	-	-	-	-
<b>Indication both ERP and IRP and/or rectocele</b>										
van den Esschert <i>et al</i> <sup>[54]</sup> , 2008	1 ERP, 16 IRP	38 <sup>1</sup>	-	-	-	-	+2.7 <sup>6</sup> (ODS)	0.091	-	-
Lauretta <i>et al</i> <sup>[24]</sup> , 2012	2 ERP, 28 IRP	13.9 <sup>1</sup>	92.8%	-	85.7%	-	9.1 (ODS) <sup>[188]</sup>	< 0.05	7.1 <sup>1</sup>	< 0.05
Badrek-Amoudi <i>et al</i> <sup>[25]</sup> , 2013	11 ERP, 37 IRP	33	68%	< 0.0001	-	-	17 (ODS) <sup>[789]</sup>	< 0.0001	4	< 0.0001
Maggiori <i>et al</i> <sup>[26]</sup> , 2013	33 <sup>8</sup>	42 <sup>1</sup>	72%. <i>De novo</i> 7%	-	90%	-	-	-	8	0.002
Mackenzie <i>et al</i> <sup>[32]</sup> , 2014	149 ERP, 487 IRP	21	56.7%. <sup>9</sup> <i>De novo</i> 1.4%	0.119	89.7%. <sup>10</sup> <i>De novo</i> 1%	0.040	12 (ODS) <sup>[188]</sup>	-	8	-
Owais <i>et al</i> <sup>[53]</sup> , 2014 <sup>11</sup>	18 ERP, 50 IRP	42	82%	-	82%	-	12.5 (ODS) <sup>[90]</sup>	< 0.001	4	< 0.001
<b>Robotic vs Laparoscopic studies - various indications</b>										
De Hoog <i>et al</i> <sup>[39]</sup> , 2009 <sup>1</sup>	20 ERP R	23.4	-	-	-	-	3.2 <sup>1</sup>	-	-	-
Mantoo <i>et al</i> <sup>[38]</sup> , 2013 <sup>12</sup>	23 ERP, 51 IRP L	16 <sup>13</sup>	-	-	-	-	6 (ODS) <sup>14</sup>	0.004	4 <sup>14</sup>	0.604
	12 ERP, 32 IRP R						14 (ODS) <sup>14[91]</sup>	0.004	4 <sup>14</sup>	0.604

<sup>1</sup>Mean instead of median; <sup>2</sup>One patient was excluded from further analysis, therefore  $n = 13$  instead of  $n = 14$  was used; <sup>3</sup>Functional data were complete in 58 of 65 patients; <sup>4</sup>The results of Formijne Jonkers *et al*, Gosselink *et al*, Tsunoda and Consten and van Iersel *et al* are displayed per indication; <sup>5</sup>Postoperative functional data were fulfilled in 44 of 59 patients; <sup>6</sup>Mean ODS score was 2.7 higher after surgery meaning function deteriorated postoperatively; <sup>7</sup>Pre- and postoperative ODS scores were available for 36 patients; <sup>8</sup>Of the 33 patients (ERP  $n = 20$ ,  $n = 13$  IRR) 3 lost to follow-up. For the remainder of patients the surgical indication was not given; <sup>9</sup>Based on 602 patients; <sup>10</sup>Based on 276 patients; <sup>11</sup>Only men included; <sup>12</sup>A modified version of the D'Hoore rectopexy used; <sup>13</sup>Not specified whether mean of median was used; <sup>14</sup>Estimation based on bar chart. OD: Obstructed defecation; FI: Faecal incontinence; ODS: Obstructed defecation syndrome score; L: Laparoscopic; R: Robot; RP: Internal rectal prolapse; ERP: External rectal prolapse; CCCS: Cleveland clinic constipation score; CCIS: Cleveland clinic incontinence score.

considers ERP a definitive indication for VMR<sup>[9]</sup>. LVMR showed improvement of obstructed defecation from 52% to 84.2% ( $P < 0.01$ - $P < 0.0001$ )<sup>[6,12,21,23,33,42-44]</sup> with a median gain of the Cleveland Clinic Constipation Score (CCCS)<sup>[45]</sup> between 4.8 and 7 points ( $P < 0.01$ - $P <$

0.0001, Table 2)<sup>[29,33,34,43,44]</sup>. Obstructed defecation *de novo* was noted in 4.8% to 17.6% of patients<sup>[6,21]</sup>. Improvement of faecal incontinence was described in 50% to 93% of patients ( $P < 0.01$ - $P < 0.0001$ )<sup>[6,12,21,23,29,31,33,42-44]</sup>. There was a median gain of the Cleveland Clinic Incontinence



