Laparoscopic sigmoid resection with transrectal specimen extraction: a novel technique for the treatment of bowel endometriosis

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BACKGROUND: Multidisciplinary laparoscopic treatment is the standard of care for radical treatment of deep infiltrating pelvic endometriosis. If bowel resection is necessary, a muscle-split or Pfannenstiel incision is also required. The avoidance of any laparotomy could decrease surgical stress response, give a faster return to normal bowel function, decrease post-operative pain and reduce wound complications and incisional hernias. We assessed post-operative outcome after a full laparoscopic sigmoid resection for bowel endometriosis.

PATIENTS AND METHODS: Twenty-one patients who underwent elective full laparoscopic sigmoid resection for bowel endometriosis from September 2009 to September 2010 were matched for age, American Society of Anesthesiologists class and BMI to 21 patients who underwent a conventional laparoscopic sigmoid resection. Groups were compared for peri-operative factors, complications, length of hospital stay, post-operative pain (Visual Analog Scale: VAS), analgesics consumption and inflammatory response (plasma C-reactive protein: CRP).

RESULTS: Median operating time was 15 min shorter with transrectal specimen extraction (P = 0.003). VAS-scores and use of analgesics were higher in the conventional laparoscopic group (P = 0.0005). Mean CRP-level tended to be higher in the transrectal specimen extraction group (38%, P = 0.054) but there was no difference in increase in CRP level between groups (P = 0.15). There were no anastomotic leaks or reinterventions in either group, and the median hospital stay was similar. At follow-up, no wound infections or incisional hernias were observed and no patients reported anal dysfunction.

CONCLUSION: Full laparoscopic sigmoid resection reduced operating times and decreased post-operative VAS-scores and analgesic requirements compared with the conventional laparoscopic sigmoid resection for bowel endometriosis.

Key words: endometriosis / laparoscopic sigmoid resection / transrectal extraction

Introduction

Multidisciplinary laparoscopic treatment has become the standard of care for radical treatment of deep infiltrating pelvic endometriosis and to optimize outcome in female patients during their reproductive years (Keckstein and Wiesinger, 2005; Kennedy et al., 2005; Bracale et al., 2009). In case of bowel endometriosis infiltrating the rectosigmoid colon, a laparoscopic rectosigmoid resection may be required (Campagnacci et al., 2005; Bracale et al., 2009; Meuleman et al., 2009). During this procedure, a small muscle-split incision in the left iliac fossa or a Pfannenstiel incision is made to extract the colonic specimen and to create the proximal part of the bowel anastomosis. The avoidance of any laparotomy could lead to a decrease in surgical stress response, a faster return to normal bowel function and diet, a decrease in post-operative pain, fewer wound complications and incisional hernias. A laparoscopic sigmoid resection with transrectal specimen extraction, or so-called full laparoscopic sigmoid resection, has the potential to decrease surgical trauma to the abdomen, which could lead to the earlier-mentioned benefits. This case-matched study compares laparoscopic sigmoid resection with transrectal specimen extraction and conventional laparoscopic sigmoid resection for the treatment of bowel endometriosis.
Patients and Methods

