Choosing the right surgical technique for deep endometriosis: shaving, disc excision, or bowel resection?

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Deep endometriosis (DE) remains the most difficult endometriotic entity to treat. Medical treatment for DE can reduce symptoms but does not cure the disease, and surgical removal of the lesion is required when lesions are symptomatic, impairing bowel, urinary, sexual, and reproductive functions. Although several surgical techniques such as laparoscopic bowel resection, disc excision, and rectal shaving have been described, there is no consensus regarding the choice of technique or the timing of surgery. Our review of publications reporting results and complications of surgery for rectovaginal DE reveals a relatively higher complication rate after bowel resection compared with shaving and disc excision, especially for rectovaginal fistulas, anastomotic leakage, delayed hemorrhage, and long-term bladder catheterization. Data show that shaving is feasible even in advanced disease. The risk of immediate complications after shaving and disc excision is probably lower than after colorectal resection, allowing for better functional outcomes. The presumed higher risk of recurrence related to shaving has not been demonstrated. For these reasons, surgeons should consider rectal shaving as a first-line surgical treatment of rectovaginal DE, regardless of nodule size or association with other digestive localizations. When the result of rectal shaving is unsatisfactory (rare cases), disc excision may be performed either exclusively by laparoscopy or by using transanal staplers. Segmental resection may ultimately be reserved for advanced lesions responsible for major stenosis or for several cases of multiple nodules infiltrating the rectosigmoid junction or sigmoid colon. (Fertil Steril® 2017;108:931–42. ©2017 by American Society for Reproductive Medicine.)

Key Words: Deep endometriosis, surgery, shaving, disc excision, bowel resection

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Endometriosis is one of the most frequently encountered benign gynecological diseases, known to occur in 7%–10% of women of reproductive age (1). It is well established that three different forms of endometriosis can coexist in the pelvis: peritoneal endometriosis, ovarian endometriosis, and deep endometriosis (DE) of the rectovaginal septum (2). Most rectovaginal DE lesions originate from the posterior part of the cervix and secondarily infiltrate the anterior wall of the rectum (3, 4).

Medical treatment of rectovaginal DE can reduce the symptoms but does not cure the disease and is often associated with side effects such as erratic bleeding, weight gain, decreased libido, and headache (5). Pregnancy does not seem to prevent disease progression (6), and resection of rectovaginal DE seems to improve fertility outcomes (3, 7). Moreover, among pregnant women with endometriosis, rectovaginal DE is associated with prematurity, hospitalization, and low birthweight (8, 9). Surgical removal of rectovaginal DE lesions is required when lesions are symptomatic, impairing bowel, urinary, sexual, and reproductive functions. Although several surgical techniques such as laparoscopic bowel resection, disc excision, or rectal shaving have been described, there is no consensus regarding the choice of technique or when surgery should be proposed.

Although infiltration up to the rectal mucosa and invasion of >50% of the circumference have been suggested as an indication for bowel resection (10, 11), this remains a subject of debate (3, 4, 12). In their review of the literature, Meuleman et al. reported that out of 3,894 patients, 71% underwent bowel resection, 10% had disc excision, and only 17% were treated with so-called superficial surgery (13). Conversely, in a more recent survey enrolling 1,135 patients

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managed for colorectal endometriosis in France in 2015, almost half (48.1%) were treated by rectal shaving, with wide disparities between the approaches of different surgical teams involved in the survey (14). Similarly, Malzoni et al. (15) reported a series of 670 cases with endometriosis invading the bowel, 62.9% of which were operated on by shaving and 37.1% by bowel resection. These discordant data result from the lack of consensus concerning the optimal surgical management of DE infiltrating the bowel.

The aim of this paper was to review the available literature comparing the conservative approach (shaving technique and discoid resection) and the more radical approach (bowel resection) in terms of surgical outcomes, complications, and recurrence rates.

SHAVING TECHNIQUE: DEFINITION

The shaving technique for the surgical treatment of rectovaginal DE of the Douglas pouch was first described in 1991 (16). The first large series was published in 1995 (17) and followed by larger series from the same team between 1997 and 2013, with the largest series so far described of about 3,298 cases (3, 4, 17–19).

To individualize the uterus, vagina, and the rectum, a uterine manipulator is necessary, as well as a sponge placed into the vagina and a probe inside the rectum. These three manipulators should be individually mobilized. The principal steps of the shaving technique involve the lateral identification of the ureter far from the lesion itself. For nodules measuring >3 cm, there is ureter involvement in 10% of cases (20), requiring ureterolysis with or without previous ureteral stenting. When lateral spaces are freed, the uterosacral ligaments are cut to leave the bowel attached to the nodule (Supplemental Video 1). Then shaving consists in the separation of the nodule from the anterior part of the rectum to reach the cleavage plan of the rectovaginal septum (Supplemental Video 2). Shaving is a more than superficial surgical treatment of rectovaginal DE (13) and consists in excision of the DE nodule, even if during this procedure the bowel lumen could be inadvertently opened. In this case, a bowel suture must be performed in one or two layers (Supplemental Video 3). Three steps have been described: [1] separation of the anterior rectum from the posterior vagina, [2] excision or ablation of the DE nodule from the posterior part of the cervix, and [3] resection of the posterior vaginal fornix and vaginal closure (Supplemental Video 4).

Shaving Technique: Surgical Outcomes

Outcomes are presented in Table 1. Shaving of the rectum can be performed using the CO_2 laser (3, 18, 21, 27, 29), cold scissors (33, 34), ultrasound scalpel or plasma energy (34), and monopolar hook (33).