Score (CCIS)<sup>[46]</sup> of 8 to 13 ( $P < 0.001 - P < 0.0001$ )<sup>[6,31]</sup> and one study reports a mean CCIS gain of 5.8 points<sup>[21]</sup>. The median Faecal Incontinence Severity Index (FISI)<sup>[47]</sup> benefit varied from 12 to 36 points ( $P < 0.01 - P < 0.0001$ )<sup>[29,33,34,43,44]</sup>. Two studies demonstrated new-onset faecal incontinence with an incidence of 1.5% and 3.2% in patients<sup>[43,44]</sup>.

#### **Laparoscopic - ERP and/or IRP and/or rectocele**

An IRP is a telescopic infolding of the rectal wall during defecation. IRP is most commonly classified by the Oxford rectal prolapse grade differentiating between an intrarectal (grade 1 and 2) and intra-anal (grade 3 and 4) intussusception<sup>[48]</sup>. An Oxford grade 3 or 4 IRP, in combination with significant functional complaints failing to conservative therapy, is considered an indication for VMR<sup>[9,10]</sup>. The expert panel stated that VMR could also be performed for a complex rectocele of more than 3-4 cm<sup>[9]</sup>. However, a rectocele frequently exists with an IRP (80%) and, therefore, an isolated rectocele is rare (10%)<sup>[49]</sup>. LVMR for IRP and/or rectocele showed improvement of obstructed defecation from 55% to 86% ( $P < 0.001 - P < 0.0001$ )<sup>[12,23,33,50-52]</sup> with a median CCCS decrease between 3.1 and 9 points ( $P < 0.01 - P < 0.0001$ , Table 2)<sup>[28,29,33,34,50,51]</sup>. Improvement of faecal incontinence with 20% to 92% of patients ( $P > 0.05 - P < 0.0001$ )<sup>[12,23,29,33,50-52]</sup> and a median gain of FISI of 16 to 25 points ( $P < 0.01 - P < 0.0001$ ) was observed in multiple cohorts<sup>[28,29,33,34,50,51]</sup>. None of the studies performing LVMR for IRP and/or rectocele described new-onset functional complaints.

Studies including both ERP and IRP and/or rectocele as indication for surgery showed 56.7% to 92.8% ( $P = 0.119 - P < 0.0001$ )<sup>[24-26,32,53]</sup> improvement for obstructed defecation complaints with a median advantage of 9.1 to 17 points in obstructed defecation syndrome (ODS) score ( $P < 0.05 - P < 0.0001$ , Table 2)<sup>[24-26,32,53]</sup>. One report described a non-significant deterioration in ODS score postoperatively<sup>[54]</sup>. A decrease in faecal incontinence complaints is reported from 82% to 90% of patients<sup>[24,26,32,53]</sup> with a median CCIS gain of 4 to 8 points ( $P < 0.05 - P < 0.0001$ )<sup>[24-26,32,53]</sup>. Literature demonstrated new-onset complaints of obstructed defecation between 1.4% and 7% of patients, with one report showing a *de novo* faecal incontinence rate of one percent<sup>[26,32]</sup>.

#### **Robotic**

To date, only two studies using synthetic mesh discuss functional outcomes following RVMR (Table 2)<sup>[38,39]</sup>. The laparoscopic cohort of de Hoog *et al.*<sup>[39]</sup> included various mobilizations and was excluded. The RVMR series of this study showed a median CCCS gain of 3.2 points, which was lower than other studies performing LVMR for ERP (Table 2). Mantoo *et al.*<sup>[38]</sup>, performing LVMR and RVMR for various indications, noted a significantly greater improvement for obstructed defecation after RVMR. Median gain

of CCIS was non-significantly equivalent between the two techniques. Both improvement of obstructed defecation and faecal incontinence was in line with the literature on LVMR for various indications (Table 2). Functional outcome was not described in the recent RCT of Mäkelä-Kaikkonen *et al.*<sup>[16]</sup>. However, this RCT did show a non-significant difference in postoperative residual rectoceles on MRI in favour of the robot compared with laparoscopy (8% vs 33%,  $P = 0.26$ ). This may result in a better functional outcome for patients suffering obstructed defecation, but these outcome measures need to be evaluated at a longer follow-up.