All patients who underwent elective laparoscopic sigmoid resection with transrectal specimen extraction for bowel endometriosis from September 2009 to September 2010 were identified from a prospective database, which was approved by the institutional review board, and were matched to patients who underwent a conventional laparoscopic sigmoid resection. Both types of resection were performed simultaneously during that year. Of the 302 patients with endometriosis treated in that period at the Leuven University Fertility Centre (a tertiary referral centre), 200 patients (66%) had deep disease with rectovaginal involvement and 102 patients underwent a bowel resection. Indication for multidisciplinary endometriosis surgery was severe pelvic pain (dysmenorrhea, dyspareunia, dyschezia), refractory medical treatments and severe bowel stenosis related to endometriosis, diagnosed through double-contrast barium enema. Control patients, selected from a database of 81 patients who underwent a conventional laparoscopic sigmoid resection, were matched for age, American Society of Anesthesiologists class (ASA score) and BMI. After CO₂ laser laparoscopic radical excision of all macroscopically visible endometriosis, which was performed by a trained and dedicated gynecologist, laparoscopic sigmoid resections were performed by colorectal surgeons experienced in advanced laparoscopic colorectal resections. Indications for sigmoid resection were infiltrating bowel endometriosis not suitable for local wedge excision and/or compromised vascularization or extensive lateral dissection at the end of CO₂ laser laparoscopy. Post-operative care was standardized for both groups. The groups were compared for peri-operative factors (operating time, estimated blood loss, specimen length and final pathological diagnosis), complications, length of hospital stay, post-operative pain using the Visual Analog Scale (VAS), analgesics consumption and inflammatory response (plasma C-reactive protein: CRP, by immunoturbidimetry, Roche/Hitachi Modular P analyser) checked on the day before surgery and daily post-operatively at 8 a.m. for 5 days. All patients were followed at a dedicated outpatient clinic, 1 week after hospital discharge and every 3 months thereafter.

Surgical technique

The operating room setup was the same for all procedures. Patients underwent full mechanical bowel preparation on the day before surgery and operations were performed under general anesthesia. Intravenous antibiotic prophylaxis was given at induction and consisted of 2 g cefuroxime and 1.5 g metronidazole. Patients were installed in a modified Lloyd-Davies position on a moldable bean bag to allow adequate Trendelenburg position. The pneumoperitoneum was created by inserting a Veress needle in the left hypochondric region subcostally. A 4-port approach was used: three 5-mm ports were placed in the right and left flank and above the umbilicus. A 12-mm port (Endopath XcelTrocar, Ethicon Endo-Surgery, Cincinnati, OH, USA) was placed in the right iliac fossa. The patient was placed in Trendelenburg position. The inferior mesenteric artery and vein were clipped and divided intracorporeally and the left and sigmoid colon were mobilized. The proximal rectum was dissected free from its mesorectum using a vessel-sealing device (Harmonic scalpel ACE, Ethicon Endo-Surgery, Cincinnati, OH, USA), so that the rectal ampulla and reservoir function could be saved and rectal capacity was not jeopardized.

In conventional laparoscopic sigmoid resection, the rectum was divided at the level of the promontory using a 60-mm endoscopic linear stapler (Endo GIA Universal Roticator, Covidien, Autosuture, Norwalk, CT, USA). The specimen was retrieved through a left iliac fossa incision of 3–5 cm using a wound protector. The proximal part of the anastomosis was made suturing the anvil in place with a purse string of a mono-filament suture (Prolene 0, Ethicon, Inc., Cincinnati, OH, USA). An end-to-end anastomosis was made using a circular stapler in a standard manner.

In laparoscopic sigmoid resection with transrectal specimen extraction, the sigmoid was isolated and both the proximal sigmoid colon and proximal rectum were tied off with a non-absorbable suture (Ethibond EXCEL 0, Ethicon Endo-Surgery, Cincinnati, OH, USA), determining the proximal and distal resection margins. A rectotomy was performed using a vessel-sealing device to deliver the anvil from a circular stapler (Proximate ILS CDH 29, Ethicon Endo-Surgery, Cincinnati, OH, USA) introduced through the anus. The spike from the circular stapler contains a prefabricated hole and was connected to a mono-filament suture (Prolene 0, Ethicon Endo-Surgery, Cincinnati, OH, USA), placed intra-abdominally via the 12-mm port and connected to the anvil. A colotomy was made at the level of the transition between descending colon and proximal sigmoid colon using a vessel-sealing device, and the anvil was introduced into the descending colon (Fig. 1). The colon was divided with a 60-mm endoscopic linear stapler (Endo GIA Universal Roticator, Covidien, Autosuture, Norwalk, CT, USA). Surprisingly, the Prolene 0-suture is not cut by the linear stapler and can be easily grasped. The anvil was retrieved by gently pulling on the Prolene suture, so that the proximal part of the anastomosis was ready for use. The rectum was transected completely and the specimen was extracted transectally in a specimen retrieval pouch (Endo Catch II™, Covidien, Autosuture, Norwalk, CT, USA). The rectum was closed at the level of the promontory with a 60-mm endoscopic linear stapler (Endo GIA Universal Roticator, Covidien, Autosuture, Norwalk, CT, USA) and the rim of proximal rectum was extracted through the 12-mm port. An end-to-end anastomosis was made using the circular stapler in a standard manner (Fig. 2). In both procedures, no drain was placed and the nasogastric tube was removed at the end of the procedure.