The mean size of the resected lesions was around 2–3 cm (3, 4, 23, 30, 32, 34, 35). However, resection of nodules measuring up to 6 cm has been repeatedly described (4, 23, 24) (Supplemental Video 5). The mean surgical time was usually <3 hours (3, 4, 16, 21, 24, 25, 29, 31, 33, 34). However, in a series of 500 endometriotic nodules with a mean size of 3.4 cm (2–6 cm), Donnez and Squifflet (3) achieved a mean surgical time of 78 minutes (31–128 minutes). In a series of 122 lesions measuring >3 cm, Roman et al. (34) reported an operating time of 162 ± 72 minutes. Most patients required a short hospital stay, between 2 and 3 days (3, 28, 31, 33).

It should be noted that the follow-up period was usually short, with a mean of 3 years (3, 25, 26, 27, 28, 34). However, data on more than 3 years of follow-up (30, 32, 35) with a maximum of 7 years are available.

Shaving Technique: Complications

Among five studies on patients managed by shaving, disc excision, or segmental resection, postoperative complications were not specifically stratified according to technique (14, 24, 25, 26, 32). Only two studies encountered no complications at all (23, 30), but they involved small numbers of patients, 23 and 18, respectively. No follow-up was reported for the first series (23), while patients benefitted from a 68-month follow-up period in the second one.

Among studies reporting precisely the complications related to the shaving technique (3, 4, 21, 23, 27–35), bowel perforation during surgery was encountered in 1.74% (n = 83/4,470). In all cases, the bowel was sutured during surgery and no unfavorable outcomes occurred.

Severe bowel complications included late bowel perforation requiring or not colostomy and rectovaginal fistulas. Late bowel perforation requiring colostomy occurred in three studies (4, 21, 35). Koninckx et al. (21) and Roman et al. (35), respectively, described 1.7% and 2.2% of late bowel perforation requiring colostomy, while Donnez et al. reported 0.03% in a series of 3,298 cases (4). Bowel complications (3, 4, 21, 23, 27–31, 34, 35) were reported in 0.13% of the cases (n = 6/4,706) operated on by the shaving technique.

Rectovaginal fistulas were signaled in 0.24% of the cases (n = 13/5,297) (3, 4, 14, 21, 23, 27–31, 33–35). Eight studies did not bring back any rectovaginal fistulas at all (3, 21, 23, 27, 28, 30, 33, 35), while three studies reported between 1% and 2.6% (29, 31, 34). Only Donnez et al. reported 0.06% of rectovaginal fistula in a series of 3,298 cases (4), and Roman et al. reported 0.6% in a snapshot of 546 cases (14).

Any intraoperative hemorrhage was described. Jatan et al. (28) and Donnez et al. (4) reported delayed hemorrhage in, respectively, 1.6% and 0.09% of cases. This complication occurred in 0.08% of cases (n = 4/4,568) (3, 4, 21, 23, 27–31, 33–35).

Two studies (34, 35) revealed 6.6% and 2.2% of long-term bladder catheterization after shaving, but this was not documented in another 10 studies (3, 4, 21, 23, 27–31, 33). The overall rate of long-term bladder catheterization was 0.19% (n = 9/4,731) (3, 4, 21, 23, 27–31, 33–35). It is important to stress, however, that bladder atony was not permanent and catheterization was required for a maximum duration of 6 weeks ± 4 (35).

Few studies analyzed bowel function after shaving. However, an objective assessment of neurological intestinal alteration after rectal shaving of rectovaginal DE suggested that this surgical technique preserves neurological bowel activity

TABLE 1

Intraoperative events and postoperative outcomes in series enrolling patients managed for rectovaginal DE, previously published in the literature.