## **RECURRENCE**

#### **Laparoscopic - ERP**

With the introduction of minimally invasive surgery, recurrence rates with rectal prolapse surgery remained low and equivalent to those of open surgery<sup>[55,56]</sup>. In the nineties, three small trials suggested that preservation of the lateral ligaments might result in a higher recurrence rate<sup>[11]</sup>. Tou *et al.*<sup>[11]</sup> speculated this was due to the limited mobilization of the rectum. Nonetheless, to date, numerous non-randomised observational studies, with increasing follow-up, quote acceptable recurrence rates following VMR. From 2004 until presently, recurrence percentages following LVMR for ERP range between 1.5% to 9.7%, with one small cohort ( $n = 13$ ) reporting a rate of 15.4% (Table 3). Several reviews demonstrate comparable recurrence rates with various rectal mobilisations and abdominal techniques<sup>[5,22,41]</sup>. In addition, a multicentre, pooled analysis of 643 patients from 15 centres undergoing abdominal surgery for ERP, showed that the method of rectopexy did not influence the recurrence rate<sup>[57]</sup>.

Variation in recurrence usually reflects differences of follow-up between studies. Articles reporting on LVMR for ERP described a time interval to presentation of recurrence between 10 and 91 mo after surgery. Most recurrences developed within the first 36 mo, but not all studies reported this time interval (Table 3). Little is known about risk factors for developing a recurrence following VMR. Mackenzie *et al.*<sup>[32]</sup> found the only predictor of recurrence was the use of polyester mesh which generated a twofold increase in recurrence rate, with an odds ratio of 1.96 ( $P = 0.017$ ), as compared with the most commonly used polypropylene graft.

#### **Laparoscopic - ERP and/or IRP and/or rectocele**

Three studies, performing LVMR for IRP and/or rectocele, quoted recurrence rates between 5.3 and 7.1 percent. Literature, including all rectal prolapse syndromes, reported recurrence percentages between 2.6% to 14.3%. The time interval between LVMR for various indications and recurrence varied from 10 to 139 mo (Table 3).