Analgesia and follow-up

All patients received paracetamol 1 g i.v. every 6 h on demand postoperatively and continued orally. Non-steroidal anti-inflammatory drugs (NSAIDs) were available to all patients for breakthrough pain. Ketolorac 10 mg was given i.v. until oral ibuprofen 400 mg could be given. A VAS was used to measure pain twice daily during hospital stay.

Statistical analysis

To compare the two procedures, Wilcoxon signed-rank and McNemar tests were used for continuous and dichotomous outcomes, respectively. A general linear model for repeated measures was used to compare the longitudinal measures of VAS scores and CRP levels between groups. In this model, it was verified whether the difference between techniques varied over time and an estimate was obtained of the overall difference between techniques. A log-transformation was applied for VAS scores (after adding a constant) and for CRP. Figures with mean and 95% confidence intervals (CIs) were constructed after back transformation to the original scale. For the outcomes of interest, a Bonferroni correction was used to correct for multiple testing, i.e. P-values smaller than 0.00625 were considered significant. All analyses have been performed using SAS software, version 9.2 of the SAS System for Windows.

Results

Patient demographics were similar between treatment groups, owing to an adequate matching process (Table I). There were no conversions to laparotomy in either of the two groups. Although all sigmoid resections were performed within 2 h, operating times measured for the duration of the bowel resection were shorter in
the transrectal specimen extraction group: the median operating time in the conventional laparoscopic group was 105 [interquartile range (IQR): 90–115] minutes versus 90 (IQR: 85–105) minutes in the transrectal specimen extraction group. The median length of the extracted sigmoid colon was longer in the transrectal specimen extraction group and the median estimated blood loss was lower in this group, but the difference is clinically irrelevant. The median length of hospital stay was comparable in the two groups. All surgical margins were microscopically free from endometriosis in both groups. Histological examination demonstrated endometriosis with infiltration into the muscularis propria or mucosa in 39 out of 42 specimens (93%). In one specimen, only serosal infiltration was found, and in two specimens, no bowel endometriosis could be found: in those three patients, endometriosis was histologically present in the nodule removed during CO2 laser laparoscopy. One sigmoid resection had to be performed because of extensive lateral dissection denervating
and devascularizing the sigmoid and rectosigmoid junction. Two sigmoid resections had to be carried out because of radical removal of endometriosis during CO2 laser laparoscopy, leaving defects not amenable to laparoscopic suturing.

Pain scores decreased quickly after both laparoscopic sigmoid resection with transrectal specimen extraction and conventional laparoscopic sigmoid resection (Fig. 3). A comparison of VAS scores, irrespective of the moment in time, showed a higher VAS score in the conventional laparoscopic group ($P = 0.0005$). The overall (geometric) mean (95% CI) in the conventional laparoscopic group was 1.50 (1.23–1.79), compared with 0.85 (0.65–1.07) in the transrectal specimen extraction group. The difference in VAS scores between groups decreased over time, but this tendency was not significant ($P = 0.32$). The day-by-day analysis of analgesic

