



Segmental and Discoid Resection are Preferential to Bowel Shaving for Medium-Term Symptomatic Relief in Patients With Bowel Endometriosis

This is the peer reviewed version of the following article:

Original:

Afors, K., Centini, G., Fernandes, R., Murtada, R., Zupi, E., Akladios, C., et al. (2016). Segmental and Discoid Resection are Preferential to Bowel Shaving for Medium-Term Symptomatic Relief in Patients With Bowel Endometriosis. JOURNAL OF MINIMALLY INVASIVE GYNECOLOGY, 23(7), 1123-1129 [10.1016/j.jmig.2016.08.813].

Availability:

This version is available <http://hdl.handle.net/11365/1031523> since 2018-02-08T23:35:41Z

Published:

DOI: <http://doi.org/10.1016/j.jmig.2016.08.813>

Terms of use:

Open Access

The terms and conditions for the reuse of this version of the manuscript are specified in the publishing policy. Works made available under a Creative Commons license can be used according to the terms and conditions of said license.

For all terms of use and more information see the publisher's website.

(Article begins on next page)

1 **Segmental and discoid resection are preferential to bowel shaving for medium-**
2 **term symptomatic relief in patients with bowel endometriosis**

3

4 Karolina Afors ^{1*}, Gabriele Centini², Rodrigo Fernandes³, Rouba Murtada⁴, Errico
5 Zupi⁵, Cherif Akladios⁶, Arnaud Wattiez⁷

6

7 ¹ King's College Hospital NHS Trust, Denmark Hill, London SE5 9RS, UK

8 Email: drkafors@gmail.com

9 Tel: 07990 533 432

10 ² University of Siena, department of developmental medicine, 53100, Siena, Italy

11 ³ ICESP - Instituto do Câncer do Estado de São Paulo - FM USP, São Paulo, Brazil

12 Oncology Center - Hospital Alemão Oswaldo Cruz, São Paulo, Brazil

13 ⁴ Département of Obstetrics and Gynaecology, Hopital Jean Verdier, Allee due 14

14 Juillet, 93140 Bondy, France

15 ⁵ Obstetrics and Gynecology, Department of Biomedicine and Prevention, University

16 of Tor Vergata, Rome Italy

17 ⁶ CHRU de Strasbourg, Pôle de Gynécologie-Obstétrique, Hôpital de Hautepierre,

18 Strasbourg, France

19 ⁷ Hopitaux Universitaires, 1 Place de l'Hopital, 67091 Strasbourg, France

20

21

22 * **Corresponding authors:**

23

24 **We, the authors declare no conflicts of interest.**

25 **Précis**

26

27 A retrospective cohort study comparing medium-term clinical outcomes of patients

28 undergoing laparoscopic shaving, discoid or segmental resection.

29

30

31

ACCEPTED MANUSCRIPT

32 **Abstract**

33 **Objective:**

34 To evaluate and compare medium-term clinical outcomes and recurrence rates in
35 the laparoscopic surgical management of bowel endometriosis comparing 3 different
36 surgical techniques (shaving, discoid and segmental resection)

37 **Design:** Retrospective Study

38 **Design Classification:** Canadian Task force II-2

39 **Setting:** Endometriosis tertiary referral Centre

40 **Patients:** A retrospective cohort of 106 patients with histological confirmation of
41 bowel endometriosis undergoing laparoscopic surgical treatment between 1st
42 January 2010 and 1st September 2012

43 **Intervention:** Assessment of laparoscopic bowel shaving, discoid or segmental
44 resection in the treatment of painful symptoms related to deep endometriosis (DE)
45 affecting the bowel with a 24 month follow up.

46 **Measurements and Main results:**

47 92 patients were included in the study and were divided into 3 groups according to
48 the surgical procedure performed (47 shaving, 15 discoid resection and 30 segmental
49 resections). All symptoms significantly improved in the immediate post operative
50 follow up, with significant reduction in all visual analogue pains scores. There was a
51 significantly higher rate of medium-term symptom recurrence in the shaving group
52 in term of dysmenorrhea and dyspareunia, in contrast to the discoid and segmental
53 resection group. Furthermore, there was a higher rate of re-intervention for
54 recurrent Deep Endometriosis (DE) lesions in the shaving group compared to those
55 who underwent segmental resection (27.6 % vs 6.6 %; RR 4.14; 95% CI 1.0 to 17.1).
56 Post-operative complication rates were similar across all 3 groups with a major
57 complications rate of 4.2%, 6.6% and 6.6% in the shaving, discoid and segmental
58 resection groups respectively.

59 Our data demonstrated that in those patients with a nodule >3 cm they had a
60 relative risk of 2.5 (95% CI 1.66 to 3.99) of requiring a bowel resection.

61 **Conclusion:**

62 The 3 treatment modalities are effective in terms of immediate symptom relief with
63 acceptable complication rates. However, significantly higher rates of symptom
64 recurrence and re-intervention were noted in the shaving group, while segmental
65 resection is more likely to be indicated in cases of large nodules.

66

67

68

69

70

71

72

73

74

75

76

77

78

79

80

81

82

83

84

85

86

87

88

89

90

91

92

93

94 **Introduction**

95

96 Rectovaginal endometriosis represents a more complex form of the disease,
97 affecting 3-37% of patients presenting with endometriosis(1, 2). The rectum and
98 sigmoid colon are most commonly involved and are responsible for up to 90% of all
99 intestinal lesions(2). Disease symptomatology can range from mild to severe and
100 include dysmenorrhoea, pelvic pain, infertility, dyspareunia, dyschezia, cyclical rectal
101 bleeding, and constipation(3). A triad of dysmenorrhea, dyspareunia and dyschezia
102 has been reported as 80% sensitive for the diagnosis of bowel endometriosis(4).
103 Severe symptoms can be debilitating for women, impacting significantly on their
104 quality of life and affecting both their personal relationships and work
105 environment(5).