**Table 3** Recurrence rates following laparoscopic and robotic ventral mesh rectopexy with synthetic mesh *n* (%)

Laparoscopic studies	<i>n</i>	FU (median)	Recurrence	Type of recurrence	Presentation of recurrence (mo)
<b>Indication ERP</b>					
D'Hoore <i>et al</i> <sup>[6]</sup> , 2004	42	61	2 (4.8)	2 ERP	54, 91
Verdaasdonk <i>et al</i> <sup>[42]</sup> , 2006 <sup>1</sup>	13	7	2 (15.4)	2 ERP	-
Auguste <i>et al</i> <sup>[21]</sup> , 2006	54	12	4 (7.4)	3 ERP, 1 IRP	26 (7-54) <sup>2</sup>
D'Hoore <i>et al</i> <sup>[84]</sup> , 2006	109	-	5 (4.6)	4 ERP, 1 enterocele	-
Cristaldi <i>et al</i> <sup>[42]</sup> , 2007	63	18	1 (1.7)	ERP	-
Boons <i>et al</i> <sup>[44]</sup> , 2010	65	19	1 (1.5)	ERP	12
Wijffels <i>et al</i> <sup>[85]</sup> , 2011	80	23	2 (2.5%)	2 ERP	6, 16
Faucheron <i>et al</i> <sup>[86]</sup> , 2012	175	74/60 <sup>3</sup>	2 (3) <sup>3</sup>	2 ERP	6, 24
Randall <i>et al</i> <sup>[31]</sup> , 2014 <sup>5</sup>	190	29	9 (4.7)	1 ERP, 8 IRP	25, 30, 31, 60 <sup>6</sup>
Gosselink <i>et al</i> <sup>[29]</sup> , 2015 <sup>3</sup>	41	12	1 (2.3)	ERP	12
Tsunoda <i>et al</i> <sup>[34]</sup> , 2016	31	25	3 (9.7)	3 IRP	10, 17, 31
<b>Indication IRP and/or rectocele</b>					
Collinson <i>et al</i> <sup>[51]</sup> , 2010	75	12	4 (5.3)	4 IRP	-
Wong <i>et al</i> <sup>[52]</sup> , 2011	84	29	6 (7.1)	6 rectocele	-
Gosselink <i>et al</i> <sup>[29]</sup> , 2015 <sup>4</sup>	50	12	3 (5.8)	3 IRP	-
<b>Indication both ERP and IRP and/or rectocele</b>					
Lauretta <i>et al</i> <sup>[24]</sup> , 2012	2 ERP, 28 IRP	13.9 <sup>7</sup>	1 (3.3)	1 IRP	19
Formijne Jonkers <i>et al</i> <sup>[23]</sup> , 2013	36 ERP, 197 IRP	30	6 (2.6)	-	-
Badrek-Amoudi <i>et al</i> <sup>[25]</sup> , 2013	11 ERP, 37 IRP	33	4 (8.3)	4 IRP	22 (median)
Maggiori <i>et al</i> <sup>[26]</sup> , 2013	33 <sup>8</sup>	42 <sup>7</sup>	2 (6.7)	2 rectocele	11, 14
Mackenzie <i>et al</i> <sup>[32]</sup> , 2014	149 ERP, 487 IRP	21	60 (9.4)	-	-
Owais <i>et al</i> <sup>[53]</sup> , 2014 <sup>9</sup>	18 ERP, 60 IRP	42	2 (2.9)	2 IRP	-
Consten/van Iersel <i>et al</i> <sup>[12]</sup> , 2015	242 ERP, 677 IRP	33.9/120 <sup>3</sup>	68 (14.3) <sup>3</sup>	15 ERP, 53 IRP	24.1 (1-139.4) <sup>2</sup>
Tsunoda <i>et al</i> <sup>[33]</sup> , 2015	19 ERP, 25 IRP	26	2 (3.4)	2 IRP	10, 15
<b>Robotic vs Laparoscopic - various indications</b>					
De Hoog <i>et al</i> <sup>[39]</sup> , 2009	20 ERP robot	23.4	4 (20)	-	-
Wong <i>et al</i> <sup>[42]</sup> , 2011	23 IRP lap	12	1 (4.3)	Rectocele	3
	15 IRP robot		1 (6.7)	Rectocele	7
Wong <i>et al</i> <sup>[36]</sup> , 2011	40 IRP lap	6	0 (0)	-	-
	23 IRP robot		0 (0)	-	-
Mantoo <i>et al</i> <sup>[38]</sup> , 2013 <sup>10</sup>	23 ERP, 51 IRP lap	16 <sup>11</sup>	6 (8)	-	-
	12 ERP, 32 IRP robot		3 (7)	-	-
Mäkelä-Kaikkonen <i>et al</i> <sup>[37]</sup> , 2014	14 ERP, 6 IRP lap	3	1 (5)	-	-
	13 ERP, 7 IRP robot		0 (0)	-	-

<sup>1</sup>One patient was excluded from further analysis, therefore *n* = 13 instead of *n* = 14 is used; <sup>2</sup>Mean (range); <sup>3</sup>Recurrence percentage is KM estimate at 60 and 120 mo of follow-up; <sup>4</sup>The results of Gosselink *et al* are displayed per indication; <sup>5</sup>Study group included the first 44 cases from Slawik *et al*<sup>[62]</sup>; <sup>6</sup>Only 4 time intervals are described; <sup>7</sup>Mean instead of median; <sup>8</sup>Of the 33 patients (ERP *n* = 20, *n* = 13 IRR) 3 lost to follow-up. For the remainder of patients the surgical indication was not given; <sup>9</sup>Only men included; <sup>10</sup>A modified version of the D'Hoore rectopexy used; <sup>11</sup>Not specified whether mean of median was used. Lap: Laparoscopic; IRP: Internal rectal prolapse; ERP: External rectal prolapse.

## Robotic

The contemporary literature comparing LVMR with RVMR show similar recurrence rates between the two techniques (Table 3). Recurrence percentages vary from 0 to 7 for the robotic and 0 to 8 for the laparoscopic inclusions and were comparable to observational LVMR studies. One additional study from the de Hoog *et al*<sup>[39]</sup> noted a recurrence rate of 20% for the robotic, and 26.7% for the laparoscopic cohort. The laparoscopic series also included Well's procedures and therefore these results were excluded for analysis (Table 3).