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Full laparoscopic sigmoid resection (n = 21)</th>
<th>Conventional laparoscopic sigmoid resection (n = 21)</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)*</td>
<td>35 (30–38)</td>
<td>34 (32–35)</td>
<td>0.135</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>23 (22–25)</td>
<td>23 (21–25)</td>
<td>1.000</td>
</tr>
<tr>
<td>ASA score</td>
<td></td>
<td></td>
<td>NA</td>
</tr>
<tr>
<td>1</td>
<td>13</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>8</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Operating time (min)*</td>
<td>90 (85–105)</td>
<td>105 (90–115)</td>
<td>0.003</td>
</tr>
<tr>
<td>Estimated blood loss (ml)*</td>
<td>0 (0–10)</td>
<td>20 (10–50)</td>
<td>0.002</td>
</tr>
<tr>
<td>Specimen length (cm)*</td>
<td>21 (17–24)</td>
<td>14 (12–15)</td>
<td>0.003</td>
</tr>
<tr>
<td>Final pathological diagnosis</td>
<td>0.97</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>No endometriosis</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Serosal invasion</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Muscularis propria invasion</td>
<td>18</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Mucosal invasion</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Duration of hospital stay (days)*</td>
<td>6 (5–7)</td>
<td>7 (6–9)</td>
<td>0.138</td>
</tr>
<tr>
<td>Follow-up (months)*</td>
<td>10.3 (8.1–11.6)</td>
<td>18.7 (10–22.2)</td>
<td>0.0003</td>
</tr>
</tbody>
</table>

*Values are median (interquartile range). ASA, American Society of Anaesthesiologists; NA, not applicable; *From Mann–Whitney U or McNemar test.
requirement revealed a higher intake of i.v. NSAIDs for the conventional laparoscopic group during the first three post-operative days. Moreover, the total amount of i.v. NSAIDs was higher in the conventional laparoscopic group; the median total amount of i.v. NSAIDs was 110 (IQR: 30–120) mg in the transrectal specimen extraction group versus 210 (IQR: 170–350) mg in the conventional laparoscopic group ($P = 0.0015$). The intake of paracetamol, either i.v. or oral, was higher at each day in the conventional laparoscopic group, with significant differences observed on the second ($P = 0.008$) and fifth post-operative day ($P = 0.015$). The total amount of required paracetamol was higher in the conventional laparoscopic group ($P = 0.0034$). On average, over the 5 days postoperatively, the plasma CRP level was 38% higher in the transrectal specimen extraction group (Fig. 4), but this difference was not significant ($P = 0.054$). There was also no difference in the increase in CRP levels during the first 5 days postoperatively between groups ($P = 0.15$). There were no anastomotic leaks and no reinterventions in either group. Overall complication rate was low and similar in both groups ($P = 0.63$). Three patients in the conventional laparoscopic group and one patient in the transrectal specimen extraction group developed a urinary tract infection, which was treated by antibiotics. One patient in the conventional laparoscopic group developed a small pelvic hematoma, which was treated conservatively. Another patient developed an atomic neurogenic urinary bladder necessitating intermittent urethral catheterization, which resolved spontaneously. During CO$_2$ laser laparoscopy, the vagina was opened (and subsequently closed laparoscopically) in a total of 10 patients (24%), 5 in each group, but without impact on post-operative morbidity. There was no 30-day readmission. No wound infections or incisional hernias were observed at a median follow-up of 10.3 (IQR: 8.1–11.6) months in the transrectal specimen extraction group and 18.7 (IQR: 10–22.2) months in the conventional laparoscopic group ($P = 0.0003$, for the comparison of follow-up). None of the patients complained of anal dysfunction or incontinence, with a median Wexner-incontinence score of 0 in both groups.