106

107 Different types of surgery have been proposed for the management of bowel
108 endometriosis, although the preferred approach in terms of long term symptom
109 relief and risk of recurrence is far from resolved(6). A more conservative approach
110 with “shaving” of endometriosis from the bowel wall has been extensively reported
111 avoiding opening the bowel itself and risks associated with this(7, 8). Equally, many
112 surgeons have adopted a more radical approach, favoring segmental resection
113 where complete removal of disease is argued to provide better outcomes(9-12).
114 Regardless of opinion, no specific guidance exists on when to adopt one technique
115 over the other and it is unlikely to be addressed in the immediate future due to the
116 relatively small number of cases in individual series and lack of uniformity in surgical
117 reporting (13, 14).

118

119 Few long-term studies comparing complications, outcomes and recurrence rates for
120 all 3 surgical techniques (shaving, discoid and segmental resection) exist, with little
121 data relating outcome to size and depth of invasion. Our aim was to evaluate the
122 medium-term outcomes of three different surgical techniques (shaving, discoid and
123 segmental resection) in treating painful symptoms related to deep endometriosis
124 (DE) and analyzing recurrence rates specific to each surgical procedure.

125 Endometriotic nodule size was also recorded to establish whether this serves as a
126 predictive factor in determining risk of bowel resection.

127

128 **Materials and Methods**

129

130 This is a retrospective study evaluating the medium-term efficacy of three different
131 techniques (shaving, discoid and segmental resection) in treating painful symptoms
132 related to DE with follow up at 3 and 24 months.

133

134 We conducted a retrospective cohort study of all patients referred with painful
135 symptoms, identified to have had laparoscopic surgical treatment of bowel
136 endometriosis in the Department of Gynaecology, at Strasbourg University Hospital
137 between January 2010 and September 2012. Further inclusion criteria were: DE
138 bowel lesion confirmed intra-operatively requiring surgical intervention (shaving,
139 discoid resection or segmental resection), histological confirmation of DE, at least
140 one painful symptom lasting 6 months or more and surgery performed
141 laparoscopically.

142

143 Patients with history of pelvic inflammatory disease or other causes of chronic pelvic
144 pain such as fibromatosis, adenomyosis or hydrosalpinx incidentally found during
145 preoperative assessment or at laparoscopy were excluded. Adenomyosis was
146 defined as the presence of 2 of the following MRI/ultrasound features or by
147 information retrieved from the operation description: a globally enlarged uterus;
148 asymmetrically enlarged uterus; round cystic area within the myometrium;
149 thickening of the junctional zone.

150 Patients under medical therapy at the time of medium-term follow up or that had
151 used medical therapy for more than 6 months were also excluded.

152

153 The STROBE statement recommendations were used to assess the quality of the
154 study and to report data findings and institutional review board (IRB) approval was
155 obtained.

156

157 Perioperative patient characteristics were recorded including age, BMI, parity,
158 previous surgery, details of surgical procedure performed, size of retrieved
159 specimens, preoperative symptoms, intra- and postoperative complications. In
160 addition three different painful symptoms related to DE (dysmenorrhoea, dyschezia,
161 dyspareunia) were assessed through a Visual Analogue Scale (VAS) from 0 to 10.

162

163 Prior to surgery all patients underwent bimanual examination, transvaginal
164 ultrasonography and MRI to evaluate the relationship between DE lesions and the
165 bowel. Bowel functioning was also investigated and any sign of obstruction recorded
166 including diarrhoea, constipation, cyclical rectal bleeding or relevant radiological
167 findings documented.

168

169 All patients were informed and counselled regarding the risk of bowel resection and
170 the final decision taken at time of surgery according to the depth of bowel
171 involvement, characteristics, localization of the lesions and risk of complications.
172 According to our practice ultra low lesions, less than 5 cm from the anal margin,
173 were considered a contraindication to bowel resection and shaving of the nodule
174 avoiding bowel opening was performed.

175

176 Three months after surgery all patients underwent a postoperative follow up
177 consultation at which time a questionnaire on gynaecological and digestive disorders
178 was completed. Short-term follow up information was collected and recorded on the
179 outpatient database. Post operatively all patients were prescribed oral
180 contraceptives and referred to their local gynaecologist for subsequent follow up.
181 Oral contraceptives were continued depending on patient's preference and whether
182 they wished to conceive. From August 2014 women were followed up by telephone
183 consultation and interviewed regarding intensity of painful symptoms, disease
184 recurrence, bowel functioning, and operative re-intervention.

185

186 To assess the efficacy and medium-term recurrence of these three techniques,
187 patients were divided into three groups according to surgical procedure (shaving,

188 discoid and segmental resection) and preoperative VAS score were compared with
189 post-operative scores at 3 and 24 months follow up.

190 In order to determine whether nodule size is a predictive factor in determining risk
191 of bowel resection, dimension of histological specimen were compared between the
192 groups. For those cases where the nodule was not removed en bloc the
193 comprehensive dimension was calculated from the summation of each fragment.

194

195 Perioperative complications were classified according to the Dindo Clavien
196 classification into minor (grade 1-2) and major (grade 3-4) and compared between
197 the groups(15). Risk of surgical re-intervention was also compared between the
198 groups.

199

200 All surgical procedures were performed by a single surgeon (AW), experienced in
201 minimally invasive treatment of endometriosis. In all cases careful evaluation of the
202 entire abdominal cavity was performed and all visible endometriotic implants were
203 removed and adhesions divided. A systematic approach was adopted, commencing
204 by releasing the physiological attachments of the sigmoid colon to the abdominal
205 wall and suspending the ovaries to the anterior abdominal wall for exposure
206 purposes. Both ureters were identified and ureterolysis performed if deemed
207 necessary. In some instances ureteric resection and re-anastomosis was performed
208 in cases of intrinsic ureteric disease or substantial extrinsic compression. In all cases
209 a tubal patency dye test was performed at the end of the procedure.