					Complications, %														
Authors	n	Mean size of the nodule (cm)	Operating time, minutes	Length of stay, days	Bowel perforation during shaving	Late bowel perforation requiring colostomy	Late bowel perforation not requiring colostomy	Rectovaginal fistulas	Anastomotic leakage	Intraoperative hemorrhage	Delayed hemorrhage	Urinary retention < 20 d	Long-term bladder catheterization	Ureteral damage	Ureteral fistula	Follow-up, mo	Recurrence pain rate, %	Reoperation rate, %	Pregnancy rate, %
Shaving																			
Total shaving					1.7 (83/4,793)	0.12 (6/4,839)	0.08 (4/4,637)	0.25 (14/5,430)	—	0	0.08 (4/4,568)	0.61 (28/4,568)	0.23 (9/4,731)	0.13 (6/4,701)	0.3 (14/4,701)		7.9 (80/1,010)	2.4 (106/4,416)	
Reich et al. 1991 (16)	100	NR	178	NR	NR	NR	NR	NR	—	NR	NR	NR	NR	NR	NR	NR	11	NR	70
Donnez et al. 1995 (17)[a]	231	NR	NR	NR	1.29	0	0	0	—	0	0	1.19	0	0	0	NR	NR	NR	NR
Koninckx et al. 1996 (21)	225	NR	120 (50–300)	1	6.3	1.7	1.3	0	—		0	0	0	0.4	0	NR	NR	NR	NR
Donnez et al. 1997 (18)[a]	500		69 (40–132)	2.8 (2–5)	0.8	0	0	0	—	0	0.4	0.8	0	0	0	NR	1.2 at 2 y	NR	NR
Jerby et al. 1999 (22)	23	NR	110 (45–355)	1 (0–4)	0	0	0	0	—	NR	NR	NR	NR	0	0	10	NR	NR	NR
Redwine and Wright 2001 (23)	23	0.4–3	NR	NR	0	0	0	0	—	0	0	0	0	0	0	NR	NR	NR	NR
Duepree et al. 2002 (24)	26	NR	168 (141–205)	1.2 (1–4)	NR	NR	NR	NR	—	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Varol et al. 2003 (25)	132	NR	120	NR	NR	NR	NR	NR	—	NR	NR	NR	NR	NR	NR	35	NR	11.2	NR
Fedele et al. 2004 (26)	53	NR	NR	NR	NR	NR	NR	NR	—	NR	NR	NR	0	NR	NR	37.5 ± 20.4	25	NR	28.9
Mohr et al. 2005 (27)	100	NR	NR	1 (0–5)	0	0	0	0	—	0	0	0	0	0	0	24	NA	14	36
Jatan et al. 2006 (28)	61	NR	NR	2.6 (0–8)	1.6	0	0	0	—	0	1.6	0	0	0	0	20	5	24	
Slack et al. 2007 (29)	128	NR	106 (35–240)	NR	11	0	0	2.3	—	0	0	3.2	0	0.8	0.8	NR	NR	NR	NR
Brouwer and Woods 2007 (30)	18	<2	NR	NR	0	0	0	0	—	0	0	0	0	0	0	68 (7–158)	22.2	NR	NR
Donnez and Squifflet 2010 (3)[a]	500	3.4 (from 2 to 6)	78 (50–218)	NR	1.4	0	0	0	—		0	0.8	0	0	0.8	37.2	7.8 (3.6% after pregnancy and 14% if not)	2.4	84
Kondo et al. 2011 (31)	183	2.9 ± 1.2	182 ± 70	3.2 ± 1.5	0	0	0	1.6	—	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Donnez et al. 2013 (4, including 18–20)	3.298	2.8 (2–6)	70 (31–128)	2.7 (2–7)	1.3	0.03	0	0.06	—	NA	0.09	0.64	0	0.12	0.18	NR	NR	0.8 bowel resection for recurrence	NR
Serrachioli et al. 2015 (32)	19	3.3 ± 1.18	NR	NR	5.2	NR	NR	NR	—	NR	NR	NR	NR	NR	NR	92.4 ± 34.8	NR	NR	NR
Afors et al. 2016 (33)	47	NR	130 ± 31	3.6 ± 1	6.4	NR	2.1	0	—	0	0	0	0	0	2.1	24	NR	27.6	NR
Roman et al. 2016 (34)	122	≥3	162 ± 72	NR	0	0	0	1.6	—	0	0	0	6.6	0	0.8	36 (12–60)	4	4.9	65.4
Roman et al. 2016 (35)	46	3 (1.5–6)	NR	NR	0	2.2	0	0	—	0	0	0	2.2	0	2.2	60	8.7	8.7	NR
Roman et al. 2017 (14)	546	NR	NR	NR	NR	NR	NR	0.6	—	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Roman, 2017 (14)	110	<3	NR	NR	NR	0	0	0.9	—	NR	NR	1.8	0	0	0	36	0.9	2.7	29.1

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TABLE 1

Continued.

Authors	n	Mean size of the nodule (cm)	Operating time, minutes	Length of stay, days	Complications, %														
					Bowel perforation during shaving	Late bowel perforation requiring colostomy	Late bowel perforation not requiring colostomy	Rectovaginal fistulas	Anastomotic leakage	Intraoperative hemorrhage	Delayed hemorrhage	Urinary retention < 20 d	Long-term bladder catheterization	Ureteral damage	Ureteral fistula	Follow-up, mo	Recurrence pain rate, %	Reoperation rate, %	Pregnancy rate, %
Disc excision																			
Total disc excision						0	0	2.8 (13/454)	0	0.6 (2/323)	3.3 (10/297)	3.7 (12/336)	0	0.3 (1/371)	0		11.7 (20/171)	9.3 (27/289)	
Jerby et al. 1999 (22)	5	NR	180 (120–275)	3 (3–9)	0	0	0	0	0	NR	NR	NR	NR	0	0	10	NR	NR	NR
Duepree et al. 2002 (24)	5	NR	382 (346–418)	1.2 (1–4)	0	0	0	0	0	0	0	0	0	0	0	NR	NR	NR	NR
Woods et al. 2003 (38)	30	< 2	NR	NR	0	0	0	3.3	0	0	3.3	NR	0	0	0	NR	NR	3.3	NR
Brouwer and Woods 2007 (30)	58	NR	NR	NR	0	0	0	0	0	0	0	0	0	0	0	68	5.2	NR	NR
Landi et al. 2008 (39)	35	<2.5	230	5	0	0	0	0	0	0	4	0	0	0	0	12–48	NR	5.7	NR
Fanfani et al. 2010 (40)	48	1.1 (0.5–3)	200 (120–480	7 (3–12)	0	0	0	2.1	0	NR	10.4	NR	0	0	0	33	13.8	4.2	27.3
Koh et al. 2012 (41)	65	NR	209	5	0	0	0	0	0	2.2	0		1	0	16		15.4	8.8	46.4
Afors et al. 2016 (33)	15	3.5	132	4.5	6.7	0	0	0	0	0	0	13.4	0	0	0	23	NR	13.3	NR
Roman et al. 2017 (14)	111	≥3 in 65.8%	206	NR	0	0	0	7.2 (11.6% when lesion ≤55 mm from anal verge)	0	0	2.7	9	0	0	0	22	NR	12.7	65.6
Roman et al. 2017 (14)	83	NR	NR	NR	NR	NR	NR	3.6	0	NR	NR	NR	NR	NR	NR	<15	NR	NR	NR
Bowel resection																			
Total bowel resection						0.5	1.2 (3/247)	4.3 (128/2,956)	3.7 (92/2,457)	0.6 (11/1,653)	4.8 (96/1,967)	0	5.4 (143/2,647)	0.04% (1/2,351)	0.3 (10/3,206)		17.2 (203/1,179)	5 (17/336)	
Jerby et al. 1999 (22)	7	NR	240 (180–390)	5 (5–7)	—	—	—	14.2	0	NR	NR	NR	NR	0	0	10	NR	NR	NR
Possover et al. 2000 (42)	34	>2	185.6 ± 82.4	NR	—	—	—	0	0	0	0	0	0	0	0	16	0	0	53.3
Redwine and Wright 2001 (23)	6	0.4–3	NR	NR	—	—	—	0	0	0	0	0	0	0	0	NR	NR	0	NR
Duepree et al. 2002 (24)	18	NR	200 (132–260)	4 (3–5)	—	—	—	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Brouwer and Woods 2007 (30)	137	NR	NR	NR	—	—	0.7	0	0.7	0	2.1	NR	1.4	0	0	68	2.2	NR	NR
Daraï et al. 2005 (43)	40	2.4 (0.4–6)	378 (240–780)	NR	—	—	—	7.5	0	0	15	NR	17.5	0	0	15	NR	NR	NR
Fleisch et al. 2005 (44)	23	NR	NR	12.7 ± 3.9	—	—	—	0	4.8	NR	9.5	NR	NR	0	0	45.2 ± 18	34.8 at 40.4 mo	NR	23.5
Keckstein and Wiesinger 2005 (45)	202	NR	180 (45–260)	NR	—	—	—	0	3	NR	0.5	NR	NR	NR	0	NR	NR	NR	NR
Dubernard et al. 2006 (46)	58	NR	NR	NR	—	—	—	10.3	0	NR	1.7	NR	NR	NR	1.7	NR	NR	NR	NR