## MULTI-COMPARTMENT PROLAPSE

Pelvic floor dysfunction is regularly characterised by multi-visceral pelvic organ prolapse<sup>[58]</sup>. With an ageing population, the prevalence of uni- and multi-visceral pelvic organ prolapse will increase<sup>[59-61]</sup>. A growing

number of articles discuss a multidisciplinary approach for multi-compartment prolapse, but only two studies avoid posterolateral rectal mobilization<sup>[62,63]</sup>. The first report, describing an open recto-vagino-vesicopexy, presented an improvement with constipation in 77% (*P* = 0.001), faecal incontinence in 69% (*P* = 0.005) and urinary incontinence in 50% (*P* = 0.18) of all patients respectively after 12 mo<sup>[63]</sup>. Two (8%) patients developed new-onset urinary incontinence. Slawik *et al*<sup>[62]</sup>, performing a laparoscopic sacro-colpo-rectopexy, described an improvement in 91% of patients with faecal incontinence and a reduction in median CCIS of 10 points after six months. Obstructed defecation resolved in 80% of patients, but 7% of these underwent an additional bowel resection. New-onset obstructed defecation occurred in 3.8%, and urinary incontinence in 2.5% of patients respectively. No patient developed a recurrence after a median follow-up of 54 mo. Thus far, no robotic studies describing a

multi-compartmental approach with a limited anterior rectal dissection are published.

## BIOLOGICAL MESH

Concerns over synthetic mesh-related complications such as erosion, dyspareunia, fistulation and stricturing have led to the introduction of a more expensive biological equivalent. The biological mesh is characterised by degradation of the graft and regeneration of host tissue<sup>[64]</sup>. In theory, this degradation could decrease the chance of erosion and chronic infection. Conversely, the partial resolution of the material may lead to a higher recurrence rate. In 2013, a systematic review by Smart *et al*<sup>[19]</sup> was published comparing 11 studies (767 patients) receiving synthetic mesh with two studies (99 patients) using a biologic graft. An erosion rate of less than one percent, with no difference identified between synthetic and biological mesh (0.7% vs 0%,  $P = 1.0\%$ ) was described. There was no significant difference in other mesh-related complications or short-term recurrence (3.7% vs 4.0%,  $P = 0.78$ ). The multicentre study of Evans *et al*<sup>[20]</sup> and two recent biological mesh studies<sup>[65,66]</sup> (4 and 20 mo follow-up) showed similar rates of mesh erosion. However, Franceschilli *et al*<sup>[66]</sup> reported a much higher percentage prolapse recurrence rate of 14% after a mean follow-up of 20 mo. Improvement with obstructed defecation was described from 82% to 92% with a mean gain of CCCS between 9 and 13 points ( $P = 0.02 - P < 0.0001$ )<sup>[65-68]</sup>. Reduction in faecal incontinence complaints occurred in 73% and 85% of patients with a mean gain in FISI score between four and 6 points ( $P = 0.01 - P = 0.001$ )<sup>[65-68]</sup>. One report demonstrated a median gain in CCIS of approximately 10 points ( $P = 0.0002$ )<sup>[65-68]</sup>. Wahed *et al*<sup>[67]</sup> was the only study describing new-onset complaints (4.6% with constipation and 3.1% with faecal incontinence). Only one study comparing and matching biological and synthetic mesh for LVMR (29 vs 29) exists, demonstrating no significant difference in mesh-related complications, recurrence or functional outcome after a median follow-up of 15.4 mo<sup>[30]</sup>. Mehmood *et al*<sup>[69]</sup>, comparing 34 LVMR with 17 RVMR patients using biological mesh, demonstrated a minor significant advantage in median CCIS gain for LVMR (10 vs 9.5,  $P = 0.02$ ). Conversely, a non-significant benefit in favour of the robot was seen in a reduction of the FISI (32 vs 35,  $P = 0.3$ ). Both the functional outcomes of the robotic and the laparoscopic cohort compared favourably to other studies describing LVMR for ERP (Table 2). No recurrences or mesh-related complications were seen in either cohort after 12 mo. There is a lack of high-level comparative evidence with long-term follow-up for biological mesh, which demonstrates any significant difference in graft-related morbidity and recurrence rates. When more data becomes available, the choice of the mesh may be influenced by cost or possible comorbidity. In a recent publication a panel of

experts suggested that biological grafts may be a better option in the following circumstances: young patients, women of reproductive age, diabetics, smokers, patients with a history of previous pelvic radiation or sepsis, inflammatory bowel disease, and in cases of intraoperative breach of the rectum or vagina<sup>[9]</sup>.

## DISCUSSION

LVMR has become popularised in the past decade and is the preferred technique for treating rectal prolapse syndromes by many surgeons, especially in Europe. The procedure is becoming increasingly applied with robotic assistance. The robot enhances visualisation and manoeuvrability to improve complicated procedures in the deep pelvis, such as dissection and intracorporeal suturing<sup>[70]</sup>. Robotic surgery has proven to be more expensive in the short-term, but may lead to an overall reduction of costs due to enhanced ergonomics for the surgeon<sup>[11,71,72]</sup>. However, a long-term cost-effectiveness analysis of LVMR vs RVMR has not been performed.