210

211 The pararectal fossae were developed bilaterally followed by dissection of the
212 rectovaginal septum. Surgical techniques used included dissection, coagulation and
213 excision using bipolar forceps and scissors or a monopolar hook. Bowel lesions were
214 systematically re-evaluated using both rectovaginal examination and bowel probe
215 placement. Bowel lesions were carefully evaluated intra-operatively and either a
216 shaving, discoid or segmental resection performed depending on extent of
217 infiltration, nodule size, and presence of stenotic or multifocal lesions.

218 Segmental resection was mainly indicated in cases of large nodules with
219 multifocal disease involvement, or in instances of extensive infiltration of the

220 muscularis, where the lesion was found to be greater than 5 cm from the anal
221 margin. Shaving was preferentially chosen in cases of superficial involvement of
222 the bowel where there were no clinical or radiological signs of stenosis. Discoid
223 resection was selected in cases where following initial shaving there was
224 extensive damage to the muscularis, which was considered to deep and/or wide
225 to maintain bowel integrity. In addition, the nodule was isolated to a single site
226 occupying the ventral surface of the bowel.

227

228 *Shaving:*

229 Shaving consisted of careful dissection of the endometriotic nodule peeling it off the
230 bowel wall without breaching the bowel lumen. Areas of exposed mucosa were then
231 sutured for reinforcement purposes.

232

233 *Discoid*

234 Discoid excision consisted of removing the disease with full thickness anterior
235 resection of the wall using a trans anal circular stapler (31/33mm diameter single use
236 circular stapler by Medtronic). Discoid resection was performed in cases where
237 following initial debulking of the nodule using the shaving technique, the extent of
238 damage to the muscularis was considered too great and the nodule was confined to
239 the ventral surface of the bowel. Equally, the nodule was within 15 cm of the anal
240 verge, approximately 2-3 cm in size with no significant stenosis of the lumen making
241 it accessible for the stapling device.

242

243 *Segmental resection*

244 Segmental resection was indicated in cases of large, multifocal nodules, or in
245 instances where extensive infiltration of the muscularis and resultant inflammation
246 created a narrowing of the bowel wall. Segmental resection was avoided in lesions
247 lower than 5cm from the anal margin. Patients reporting symptoms of significant
248 dyschezia was considered a discriminating symptom in favour of segmental resection
249 In cases of segmental resection the bowel was dissected at the edge of the
250 mesentery respecting all the vascular branches and the diseased bowel segment
251 dissected. A linear stapling device was used to divide the bowel caudally to the

252 lesion. The specimen was retrieved transabdominally, transvaginally or transanally.
253 Re-anastomosis was completed using a transanal circular stapler of diameter
254 congruent to the bowel size. In cases of sigmoid re-anastomosis a 28 mm diameter
255 single use stapler by Medtronic was used, while a larger diameter (31/33mm) was
256 chosen in cases of rectal involvement.

257

258

259 **Statistical Analysis**

260

261 The data was analysed using a computed based software Prism version 6.00,
262 GraphPad Software, La Jolla California USA. The continuous data were assessed for
263 distribution with D'Agostino - Pirson normality test. The parametric and non-
264 parametric data was analysed using t-test and the Mann-Witney test. The categorical
265 data was analysed with the Fisher exact test through a contingency table.
266 Statistically significant differences were defined as those with a P-value <0.05.

267

268

269

270

271

272 Results

273 106 patients were included in the study amongst which 4.7% (n= 5), consisting of
274 overseas patients were lost at initial 3 months follow up. A further 8.4 % (n= 9) were
275 unreachable for medium-term follow up telephone questionnaire. Finally 92 women
276 were included in this study: 47 shaving, 15 discoid and 30 segmental resections. The
277 characteristics of the patients were comparable in terms of age, BMI, parity,
278 previous surgery and usage of medical therapy (table 1). Our data demonstrated
279 short-term improvements in symptom relief for each surgical intervention with a
280 significant reduction in all visual analogue pain scores (dysmenorrhoea, dyschezia,
281 dyspareunia) 3 months after surgery (Figure 1).

282

283 Concerning medium-term follow up, however, the shaving group was less effective
284 in terms of symptom relief for dysmenorrhoea and dyspareunia as was the discoid
285 resection group for dyspareunia. In fact in the shaving group the VAS scores of these
286 two symptoms increased significantly between the 3 month and 2-year follow up
287 while in the other groups this increase was not statistically significant (Figure 1A and
288 1B). Despite these slight increases, the difference between preoperative and
289 medium-term follow up score remained significant for symptoms of both
290 dysmenorrhoea and dyspareunia in the shaving and segmental group. In the discoid
291 resection group, however, there was no significant improvement in symptoms of
292 dyspareunia after 2 year follow up (Figure 1A and 1B).

293

294 Medium-term improvements in dyschezia ratings were similar across all three
295 groups, with the VAS scores significantly lower at 2-year follow up, with a slight
296 increase in pain score levels demonstrated between immediate and medium-term
297 follow up (Figure 1C).

298

299 The dimension of DE nodules was compared between the groups and the data
300 demonstrated significantly smaller sized nodules amongst the shaving group when
301 compared with the others ($p < 0,0001$). Difference in nodule size between the discoid
302 and segmental resection groups were not significant (Figure 2). To determine the

303 nodule size threshold predictive for bowel resection we further divided the group in
304 two; those who were underwent shaving procedure and those who underwent
305 bowel resection either discoid or segmental resection. A ROC curve was generated,
306 providing sensitivity of 64.4%, specificity of 92.8 % and a likelihoods ratio of 9.0
307 when a threshold value of 3 cm was used. Data showed that patients with nodules \geq
308 3 cm had a Relative Risk of 2.5 (95% CI 1.66 to 3.99) of receiving a bowel resection
309 when compared to those patients with smaller nodules.

310

311 The data regarding re-intervention rates showed that 18.4 % (17/92) of patients
312 underwent further surgery because of recurrent DE lesions. There was a higher rate
313 of re-intervention for recurrent DE lesions in the shaving group as compared to those
314 patients who underwent segmental resection (27.6 % vs 6.6 %; RR 4.14; 95% CI 1.0
315 to 17.1). The re-intervention rate in the discoid group was 13.3 % (2/15) which when
316 compared with the other 2 groups was not statistically significant (Figure 3).