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TABLE 1

Continued.

Authors	n	Mean size of the nodule (cm)	Operating time, minutes	Length of stay, days	Complications, %														
					Bowel perforation during shaving	Late bowel perforation requiring colostomy	Late bowel perforation not requiring colostomy	Rectovaginal fistulas	Anastomotic leakage	Intraoperative hemorrhage	Delayed hemorrhage	Urinary retention < 20 d	Long-term bladder catheterization	Ureteral damage	Ureteral fistula	Follow-up, mo	Recurrence pain rate, %	Reoperation rate, %	Pregnancy rate, %
Mereu et al. 2007 (47)	192	5% < 2 and 95% > 2	326.7 (312.8–340.5)	9.4 (8.8–10.1)	—	0.5	—	2.7	4.7	0.8	6	NR	4.7	0.5	1.6	up to 36	NR	NR	NR
Darai et al. 2007 (48)	71	3 (1–9)	366 (180–780)	NR	—	—	—	8.4	0	8.4	14.1	NR	NR	NR	0	24.4	NR	NR	NR
Seracchioli et al. 2007 (49)	22	3.6 (3.1–5.3)	192.8 ± 41.7	8 (6–19)	—	—	4.5	0	4.5	NR	4.5	NR	13.6	0	0	36	0 at 30 mo	0 at 30 mo	NR
Minelli et al. 2009 (50)	334	NR	300 (85–720)	NR	—	—	—	3.9	1.1	NR	10	NR	9.5	0	0.6	19.6 (6–48)	NR	NR	41.6
Ferrero et al. 2009 (51)	46	≥ 3	NR	NR	—	—	—	2.2	2.2	NR	10.8	NR	4.3	0	0	49.9 ± 24.1	NR	NR	42.9
Dousset et al. 2010 (52)	100	2.6	320 ± 210	NR	—	—	—	4	2	0	2	NR	16	NR	2	78 ± 15	6	7	NR
Fanfani et al. 2010 (40)	88	1.5 (1.2–3)	300 (90–540)	8 (3–36)	—	—	1.1	3.4	1.1	NR	5.7	NR	14.7	NR	1.1	30	NR	4.5	NR
Ruffo et al. 2010 (53)	436	NR	NR	NR	—	—	—	3.2	2.1	NR	3.2	NR	16.3	NR	0	NR	NR	NR	NR
Meuleman et al. 2011 (54)	45	NR	420 (240–600)	7	—	—	—	0	0	0	0	0	2.2	0	0	36	11% at 3 y	11% at 3 y	46
Wolthuis et al. 2011 (55)	21	NR	90 (65–120)	6	—	—	—	0	0	0	0	0	0	0	0	18	NR	NR	NR
Ruffo et al. 2014 (56)	774	NR	NR	NR				NR	NR	NR	NR	NR	NR	NR	NR	54	15.4	NR	16.5
Belghiti et al. 2014 (57)	198	3 (0.5–11)	NR	NR	—	—	—	4.5 (18.1% in case of low colorectal anastomosis	3	NR	0	NR	NR	0	0	NR	NR	NR	NR
Akladios et al. 2015 (58)	41	>3	210	8 (5–35)	—	—	—	2.4	2.4	2.4	4.8	0	0	0	2.4	18	122	2.4	NR
Milone et al. 2015 (59)	90	NR	206	NR	—	—	—	0	2.0	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Malzoni et al. 2016 (15)	248	Between 3 and 7	169.88 ± 58.78	7.6 ± 2.3	—	—	—	2.4 in total and 13.3 in case low rectal lesions	1.6	0	0.4	0	0	0	0	12	22.9 at 1 y	NR	61
Abo et al. 2017 (60)	139	≥3 in 66.9%	263 ± 79	NR	—	—	—	5.8	NR	NR	1.4	NR	4.3	0	0	38 ± 20	NR	NR	NR
Roman et al. 2017 (14)	532	NR	NR	NR	—	—	—	3.9	0.8	NR	NR	NR	NR	NR	NR	<15	NR	NR	NR

Note: NR = not reported.
[a] Included in line Donnez et al. 2013 (4).

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over more than 7 years of follow-up (32). Roman et al. (35) recently described better functional outcomes for postoperative constipation and anal continence after shaving compared with bowel resection. In two case series enrolling patients exclusively managed by shaving whose digestive tract function was assessed using standardized gastrointestinal questionnaires, a significant improvement in constipation and gastrointestinal quality of life was recorded 1 and 3 years postoperatively (34, 36).