The current evidence shows that LVMR and RVMR are safe procedures in terms of intraoperative, post-operative and mesh-related complications. Both LVMR and RVMR generate an acceptable recurrence rate and satisfactory improvement of functional outcome, with only one small laparoscopic cohort reporting an overall non-significant deterioration with obstructed defecation after surgery<sup>[54]</sup>. There may be a trend towards a better outcome for obstructed defecation following RVMR as compared with LVMR, but the level of evidence is low<sup>[16,38]</sup>. LVMR and RVMR show similar good results for improvement of faecal incontinence. Based on the currently available data, no superiority for either technique can be determined. As compared with other observational studies describing an abdominal approach to treat rectal prolapse syndromes, VMR shows similar recurrence rates and less constipation postoperatively<sup>[5,22,41]</sup>. Circumspection is required interpreting these results, however. Heterogeneity between the articles in patient selection and outcomes measured makes it difficult to draw conclusions from the current literature. In addition, follow-up has been relatively short and lacks a systematic approach for the majority of studies, especially the robotic series. Since pelvic floor dysfunction increases with age, long-term follow-up is required to assess functional outcome and recurrence. The true mesh erosion rate can only be obtained with adequately powered, long term studies incorporating a vaginal and anorectal examination for every patient. Thus far, only level 3 evidence exists with a paucity of RCT's and case controlled trials. There are no results of comparative studies including VMR available. In a recent critical appraisal, Lundby and Laurberg expressed their concerns about the rapid implementation of LVMR for obstructed defecation syndrome based on the contemporary evidence<sup>[73]</sup>.

High-level comparative evidence is necessary to overcome these doubts and to determine the value of VMR in the definitive treatment of rectal prolapse syndromes.

## FUTURE RESEARCH

This review focusses solely on VMR, but more than three hundred different procedures to treat rectal prolapse syndromes have been described. Thus far, no technique has been shown to be superior. This was confirmed by an international survey in 2012, showing no uniformity of surgical procedure<sup>[74]</sup>. The survey demonstrated, inter alia, that more than 20% of the surgeons preferred stapled transanal resection of the rectum (STARR) for the treatment of IRP. Festen *et al.*<sup>[75]</sup> suggested an IRP associated with fecal incontinence should be treated with LVR and an IRP in combination with obstructed defecation with STARR or LVR. At present, one Italian trial is comparing LVMR with STARR for obstructed defecation syndrome<sup>[76]</sup>. In addition, there are eight ongoing surgical trials, of which five are mentioned by the cochrane study of Tou *et al.*<sup>[11]</sup>; two comparing LVMR with Delorme's procedure for ERP<sup>[77,78]</sup>, one investigating the outcomes of LVMR versus laparoscopic posterior rectopexy without mesh<sup>[79]</sup>, one comparing laparoscopic resection rectopexy (RR) with laparoscopic fixation rectopexy<sup>[80]</sup>, one assessing the difference between standard mesh rectopexy with ventral rectopexy<sup>[81]</sup>, one studying the efficacy of LVMR for the treatment of chronic constipation<sup>[82]</sup> and two examining LVMR versus RVMR<sup>[16,83]</sup>. The trial by Mäkelä-Kaikkonen *et al.*<sup>[16]</sup> has presented its short-term results, but long-term outcomes are awaited. The survey also shows VMR and RR are the two most common abdominal procedures for RP<sup>[74]</sup>. RR was developed to reverse the symptoms of rectal denervation inertia which is associated with traditional posterolateral rectal mobilization, but introduces the risks of a pelvic anastomosis. Three trials, comparing (predominantly open) abdominal rectopexy with and without sigmoid resection, described that RR was associated with less postoperative constipation but with a higher complication rate ( $P > 0.05$ )<sup>[11]</sup>. There is a need for a well-designed and adequately powered RCT comparing these two techniques laparoscopically or robotic-assisted. Lastly, high-quality evidence for the choice of a specific mesh type, either synthetic or biological, is required. The authors do acknowledge the slow recruitment and logistical difficulties of performing such trials, however.

## CONCLUSION

Ventral mesh rectopexy (laparoscopic and robotic) appears a safe and effective procedure to correct different rectal prolapse syndromes with a low morbidity rate, acceptable long-term recurrence rates

and a good functional outcome.

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