317

318 Concerning intraoperative complications the bowel was inadvertently opened 3
319 times in the shaving group, and once in the discoid resection, whilst this did not
320 occur in the segmental resection group. Postoperative complication rates were
321 similar with no significant differences between the three groups, and an overall rate
322 of 21.2%, 13.3% and 20% for the shaving, segmental and discoid resection groups
323 respectively. Dividing the complications according to the Dindo-Clavien
324 classification in the discoid group gave rise to 1 major and 2 minor complications.
325 The major complication was caused by an infected hematoma followed by a second
326 look laparoscopy which was successfully managed conservatively, the minor
327 complications consisted of 2 cases of urinary retention which resolved
328 spontaneously within 15 days. In the segmental resection group there were 4
329 complications; 2 minor involving bladder functioning and 2 major (1 rectovaginal
330 fistula and 1 anastomotic leakage requiring an ileostomy). In the shaving group 10
331 complications occurred 8 minor complications including 3 urinary tract infections
332 and 1 voiding problem. 2 major complications occurred requiring a second look
333 laparoscopy within 4 days (1 bowel perforation and 1 urinoma).

334

335

336 **Discussion**

337

338 Several different approaches exist for the laparoscopic management of bowel
339 endometriosis including shaving, discoid and segmental resection(16, 17). A clear
340 consensus of which specific surgical procedure to adopt over another remains
341 unanswered and there are few medium-term studies comparing safety, efficacy and
342 recurrence rates, regarding these different approaches(13).

343

344 Several studies have demonstrated the efficacy of laparoscopic surgical excision of
345 deep infiltrating endometriosis in symptomatic patients(18, 19). Whilst laparoscopy
346 is considered to be the gold standard for the treatment of mild deep infiltrating
347 endometriosis it can be similarly applied for the management of severe bowel
348 endometriosis. All cases included in this study were performed laparoscopically and
349 our data demonstrated significant improvements in immediate symptom relief with
350 respect to all 3 surgical treatment modalities (shaving, discoid and segmental
351 resection). Our results, however, demonstrated a significantly higher rate of
352 medium-term symptom recurrence in the shaving group, in addition, to a higher rate
353 of re-intervention in this cohort of patients. Conversely, there was no significant
354 increase in medium-term symptom recurrence for those patients who underwent
355 discoid or segmental resection. The higher rate of symptomatic recurrence in the
356 shaving group can be explained by residual disease being left behind with resultant
357 incomplete excision, which over time may progress. Remorgida et al demonstrated
358 that histological examination of surgical specimens where resection was preceded by
359 nodulectomy found residual endometriosis infiltrating the muscle layer in 43.8% of
360 cases(20). These findings support discoid or segmental resection as a more complete
361 form of treatment by excising any remnants of diseased tissue. Whilst these
362 techniques attempt to excise all macroscopic appearance of endometriotic nodules it
363 is not a guarantee of disease-free margins and histological evidence of positive
364 margins following segmental resection have been reported in up to 22% of cases(21,
365 22).

366

367 In this study symptom relapse was used to evaluate recurrence. Whilst recurrence
368 rates in both the discoid and segmental resection were comparable to those
369 published in the literature, the rate of recurrence was higher in the shaving group.
370 Whilst there exists several limitations in our study, such as limiting postoperative
371 treatment to 6 months, this was done in an attempt to maintain a homogenous
372 group. Equally, some patients declined to be on long-term medical treatment for their
373 own personal preferences, a decision, which must be respected. Lastly, in our cohort
374 of patients most cases consisted of severe stage IV disease, in patients who had
375 already undergone surgery, where the smallest nodule size was 1.5 cm. Deep
376 endometriosis can be highly variable and severity of the disease encountered may
377 equally influence recurrence, making the risk of recurrence higher.

378

379 Donnez et al have published extensively on clinical outcomes following largely the
380 shaving technique and have reported both low complications and recurrence
381 rates(7, 23). Despite these promising results, complications were not clearly defined
382 nor were recurrence rates clearly elucidated and severe pelvic pain recurrence was
383 high (20%) amongst patients not wishing to conceive(7). In contrast to Donnez et al
384 there are several studies reporting favorable outcomes of bowel resection for the
385 management of deep infiltrating bowel endometriosis(7). Other groups have also
386 reported largely promising results on cohorts of mixed patients undergoing different
387 surgical treatments. Similarly low complication rates in keeping with our results have
388 been reported following segmental resection, with equally low recurrence rates
389 when compared to the mixed study group (5.8% versus 17.8%)(21, 23).

390

391 When discussing different treatment options for bowel endometriosis one must
392 ensure that patient selection is similar and comparable. Donnez et al included
393 largely type 2 lesions, often less fixed and not always extending to the rectal wall(7,
394 24). Equally multifocal disease was not addressed nor does it appear were higher
395 lesions involving the rectosigmoid based on the classification used in the study(7).
396 Whilst there is no disputing the efficacy of the shaving technique, one treatment is
397 not adequate for all. Segmental resection is perhaps best reserved for lesions

398 fulfilling 1 or more of the following parameters; > 3 cm, multifocal disease
399 involvement, rectosigmoid disease involvement and/or stenotic lesions.

400

401 This is further supported by our data where the dimension of DE nodules in the
402 shaving group were significantly smaller in size. Furthermore, patients with nodules
403 ≥ 3 cm had a Relative Risk of 2.5 (95% CI 1.66 to 3.99) of receiving a bowel resection,
404 suggesting that nodules size serves as a predictive factor in determining the need for
405 a segmental or discoid resection. The mean nodule size described by Donnez et al
406 was 3 cm where in all cases manual closure of the defect was performed(7). Whilst
407 this technique may be of benefit to those patients with smaller nodules, one must
408 question the safety of this technique particularly for closure of large defects where
409 nodules are > 3 cm or there are several adjacent multifocal lesions present. The
410 decision to perform a bowel resection is not solely dictated by the presence of
411 disease within the mucosal layer but is based on careful evaluation of the lesion.
412 Often the mucosal layer is spared but involvement of the muscle layer can cause
413 puckering and retraction resulting in stenosis(25). Lastly, following excision of large
414 bowel nodules, if the integrity of the bowel wall is questionable and not restorable
415 with primary bowel suture repair then a resection may be indicated to minimize
416 postoperative bowel complications.