Shaving Technique: Recurrence

A recurrence of pain was observed in <10% of the patients who had shaving (3, 16, 28, 34, 35). Roman et al. noticed a 4% recurrence rate after 3-year follow-up (34) and 8.7% after 5-year follow-up (35). This is consistent with the results of Donnez and Squifflet (3) who considered a 7% recurrence rate of severe pelvic pain (36 of 500), which was found to be significantly lower ($P<.05$) in women who became pregnant after surgery (3.6%) than in those who did not (14%). Only 2.4% in this series required reintervention. A reintervention rate of <10% was observed in four studies with a follow-up of 3–5 years (3, 4, 34, 35). However, in two studies, the reintervention rate was as high as 24% after 20 months of follow-up (28) and 27.6% after 24 months of follow-up (33). No explanation was provided by these authors regarding such high reintervention rates when compared with other reports on the shaving technique. The authors claimed that this high reoperation rate was related to the shaving technique itself. However, reoperation rates from other trials (usually <10%) suggested that the way in which the technique was performed may have been questionable, resulting in incomplete surgery.

DISC EXCISION TECHNIQUE: DEFINITION

Disc excision was introduced more than 20 years ago by surgeons who reported rectovaginal DE removal with bowel lumen opening, followed by the suture of bowel (61). Other surgeons preferred using the transanal end-to-end anastomosis (EEA) stapler (Ethicon Endo-Surgery) to perform tight sutures of the rectal wall (22, 36, 39, 62, 63), and the procedure progressively spread worldwide. However, when the low rectum is infiltrated by huge endometriotic nodules, it may be awkward to perform rectal shaving and laparoscopic or open disc excision. In response to these challenges, a new technique was introduced (the Rouen technique) using the Contour Transtarstapler (Ethicon Endo-Surgery) in combined laparoscopic and transanal full-thickness disc excision of large rectovaginal DE infiltrating the low and mid rectum (63, 64). In a recent survey enrolling 1,135 patients managed for colorectal rectovaginal DE in France in 2015, disc excision was employed in only 7.3% of cases and in only 16 facilities out of 56 participating in the study (14).

The technique for full-thickness rectovaginal DE excision involves at least two different steps and may combine both laparoscopic and transanal approaches. The first step is performed laparoscopically, and the goal is to achieve rectal shaving (62, 64). The nodule is dissected away from the rectal wall and removed, when required, by resection of the vaginal fornix, the uterine torus, and the uterosacral ligaments. In rectovaginal DE infiltrating the vagina >3 cm in diameter, a combined vaginal-laparoscopic approach may be useful (42, 65). In cases where the shaved area of the rectal wall is still infiltrated by implants of DE, it appears hollow, rigid, and thickened under palpation with a laparoscopic probe (Supplemental Videos 6 and 7). In these circumstances, a more complete treatment may be achieved by full-thickness disc excision of the shaved area, followed by either direct suture using several stitches or the use of transanal staplers. The first procedure does not avoid bowel opening into the pelvis, which may increase the risk of postoperative pelvic abscess. Conversely, during the disc excision procedure using transanal staplers, the bowel is never opened as both sections are stapled. The Contour Transtar stapler allows for large disc excision (5–6 cm diameter on average) when the shaved area is located between 8 and 10 cm above the anus (Supplemental Video 6), while the EEA circular stapler removes discs 3 cm in diameter located in the upper rectum and rectosigmoid junction (Supplemental Video 7) (37). Preliminary rectal shaving determines the size of rectal patch: the thinner and softer the shaved rectal wall, the larger the diameter of the rectal patch that can be removed using the transanal stapler (37) (Supplemental Video 6).

Disc Excision Complications

In the FRIENDS survey, the rate of rectovaginal fistula in patients managed by disc excision was 3.6%, which was threefold higher than the rate recorded in patients managed by shaving (1.3%) and comparable to segmental resection (3.9%) (14). This rate is similar to that reported by an Australian team in a series enrolling patient managed by disc excision using the circular transanal stapler (38).

In a recent series of 111 patients, reported by Roman et al., the rate of rectovaginal fistula was as high as 7.2%, mainly due to the high prevalence of this event in patients with low rectovaginal DE managed by the Rouen technique (37). Rectovaginal fistulas were more frequent (11.9%) in a specific group of women with rectal nodules located on average 5.5 cm above the anus, with a mean diameter of infiltrated rectum of >3 cm in diameter in 93%, with adjacent vaginal involvement in 83.3% and measuring >3 cm in diameter in 69% of cases. Despite a combined vaginal-laparoscopic approach and the systematic use of omentoplasty separating vaginal and rectal sutures, the risk of rectovaginal fistula in such patients was expectedly high. In the literature, no similar series of patients with low rectal endometriosis has yet been reported to allow comparison with the outcomes reported in this study (37).

When a disc excision is carried out, bowel suture is transversal and semicircular. Consequently, the risk of bowel stenosis at the level of the suture appeared unlikely and has not yet been reported in the literature (66).

Postoperative bladder dysfunction was assessed in several reports. This complication is obviously not due to disc excision itself but more to the lateral spread of the disease to the inferior hypogastric plexus and splanchnic nerves and

to surgical dissection. Hence, the rate of bladder dysfunction is higher (up to 9%) in series including high proportions of patients managed for low rectal nodules (37).

Disc Excision Technique: Recurrence

To date, there are no comparative studies with long-term follow-up that provide valuable answers regarding recurrence. However, various series available in the literature report low recurrence rates, with a 1.8% risk of recurrence at 2 years (37). Fanfani et al. reported an 8.3% risk of recurrence after disc excision; however, the authors did not specify where they were located (40).