**Discussion**

The importance of a multidisciplinary approach to treat severe endometriosis, including intestinal involvement, has already been emphasized (Keckstein and Wiesinger, 2005; Kennedy et al., 2005). The ultimate goal of radical endometriosis surgery is to obtain symptom relief and good long-term outcome (Garry et al., 2000). For deep infiltrating endometriosis of the sigmoid colon and rectosigmoid junction, a radical segmental resection may be required in order to obtain complete macroscopic clearance of endometriotic lesions or scars, resulting in a good outcome with regard to pain, quality of life and infertility (Dubernard et al., 2008). Several groups have reported good results after bowel resection for endometriosis (Duepree et al., 2002; Keckstein et al., 2003; Dubernard et al., 2006; Darai et al., 2007a,b; Mereu et al., 2007; Meuleman et al., 2009; Stepniewska et al., 2009; Ruffo et al., 2010), but a selective approach toward bowel resection is justified because endometriosis is a benign condition and operative morbidity/trauma should be kept as low as possible. In the present study, the absence of endometriosis in two specimens and only serosal infiltration in one could lead to the assumption that these patients were possibly overtreated, because bowel endometriosis is defined as the infiltration of endometrial-like glands and stroma reaching at least the subserosal bowel wall (Remorgida et al., 2007). However, these three patients all had deep infiltrating endometriosis in the bowel wall, leading to radical excision by CO$_2$ laser laparoscopy. In these three patients, the sigmoid had to be resected because the colonic defect was too large to be sutured after CO$_2$ laser laparoscopy. However, these three patients all had deep infiltrating endometriosis in the bowel wall, leading to radical excision by CO$_2$ laser laparoscopy ($n = 2$) or because the sigmoid colon was denervated and devascularized. In two patients, disc excision was performed, but the resulting bowel defect required segmental resection. In one...
Patient, resection of the nodule resulted in a critical blood supply to the sigmoid colon, necessitating resection. Thus, full thickness disc excision is limited to the size of the lesion and the localization (rectum) and fails to be complete in 40% of women with active glandular endometriosis. Being responsible for a deeper infiltration of the rectum and fails to be complete in 40% of women with active glandular endometriosis, excision is limited to the size of the lesion and the localization of the patient, resection of the nodule resulted in a critical blood supply to the bowel wall than fibrosis and smooth fibers (Remorgida et al., 2005; Roman et al., 2009).

In a recent randomized trial comparing laparoscopically assisted and open colorectal resection for endometriosis, it was shown that laparoscopy is safe and immediate benefits on pain and post-operative complications were noted. Moreover, a laparoscopic approach offered a higher spontaneous pregnancy rate and similar improvement in quality of life compared with open surgery (Daraï et al., 2010). It has also been shown that there is an association between incisional hernia rate and the length of an abdominal incision, supporting the role of laparoscopy in minimizing abdominal access (Laurent et al., 2008). Therefore, in a tailored approach of segmental bowel resection of severe symptomatic endometriosis, access trauma to the abdomen should be minimal to allow fast recovery.

To reduce access trauma even more, a laparoscopic sigmoid resection with transrectal specimen extraction is an attractive and novel procedure avoiding a mini-laparotomy for specimen extraction. Natural orifice specimen extraction (NOSE) has extensively been reported during gynecologic laparoscopic procedures and different specimens have been extracted via posterior colpotomy (Tsin, 2001; Tsin et al., 2001; Ghezzi et al., 2002). A combined laparoscopic-transvaginal approach, with transvaginal specimen extraction, has been published for the treatment of rectosigmoid endometriosis and several authors have reported the results (Table II). However, only case series without matching or randomization have been reported and multiple variants of transvaginal specimen extraction and re-anastomosis have been described, which makes evidence poor. The avoidance of an additional colpotomy can be achieved by transrectal specimen extraction, so that the benefits of minimal access trauma and NOSE can be maintained. The insertion of the anvil into the proximal colon transanally during laparoscopic anterior resection for endometriosis has been described in a case report, but the colonic specimen was extracted transabdominally using a small incision (Ford et al., 2005). The first report on transanal extraction for bowel endometriosis was published in 1991 (Redwine and Sharpe, 1991) and since then, different modifications have been reported, but the technique never became popular (Franklin and Diaz, 2000; Palanivelu et al., 2008; Akamatsu et al., 2009; Cheung et al., 2009; Wolthuis et al., 2010). The main difference in comparing our technique with others and the novelty presented here is the use of a specimen retrieval pouch to extract the specimen to minimize local soiling, to protect the rectum and to prevent rectal prolapse. During the procedure, both the colon and the rectum are opened and manipulated, leading to concerns with regard to the development of a pelvic abscess and other post-operative complications. Based on a similar inflammatory response and the low complication rate in our study, intra-operative bowel opening does not seem to have a major impact. Moreover, the present technique could eventually lead to cosmetic advantages because the mini-laparotomy scar for specimen retrieval is avoided. The main difficulties with this totally laparoscopic technique are the preparation of the proximal part of the anastomosis using the anvil and the spike with the mono-filament suture attached to it and the insertion of the specimen retrieval pouch transanally. Technically, the most difficult part of the operation is the insertion and retrieval of the anvil in the proximal colon. Therefore, the procedure has to be performed in a stepwise fashion by an experienced laparoscopic colorectal surgeon.