417

418 Historically arguments against segmental resection have always maintained that it is
419 an unnecessary, overly aggressive and potentially morbid treatment for an otherwise
420 benign disease. Traditionally radical excision of all remnants of disease was
421 advocated, mimicking a surgical approach similar to that used for treatment of
422 colorectal cancer and overall complications rates were higher (26). As techniques
423 and expertise have developed, however, the surgical approach has become more
424 refined with an emphasis on preservation of organ function. Economical bowel
425 resection allows preservation of vasculature and nerve supply whilst avoiding
426 transmesenteric (TME) approach (27, 28). Implementing this approach complication
427 rates between shaving and segmental resection remain comparable, with
428 complication rates ranging from 3-10.5% (10, 11, 29, 30) a finding similarly reflected
429 in our study. There was no significant difference in complication rates irrespective of

430 whether shaving, discoid or segmental resection was performed and our overall
431 complication rate (including both minor and major complications) was 13% in the
432 segmental resection group. Of the major complications that were encountered there
433 was one rectovaginal fistula and one anastomotic leak necessitating the need for an
434 ileostomy occurring in a patient with a low resection at 6 cm from the anal margin.

435

436 In our practice we do not advocate the use of routine defunctioning ileostomy in
437 patients undergoing segmental resections. Whilst anastomotic leaks following
438 colorectal resections are associated with a significant increase in morbidity and
439 mortality its incidence in otherwise young healthy patients with endometriosis is
440 rare. Adopting a good surgical technique by avoiding high ligation of the mesenteric
441 artery and preserving vascular supply is associated with a 3 fold lower incidence of
442 anastomotic leak(31). Provided the anastomosis is > 5 cm from the anal verge, there
443 are no adverse intraoperative complications and patients are carefully monitored
444 post-operatively in an otherwise fit and healthy woman then a protective ileostomy
445 and morbidity associated with stoma formation can be avoided(32).

446

447 Regarding long-term functional outcomes significant fecal incontinence and urgency
448 has been reported in cases series of patients treated with colorectal resection(33).
449 We encountered no incidence of fecal incontinence or urgency in our series of
450 patients. Some patients in both the shaving and segmental resection group did
451 encounter voiding difficulties, although this was typically transient, with all resolving
452 after 6 months. These differences may be down to surgical technique where
453 attempts to excise disease whilst meticulously respecting organ function and nerve
454 preservation was implemented as much as possible.

455

456 **Conclusion:**

457

458 Surgical management of bowel endometriosis should be performed in specialized
459 centers by experienced surgeons in order to maintain low complication rates. Care
460 should be individualized according to disease severity whilst also respecting and
461 safeguarding patient's requests and wishes. Based on our data, in cases where

462 lesions > 3 cm are suspected patients should be appropriately counseled and
463 informed of the higher risk of segmental or discoid excision. Although nodule size is
464 one of the few parameters, which can be evaluated pre-operatively, additional
465 factors such as depth of invasion, localization and potential risk of complications
466 should equally not be overlooked prior to making a final decision regarding
467 preferential mode/type of bowel treatment. This study will enable us to provide
468 more accurate counseling regarding medium-term symptom relief.

469
470
471
472
473
474
475
476
477
478
479
480
481
482
483
484
485
486
487
488
489
490
491
492
493
494
495
496
497
498
499
500
501
502
503
504
505
506
507

508 **References**

509

510

511 1. Revised American Society for Reproductive Medicine classification of
512 endometriosis: 1996. *Fertil Steril.* 1997;67(5):817-21.

513 2. Campagnacci R, Perretta S, Guerrieri M, Paganini AM, De Sanctis A,
514 Ciavattini A, et al. Laparoscopic colorectal resection for endometriosis. *Surg*
515 *Endosc.* 2005;19(5):662-4.

516 3. Fauconnier A, Chapron C, Dubuisson JB, Vieira M, Dousset B, Bréart G.
517 Relation between pain symptoms and the anatomic location of deep infiltrating
518 endometriosis. *Fertil Steril.* 2002;78(4):719-26.

519 4. Leng JH, Lang JH, Dai Y, Li HJ, Li XY. [Relationship between pain symptoms
520 and clinico-pathological features of pelvic endometriosis]. *Zhonghua Fu Chan Ke*
521 *Za Zhi.* 2007;42(3):165-8.

522 5. Nnoaham KE, Hummelshoj L, Webster P, d'Hooghe T, de Cicco Nardone F,
523 de Cicco Nardone C, et al. Impact of endometriosis on quality of life and work
524 productivity: a multicenter study across ten countries. *Fertil Steril.*
525 2011;96(2):366-73.e8.

526 6. Kruse C, Seyer-Hansen M, Forman A. Diagnosis and treatment of
527 rectovaginal endometriosis: an overview. *Acta Obstet Gynecol Scand.*
528 2012;91(6):648-57.

529 7. Donnez J, Squifflet J. Complications, pregnancy and recurrence in a
530 prospective series of 500 patients operated on by the shaving technique for deep
531 rectovaginal endometriotic nodules. *Hum Reprod.* 2010;25(8):1949-58.

532 8. Roman H, Vassilieff M, Gourcerol G, Savoye G, Leroi AM, Marpeau L, et al.
533 Surgical management of deep infiltrating endometriosis of the rectum: pleading
534 for a symptom-guided approach. *Hum Reprod.* 2011;26(2):274-81.

535 9. Ruffo G, Sartori A, Crippa S, Partelli S, Barugola G, Manzoni A, et al.
536 Laparoscopic rectal resection for severe endometriosis of the mid and low
537 rectum: technique and operative results. *Surg Endosc.* 2012;26(4):1035-40.