COLORECTAL SEGMENTAL RESECTION: DEFINITION AND TECHNIQUE

Segmental resection is the main procedure used to manage bowel diseases in colorectal surgery. Except for endometriosis, bowel diseases start inside the bowel, then cross the bowel wall and may ultimately spread throughout the digestive tract. In advanced stages of bowel rectovaginal DE, when the infiltration is large and responsible for irreducible distortion of stenosis of the bowel, segmental resection of digestive tract is unavoidable (41, 67). In the United States, the rate of colorectal resection indicated for endometriosis increased from 0.19% to 0.29% between 2006 and 2014 (68).

The technique of colorectal resection for rectovaginal DE was described in 1992 by Nezhat et al. (69) and generally follows the same path (Supplemental Video 8). Pararectal spaces are opened longitudinally, medially from uterosacral ligaments and inferior hypogastric plexus to preserve bladder, vaginal, and rectal innervation. Then the nodule is detached from surrounding structures (uterosacral ligaments, uterine isthmus, vagina, etc.), and the rectum is sectioned with a 1–2 cm short healthy rectal margin. Then the rectum is extracted through an abdominal wall or vaginal incision, and proximal section is performed above the nodule. Colorectal anastomosis (either end-to-end or side-to-end) is generally carried out using transanal circular staplers. The rectal air test is used to check the quality of colorectal suture. A diverting stoma may temporarily be created in patients with concomitant rectal and vaginal suture (43).

Colorectal Resection Technique: Complications

Rectovaginal fistulas and leakage are two major complications related to the opening of colorectal suture, with rates varying from 0 to 18.1% depending on the characteristics of patients enrolled in several series of patients managed for bowel endometriosis (14, 22, 25, 30, 32,43–59, 69). The risk seems related to the height of rectal involvement: the lower the bowel infiltration, the higher the risk of fistula. Malzoni et al. (15) reported 13.3% rectovaginal fistula when the lesion was located $\leq$8 cm from the anal verge, and Belghiti et al. reported 18.1% rectovaginal fistula in cases of low colorectal anastomosis (57).

Postoperative bleeding originating from the stapled line was recorded in 0–14.1% of cases on average and may occur immediately after the surgery (13, 15, 50). Severe bleeding may require blood transfusion and hemostasis under colonoscopy or second-look laparoscopy.

Anastomotic stenosis is a complication arising more frequently in series of patients managed for endometriosis than in series enrolling patients with various digestive tract diseases, which suggests that it could be related to the inflammatory status of the pelvis in women with pelvic endometriosis (70). Several authors report a significant reduction in the bowel lumen at the level of colorectal anastomosis carried out for endometriosis, particularly when using transanal staplers (50, 70). However, this complication may be overlooked in patients in whom postoperative constipation is unexplored.

Colorectal Resection Technique: Functional Outcomes

During the last 10 years, several authors have underlined the importance of functional outcomes in the evaluation of the surgical management of the digestive tract. These outcomes are directly related to removal of a part of the digestive tract, bowel denervation, loss of compliance, or hypersensitivity (71, 72) and may lead to unbearable complaints such as anal incontinence, major dyschesia, and fecal urgency. Functional complaints may or may not improve in the long run, and their assessment requires long-term follow-up (52). However, owing to their long evolution and major negative impact on long-term quality of life, they may be much more unpleasant than immediate complications, which are usually solved earlier than one postoperative year. On the other hand, their assessment is more challenging and requires the use of various scores and scales such as the Knowles-Eccersley-Scott-Symptom Questionnaire (KESS) (73), the Gastrointestinal Quality of Life Index (GIQLI) (74), the Wexner scale (75), or the low anterior rectal resection syndrome score (LARS) (72). Furthermore, assessing the specific role of surgery in the presumed impairment of digestive function is challenging, as recent studies have shown that patients with colorectal endometriosis may preoperatively present with rectal or bladder dysfunction (76), that is, anal and urethral sphincter hypertonia, and these troubles may be irreversible and not restored by removal of nodules.

Surgeons should be aware that surgery may result in several unfavorable functional outcomes and normal bowel function may be incompletely restored (77). Outcomes may be either temporary (in most of cases) or definitive, hence the need to inform patients of this risk particularly when low colorectal resections are required (52, 72). The frequency of defecation may increase after surgery (77).

Colorectal Resection Technique: Recurrences

The removal of bowel endometriosis foci is logically more complete by segmental resection. Most authors have reported a low risk of recurrence in patients managed by colorectal resection. No recurrences were reported in two series with 5 (52) and 8.5 years of follow-up (35). In another series, one patient out of 103 presented with a recurrence on the rectal stapled line 2 years after surgery (78). However, it must be underlined that in most series, the length of postoperative

follow-up scarcely exceeded 2 years, while the risk of recurrence is logically a time-dependent variable.

DISCUSSION

In the literature, there are no definitive indications for any of the three procedures to treat DNE of the rectum. Various experienced surgeons who have published their opinions based on their own practice and outcomes have defended each of them (3, 15, 79), with some of them able to manage 99% of all their cases using one technique (4). Several surgeons agree that large DNRE and multifocal DNRE should be managed exclusively by segmental resection (79). However, this criterion is far from being accepted by other investigators, particularly when the nodules infiltrate mid and low rectum, as low en bloc colorectal resection may be responsible for low anterior resection syndrome. Indeed, the Rouen technique and the shaving technique allow for removal of rectal nodules >5 cm in diameter, with good functional outcomes (4, 37). According to our review, the size of the nodule should not dictate the type of surgery to be performed. In multiple nodules infiltrating the rectum and sigmoid colon, associating rectal disc excision and segmental resection of sigmoid colon allows for the conservation of the rectum and the intermediate healthy colon located between two consecutive nodules (37, 66).