In the present study, laparoscopic sigmoid resection with transrectal specimen extraction for bowel endometriosis was found to be safe, feasible and reproducible by a highly trained multidisciplinary team. To the best of our knowledge, the present case-matched series is the first controlled study in literature. No comparative studies on the outcome for laparoscopic sigmoid resection with transrectal extraction could be found with regard to operative trauma, pain scores, analgesic requirement and inflammatory response. Owing to the short median follow-up in this study, we did not focus on post-operative pregnancy rates. Although the present study was not randomized and had a small sample size, all data point at better results (shorter operative time, reduced blood loss, improved post-operative pain scores and reduced analgesic requirements) after transrectal specimen extraction when compared with the conventional

<table>
<thead>
<tr>
<th>Author, year</th>
<th>Patients (n)</th>
<th>BMI (kg/m²)</th>
<th>Operating time (min.)</th>
<th>Specimen length (cm)</th>
<th>Length of hospital stay (days)</th>
<th>Technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>Redwine and Sharpe (1991)</td>
<td>1</td>
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<td>180</td>
<td>NA</td>
<td>4</td>
<td>Transrectal</td>
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<tr>
<td>3</td>
<td>NA</td>
<td>365 (270–400)</td>
<td>NA</td>
<td>4 (4–5)</td>
<td>Transvaginal</td>
<td></td>
</tr>
<tr>
<td>Abrao et al. (2005)</td>
<td>8</td>
<td>NA</td>
<td>178 (119–251)</td>
<td>NA</td>
<td>4.1 (2–5)</td>
<td>Transvaginal</td>
</tr>
<tr>
<td>Boni et al. (2007)</td>
<td>11</td>
<td>NA</td>
<td>240 (mean)</td>
<td>NA</td>
<td>5 (mean)</td>
<td>Transvaginal</td>
</tr>
<tr>
<td>Ghezzi et al. (2008)</td>
<td>33</td>
<td>19.6 (16–22)</td>
<td>280 (200–390)</td>
<td>NA</td>
<td>6.7 (mean)</td>
<td>Transvaginal</td>
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<tr>
<td>Ebert et al. (2009)</td>
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<td>NA</td>
<td>210</td>
<td>NA</td>
<td>8</td>
<td>Transvaginal</td>
</tr>
<tr>
<td>Knol et al. (2009)</td>
<td>1</td>
<td>20.7</td>
<td>113</td>
<td>NA</td>
<td>10</td>
<td>Transrectal</td>
</tr>
<tr>
<td>Current series</td>
<td>21</td>
<td>23 (18–31)</td>
<td>90 (65–120)</td>
<td>21 (7–32)</td>
<td>6 (4–13)</td>
<td>Transrectal</td>
</tr>
</tbody>
</table>

*Values are median (range).*

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**Table II** Reported case series of laparoscopic bowel resection with NOSE for severe endometriosis.
laparoscopic approach. These observations need to be confirmed in a prospective study or a RCT before it can be proposed that transrectal specimen extraction can replace a conventional laparoscopic segmental bowel resection in the treatment of endometriosis.

**Authors’ roles**

A.M.W. contributed in all works including in study design, execution, analysis, manuscript drafting and critical discussion. C.M., C.T. and T.D.H. supervised all works, including study design, analysis, manuscript drafting and critical discussion. S.F. contributed mainly to data analysis, manuscript drafting and critical discussion. F.P. and A.D.H. contributed to study design, execution, analysis, manuscript drafting and critical discussion.

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