538 10. Ruffo G, Scopelliti F, Manzoni A, Sartori A, Rossini R, Ceccaroni M, et al.
539 Long-term outcome after laparoscopic bowel resections for deep infiltrating
540 endometriosis: a single-center experience after 900 cases. *Biomed Res Int.*
541 2014;2014:463058.

542 11. Malzoni M, Di Giovanni A, Exacoustos C, Lannino G, Capece R, Perone C, et
543 al. Feasibility and Safety of Laparoscopic-Assisted Bowel Segmental Resection for
544 Deep Infiltrating Endometriosis: A Retrospective Cohort Study With Description
545 of Technique. *J Minim Invasive Gynecol.* 2016;23(4):512-25.

546 12. Keckstein J, Wiesinger H. Deep endometriosis, including intestinal
547 involvement--the interdisciplinary approach. *Minim Invasive Ther Allied*
548 *Technol.* 2005;14(3):160-6.

549 13. De Cicco C, Corona R, Schonman R, Mailova K, Ussia A, Koninckx P. Bowel
550 resection for deep endometriosis: a systematic review. *BJOG.* 2011;118(3):285-
551 91.

552 14. Zupi E, Lazzeri L, Centini G. Deep endometriosis: less is better. *Journal of*
553 *Endometriosis and Pelvic Pain Disorders.* 2015;7(1):1-2.

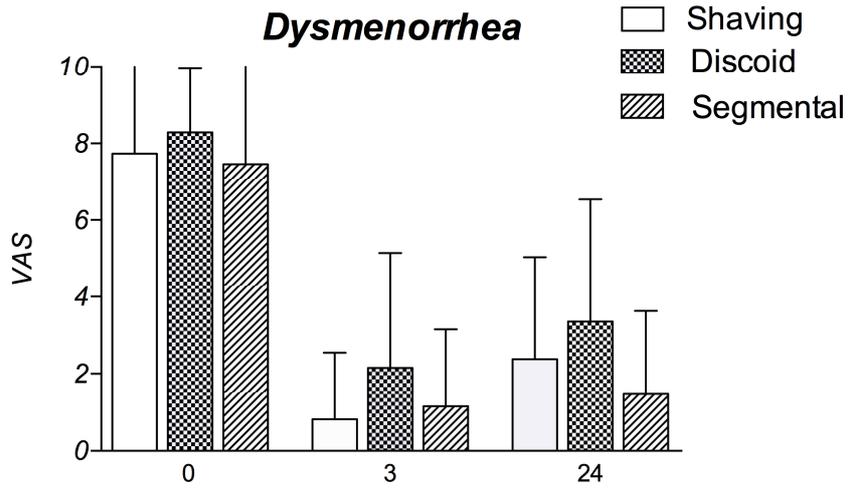
554 15. Dindo D, Demartines N, Clavien PA. Classification of surgical
555 complications: a new proposal with evaluation in a cohort of 6336 patients and
556 results of a survey. *Ann Surg.* 2004;240(2):205-13.

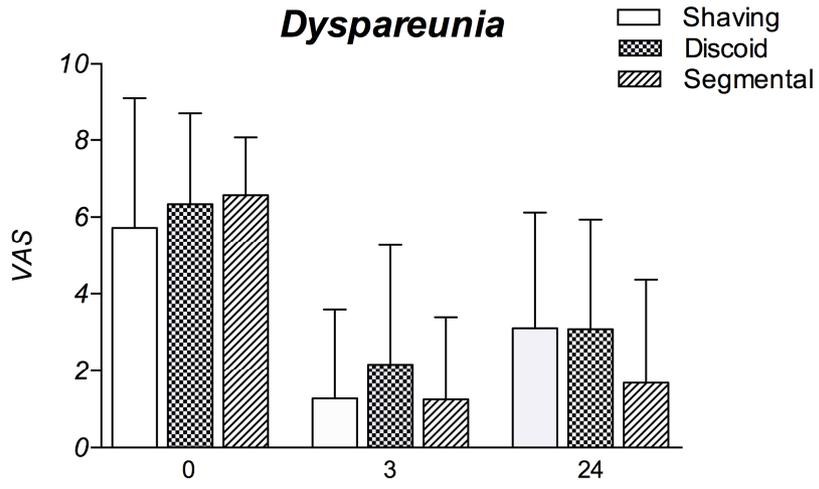
- 557 16. Alabiso G, Alio L, Arena S, di Prun AB, Bergamini V, Berlanda N, et al. How
558 to Manage Bowel Endometriosis: The ETIC Approach. *J Minim Invasive Gynecol.*
559 2015;22(4):517-29.
- 560 17. Abrão MS, Petraglia F, Falcone T, Keckstein J, Osuga Y, Chapron C. Deep
561 endometriosis infiltrating the recto-sigmoid: critical factors to consider before
562 management. *Hum Reprod Update.* 2015;21(3):329-39.
- 563 18. Daraï E, Dubernard G, Coutant C, Frey C, Rouzier R, Ballester M.
564 Randomized trial of laparoscopically assisted versus open colorectal resection
565 for endometriosis: morbidity, symptoms, quality of life, and fertility. *Ann Surg.*
566 2010;251(6):1018-23.
- 567 19. Centini G, Afors K, Murtada R, Argay IM, Lazzeri L, Akladios CY, et al.
568 Impact of Laparoscopic Surgical Management of Deep Endometriosis on
569 Pregnancy Rate. *J Minim Invasive Gynecol.* 2016;23(1):113-9.
- 570 20. Remorgida V, Ragni N, Ferrero S, Anserini P, Torelli P, Fulcheri E. How
571 complete is full thickness disc resection of bowel endometriotic lesions? A
572 prospective surgical and histological study. *Hum Reprod.* 2005;20(8):2317-20.
- 573 21. Meuleman C, Tomassetti C, D'Hoore A, Van Cleynenbreugel B, Penninckx
574 F, Vergote I, et al. Surgical treatment of deeply infiltrating endometriosis with
575 colorectal involvement. *Hum Reprod Update.* 2011;17(3):311-26.
- 576 22. Meuleman C, Tomassetti C, D'Hoore A, Buyens A, Van Cleynenbreugel B,
577 Fieuws S, et al. Clinical outcome after CO₂ laser laparoscopic radical excision of
578 endometriosis with colorectal wall invasion combined with laparoscopic
579 segmental bowel resection and reanastomosis. *Hum Reprod.* 2011;26(9):2336-
580 43.
- 581 23. Donnez J, Nisolle M, Casanas-Roux F, Bassil S, Anaf V. Rectovaginal
582 septum, endometriosis or adenomyosis: laparoscopic management in a series of
583 231 patients. *Hum Reprod.* 1995;10(3):630-5.
- 584 24. Squifflet J, Feger C, Donnez J. Diagnosis and imaging of adenomyotic
585 disease of the retroperitoneal space. *Gynecol Obstet Invest.* 2002;54 Suppl 1:43-
586 51.
- 587 25. Kavallaris A, Köhler C, Kühne-Heid R, Schneider A. Histopathological
588 extent of rectal invasion by rectovaginal endometriosis. *Hum Reprod.*
589 2003;18(6):1323-7.
- 590 26. Mohr C, Nezhat FR, Nezhat CH, Seidman DS, Nezhat CR. Fertility
591 considerations in laparoscopic treatment of infiltrative bowel endometriosis.
592 *JSL.* 2005;9(1):16-24.
- 593 27. Redwine DB, Koning M, Sharpe DR. Laparoscopically assisted transvaginal
594 segmental resection of the rectosigmoid colon for endometriosis. *Fertil Steril.*
595 1996;65(1):193-7.
- 596 28. Fegiz G, Tonelli F, Rossi P, Di Paola M, De Masi E, Simonetti G.
597 Preservation of the superior hemorrhoidal artery in resection of the colon and
598 rectum. *Surg Gynecol Obstet.* 1976;143(6):919-25.
- 599 29. Kondo W, Bourdel N, Tamburro S, Cavoli D, Jardon K, Rabischong B, et al.
600 Complications after surgery for deeply infiltrating pelvic endometriosis. *BJOG.*
601 2011;118(3):292-8.
- 602 30. Koninckx PR, Timmermans B, Meuleman C, Penninckx F. Complications of
603 CO₂-laser endoscopic excision of deep endometriosis. *Hum Reprod.*
604 1996;11(10):2263-8.