Complications

Our review of publications reporting the results and complications of surgery for treatment of rectovaginal DE nodules reveals relatively higher complication rates after bowel resection compared with shaving or disc excision, especially for anastomotic leakage, delayed hemorrhage, and long-term bladder catheterization. Indeed, rates of urinary retention (0–17.5%), ureteral lesions (0–2%), anastomotic leakage (0–4.8%), and pelvic abscesses (0–4.2%) were all higher than with the shaving technique and disc excision. The rate of rectovaginal fistulas was likewise found to be relatively high after bowel resection (0–18.1%), but also after disc excision (0–11.6%), compared with shaving (0–2.3%). During shaving, bowel perforation was encountered in 0–11% of cases, so it is somewhat surprising that the rate of rectovaginal fistula was lower with shaving. This may be explained by the absence of bowel tissue resection during the shaving procedures, while the other two techniques involved at least a degree of bowel wall resections with subsequent inadequate healing leading to leakage or fistulas.

It has been stated that a protective ileostomy at the time of surgery could have a protective impact on the risk of rectovaginal fistula or anastomotic leakage after bowel resection (80, 81). The rate of diverting stoma after bowel resection for rectovaginal DE is widely variable, from 1.6% (15) to 96% (52), depending on patients' enrollment criteria and surgeons' preferences. While Matthiessen et al. (82) and Shiomi et al. (80) reported that the use of stoma reduces the risk of both fistulas and reintervention for fistulas after low colorectal anastomosis, the rate of rectovaginal fistulas remains as high as 13% and 18% when the anastomosis is low (15, 56).

Opening the vagina during surgery has been identified by some authors as a risk factor for rectovaginal fistulas (43, 46, 48), but other authors suggest a possibly higher risk of recurrence when the vagina is not opened (17, 18, 81). Back in 1995 (17), resection of the posterior vaginal fornix was systematically proposed during shaving, as it was believed to yield lower rates of recurrence. In this series, endometriotic glands and stroma were often detected by serial section up to the vaginal mucosa, which was sometimes replaced by endometrial epithelium (18). This was confirmed 12 years later by Matsuzaki et al. (83), who determined that the minimum distance between the vaginal mucosal epithelium and endometriotic glands was <5,000 μm in 98.4% of cases when the nodule measured >2 cm. Most studies on the shaving technique report low rates of rectovaginal fistulas, despite systematic resection of the posterior vaginal fornix by most authors (4). According to our review, the risk of rectovaginal fistulas after shaving is only 0.25%, compared with around 2.8% and 4.3% after disc excision and bowel resection, respectively. The risk of rectovaginal fistula appears to be more related to the opening and resection of the bowel than the vagina, especially when managing lower lesions (4, 17, 18).

Several experienced surgeons using mainly the shaving technique can manage more than 80%–90% of their patients with colorectal rectovaginal DE (3, 4, 18–21, 27, 32). Other series of patients managed by shaving are reported by surgeons using the three techniques in various proportions, with the aim of attempting conservative surgery (shaving or disc excision) each time it is feasible (14, 24, 36). In these latter series, it is obvious that patients managed by conservative or radical techniques presented with different diseases, which explains why they received different surgeries. Patients with more severe disease could also be at risk of more frequent complications, which may explain some differences in complication rates. Hence, based on the currently available data published in the literature, it is impossible to state the exact proportion of patients who may or may not be treated by conservative surgery.

Functional Outcomes

Except in four small (32, 54, 57, 69) and one larger study (15) that did not report any functional degradation, most studies on colorectal segmental resection reported unpleasant urinary and digestive symptoms (29, 83–87). Indeed, urinary retention is quite frequent (1.4%–17.5%) after bowel resection. Interestingly, there are lower rates of urinary retention following shaving and disc excision. However, as different results were reported according to series (15, 43), it is unclear whether these higher rates of urinary dysfunction were related to the bowel resection technique itself or to the overall surgical philosophy of using a more radical approach. Whereas poor functional outcomes and morbidity may be associated with low anastomosis according to some authors (29, 35), Seracchioli et al. demonstrated that the laparoscopic shaving technique preserves intestinal neurological activity (32).

Bowel resection should not be undertaken with the expectation that functional bowel symptoms will improve (88).

When compared with colorectal resection, conservative techniques such as shaving or disc excision might result in better postoperative digestive function, as suggested by better KESS and GIQLI scores (35, 89).

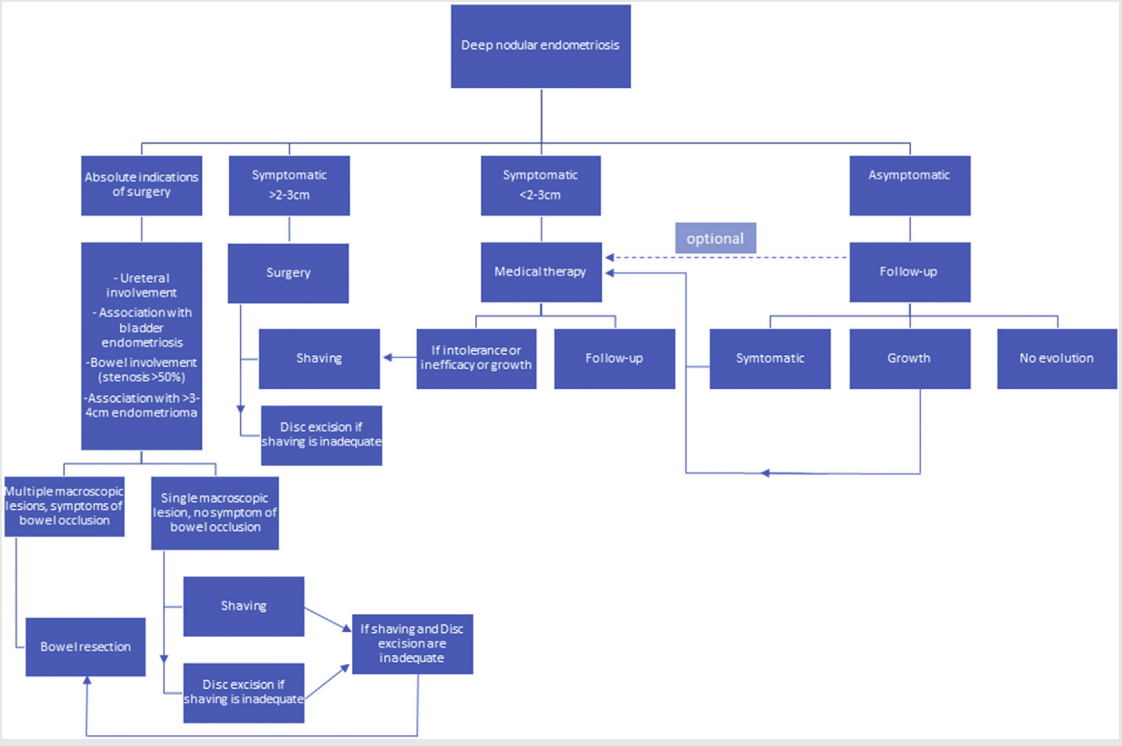
The risk of low anterior resection syndrome in women with low colorectal resection cannot be contested, whatever the disease requiring resection. Based on this evidence, it is logical to attempt a conservative technique in patients with low or mid rectal nodules, as the feasibility of these techniques, either by shaving or by disc excision, has been clearly demonstrated.

Recurrence

In the literature, rates of postoperative pain recurrence appear to be higher after bowel resection and disc excision than after shaving (Table 1), respectively, 17.2%, 11.7%, and 7.9%. It should, however, be stressed that the disease probably presents differently between centers and studies, so these high rates could well be due to a more aggressive form. Postoperative endometriosis related pain may be due to various factors such as postoperative administration of pain relief, which logically lowers the rate of pain. Postoperative dysmenorrhea may be caused by incomplete surgery outside of the uterus or by endometriosis located in the side of the uterine wall (adenomyosis uteri) (45). The rate of recurrent pain after conservative surgery is therefore roughly comparable to that encountered after more aggressive surgery, including bowel resection. In most series reporting data on bowel resection, the recurrence rate of severe pelvic pain has been evaluated at 0–34.8%. However, it is difficult to gauge the proportion of women with pelvic pain due to a genuine recurrence of endometriosis and those with adenomyosis, pelvic hypersensitivity, or postoperative adhesions related to severe complications.

Moreover, residual lesions after bowel resection and disc excision are frequent. Indeed, even with bowel resection, the margins are not free of disease in more than 10% of cases (90, 91) and some authors reported high rates of positive margins, up to 22%, on the bowel specimen (13). In numerous cases, microscopic foci are left behind on the bowel, because macroscopic nodules are frequently surrounded by bowel occult microscopic endometriosis implants as far as 3 cm in 19% of cases (78, 92). Remorgida et al. were the first to observe that microscopic endometriosis foci may persist around the disc removed from the bowel in 43.8% of cases (93). In the same way, Roman et al. observed that 42% of disc specimens presented endometriosis foci on the specimen edges (37). As endometriotic foci may be left behind after rectal shaving, disc excision, and bowel resection, the question is whether these foci can further develop and be responsible for postoperative clinical recurrence. Recent research on baboons suggested that the process that supports invasion of endometrial glands could

FIGURE 1



Algorithm for surgical management of rectovaginal DE.

Donnez. Surgery for deep rectovaginal endometriosis. Fertil Steril 2017.

be dominated by collective cell migration, with the center of the lesion connected to the invasion front. When the center is removed, residual glands were unable to evolve (94, 95).

The defenders of endometriosis management by colorectal resection stress that this procedure is standardized, reproducible, and well-known by all general surgeons worldwide. It provides a bowel specimen for histological examination, and the completeness of the resection can be accurately measured. Conversely, the shaving technique requires specific training in endometriosis surgery and is probably differently performed by various surgeons, which renders the comparison challenging. The completeness of the removal of the endometriosis nodule varies, and it is likely that microscopic implants are left behind on the rectal wall. Disc excision is an intermediate procedure with demonstrated reproducibility and a bowel specimen available for analysis; however, the completeness may sometimes be disputed. All data considered, there is no strong evidence for the exact risk of recurrence of rectovaginal DE following these three techniques.

CONCLUSION

Data in the literature allow for some hypotheses and conclusions. In an overall context of colorectal surgery, there is a general tendency toward more conservative surgical techniques in diseases as various as rectal cancer, Crohn's disease, or rectocolitis. This tendency is based on the evidence that more radical rectal surgery is associated with a higher risk of complications. It is unavoidable that this tendency also concerns rectovaginal DE. According to our review, we propose an algorithm (Fig. 1). Data in the literature show that shaving is feasible even in advanced disease. Furthermore, the risk of immediate complications is probably lower after shaving and disc excision than after colorectal resection, allowing for better functional outcomes. The presumed higher risk of recurrence related to shaving has not been demonstrated. For these reasons, surgeons should consider rectal shaving for the first-line surgical treatment of rectovaginal DE, regardless of nodule size or association with other digestive localizations. In rare cases when the result of rectal shaving is unsatisfactory, disc excision may be performed either exclusively by laparoscopy or by using transanal staplers. Segmental resection may ultimately be reserved for advanced lesions responsible for major stenosis or for several cases of multiple nodules infiltrating the rectosigmoid junction or sigmoid colon.

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