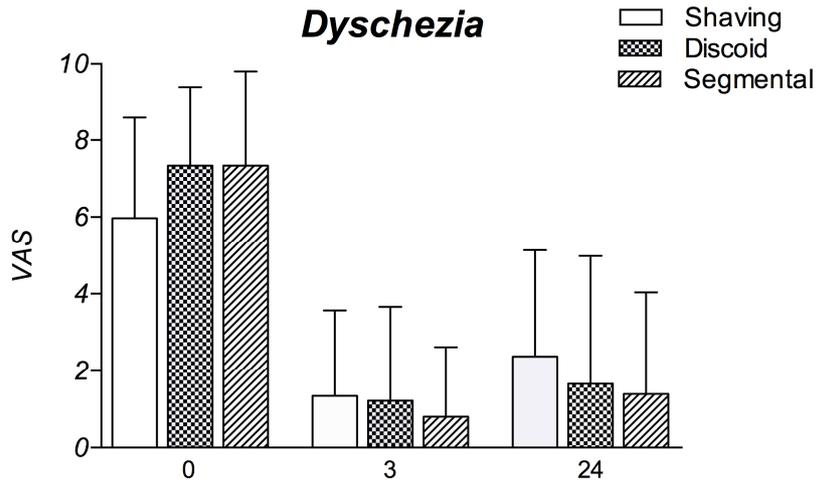
- 605 31. Trencheva K, Morrissey KP, Wells M, Mancuso CA, Lee SW, Sonoda T, et al.
606 Identifying important predictors for anastomotic leak after colon and rectal
607 resection: prospective study on 616 patients. *Ann Surg.* 2013;257(1):108-13.
- 608 32. Akladios C, Messori P, Faller E, Puga M, Afors K, Leroy J, et al. Is ileostomy
609 always necessary following rectal resection for deep infiltrating endometriosis? *J*
610 *Minim Invasive Gynecol.* 2015;22(1):103-9.
- 611 33. Roman H, Bridoux V, Tuech JJ, Marpeau L, da Costa C, Savoye G, et al.
612 Bowel dysfunction before and after surgery for endometriosis. *Am J Obstet*
613 *Gynecol.* 2013;209(6):524-30.
614
615

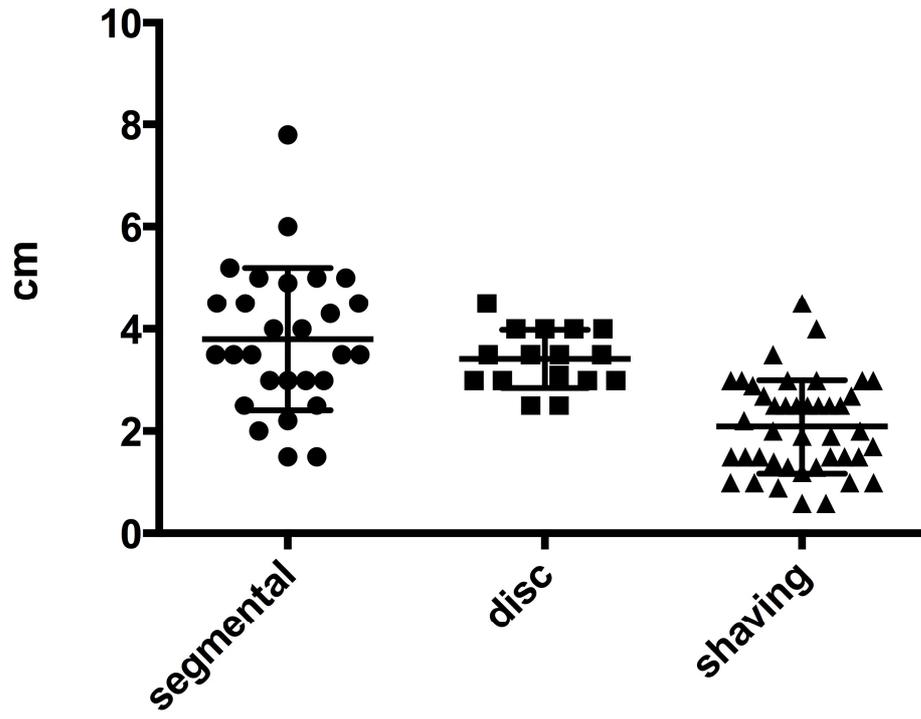
Table 1: Patients characteristics and details of the procedures of the three groups.

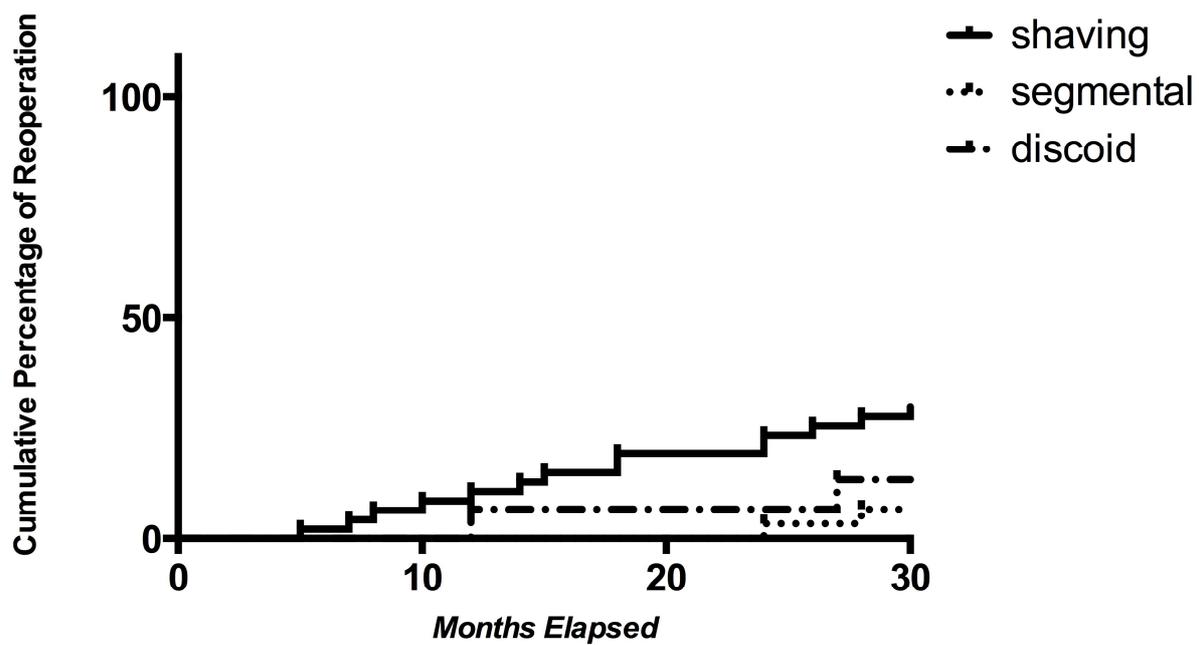
	Shaving (n=47)	Discoid (n=15)	Segmental (n=30)
Age (yrs)(mean; SD)	32 ± 5.4	29,47 ± 5.7	31,12 ± 4.5
BMI (kg/m²)(mean; SD)	26.4 ± 3.4	24.1 ± 5.2	27.3 ± 4.2
Nulliparous (n; %)	39 (82.9)	12 (80)	6 (79.9)
Infertility (n; %)	15 (31.9)	8 (53.3)	14 (46.6)
Complete Removal of the disease (n; %)	45 (95.7)	15 (100)	29(96.6)
Previous Surgery (n; %)	6 (12.7)	0 (0)	3 (10)
Previous Surgery for Endometriosis (n; %)	17 (36.1)	7 (46.6)	12 (43.3)
Duration of Surgery (min) (mean; SD)*	130,0 ± 31	132,4 ± 74	184,2 ± 59
Preoperative Double J (n, %)	3 (6.3)	0 (0)	4 (13.3)
Additional Procedure (n; %)	9 (19.1)	5 (33.3)	11 (36.6)
Associated Endometrioma (n; %)	18 (38.2)	7 (46.6)	9(29.9)
Vaginal Opening (n, %)	16 (34.4)	10 (66.6)	18 (59.9)
Ileostomy/Colostomy (n; %)	0 (0)	0 (0)	1 (3.3)
Drainage (n;%)	1 (2.1)	1 (6.6)	2 (6.6)
Hospitalization (days)(mean; SD)**	3.6 ± 1.0	4.5 ± 0.5	5.4 ± 1.3
Intra-operative Complications (n; %)	3 (6.3)	1 (6.6)	0(0)
Post-operative Complications (n; %)	10 (21.2)	2 (13.3)	4 (13.3)
Post-op. Major Complications (n; %)	2 (4.2)	1 (6.6)	2 (6.6)
Follow Up (months)(mean; SD)	22.8 ± 5.8	23.1± 9.4	24.6± 9.1
* The procedures lasted statistically longer for those patients underwent segmental resection when compared with both shaving (p=0.04) and discoid (p<0.001).			
** The hospitalization was significantly longer is case of bowel resection when compared with both discoid (p<0.006) and shaving (p<0.001), also the discoid resection resulted longer when compared with the shaving (p=0.001).			











Précis

A retrospective cohort study comparing medium-term clinical outcomes of patients undergoing laparoscopic shaving, discoid or segmental resection.

ACCEPTED MANUSCRIPT