Clinical outcome after CO₂ laser laparoscopic radical excision of endometriosis with colorectal wall invasion combined with laparoscopic segmental bowel resection and reanastomosis

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BACKGROUND: Laparoscopic segmental bowel resection and reanastomosis for endometriosis with colorectal wall invasion can be associated with high complication rates. This study was performed to test the hypothesis that this high complication rate can be prevented and combined with a good clinical outcome, following a multidisciplinary surgical approach.

METHODS: A retrospective cohort study of all patients with deep endometriosis and colorectal invasion treated by CO₂ laser laparoscopic radical excision between September 2004 and September 2006 (n = 45) to document the clinical outcome: complications, recurrence and fertility (life table analysis), pain, quality of life (QOL) and sexual function.

RESULTS: No immediate major post-operative complications requiring surgical reintervention were recorded. Gynaecological pain (P < 0.0001), sexual function (P < 0.03) and QOL (P < 0.0001), improved significantly after a median follow-up period of 27 (range: 16–40) months. Although five patients (11%) had a surgical reintervention, histologically proven recurrent endometriosis was observed in only two (4%), with a cumulative endometriosis recurrence rate of 2.2 and 4.4% after 1 and 3 years, respectively. Thirteen of 28 patients who wanted to become pregnant conceived after surgery. One patient delivered twice. These 14 pregnancies were achieved spontaneously (n = 9) or after IVF (n = 5). The cumulative pregnancy rate was 47% after 3 years.

CONCLUSION: Pain, sexual function and QOL improved significantly and were associated with a good fertility rate and a low complication and recurrence rate after a CO₂ laser laparoscopic radical excision of endometriosis with colorectal wall invasion combined with laparoscopic segmental bowel resection and reanastomosis.

Key words: colorectal endometriosis / deep infiltrating endometriosis / dysmenorrhoea / dyspareunia / quality of life

Introduction

Endometriosis is defined as functioning ectopic endometrial tissue and affects 10% of women of child-bearing age (Wheeler, 1989; Eskenazi and Warner, 1997; D’Hooghe et al., 2003). The main symptoms of endometriosis are pain and infertility (Burns and Schenken, 1999). Deep infiltrating endometriosis (DIE) is characterized by the invasion of anatomical structures and organs deeper than 5–6 mm beyond the peritoneum (Koninckx and Martin, 1994; Vercellini et al., 2004), affects ~20–35% of the women with endometriosis (Chapron
et al., 2001) and involves uterosacral ligaments, rectosigmoid colon, vagina and bladder (Jenkins et al., 1986). Intestinal involvement occurs in 3–37% of cases (Graham and Mazier, 1988; Collin and Russell, 1990; Coronado et al., 1990), affecting much more frequently the rectum and rectosigmoid junction (70–93% of all intestinal endometriosis; Coronado et al., 1990; Bailey et al., 1994) than the appendix (2–18%), distal ileum (2–16%) or cecum (<2%; Zwas and Lyon, 1991). The term ‘bowel endometriosis’ is used when endometriotic-like glands and stroma infiltrate the bowel wall reaching at least the subserous fat tissue or adjacent to the neurovascular branches (subserous plexus; Remorgida et al., 2007). In contrast, endometriotic foci located on the bowel serosa should be considered peritoneal and not bowel endometriosis (Chapron et al., 2003; Remorgida et al., 2007). Bowel endometriosis can cause severe symptoms, such as bowel cramping, abdominal bloating, diarrhoea, constipation, dyschezia and cyclical rectal bleeding (Garry et al., 2000; Redwine and Wright, 2001), which affect the quality of life (QOL). Complete removal of DIE improves the QOL and potentially fertility but may be associated with a high risk of post-operative complications (Coronado et al., 1990; Hughes et al., 1993; Adamson, 1997; Redwine and Wright, 2001; Abbott et al., 2003). Therefore, surgical management of DIE with bowel and urological extension requires the skills of an experienced team led by a gynaecological reproductive surgeon working together with a colorectal surgeon and an urologist.

In our first study (Meuleman et al., 2009), we described how laparoscopic multidisciplinary surgical management of DIE with colorectal invasion and/or invasion of the bladder and ureters resulted in a low post-operative complication and recurrence rate, high pregnancy rate and improved QOL, pain and sexual function, even though most patients had received a bowel resection and reanastomosis. However, segmental bowel resection and reanastomosis has been criticized for increasing the risk of complications when compared with discoid excision (Mohr et al., 2005; Ret Davalos et al., 2007; Landi et al., 2008; Fanfani et al., 2010; Roman et al., 2010), and very few long-term follow-up data are available regarding clinical outcome after this type of surgery (Meuleman et al., 2011). Therefore, the current study was performed to test the hypothesis that a low complication rate and a good clinical outcome can be achieved within 2 years after surgery in a selected subgroup of women with DIE and colorectal wall invasion when treated using multidisciplinary laparoscopic surgery including CO2 laser radical endometriosis excision and segmental bowel resection and reanastomosis.

Materials and Methods

Our study (ClinicalTrials.gov ID: NCT00462176) was approved by the Ethical Committee of the University Hospital Leuven, Belgium, and informed consent was obtained from participants.

Patient selection

Data were retrieved retrospectively from a prospectively maintained electronic database. All women (n = 45) who had undergone a bowel resection and reanastomosis at the end of a CO2 laser laparoscopic radical excision of endometriosis between September 2004 and September 2006 were selected. During that time period, a total number of 427 patients underwent surgery via laparoscopy in our centre (238 of 427 or 56% in 1-day surgery). Most patients (60%; 258 of 427) had laparoscopic excision of endometriosis of any stage, as defined by the revised American Fertility Society (rAFS), and a significant proportion (33%; 140 of 427) had laparoscopic surgery for DIE in hospitalization setting. The surgery performed in our selected study group (n = 45) represents 10.5% (45 of 427) of all surgeries, and 32% (45 of 140) of surgeries for DIE. The study group also clearly excludes women with peritoneal or deep endometriosis which can be peeled off or excised from the bowel with the CO2 laser without any major consequences for the integrity of the bowel wall.

Preoperative procedure

All patients were treated according to a standardized clinical protocol in place at the Leuven University Fertility Centre following ISO 9001-2000 certification in 2004, as described previously (Meuleman et al., 2009). In patients without previous surgery showing bowel endometriosis but with a clinical picture suggestive for DIE, based on medical history, surgical history, abdominal and vaginal examination and expert gynaecological ultrasound, a barium enema and intravenous pyelogram were performed to assess if, and to what extent, the bowel, bladder and/or ureters were affected. All patients were informed about the collaboration of the reproductive surgeon with a colorectal surgeon and an urologist. Patients with documented colorectal wall involvement were informed preoperatively of the possibility of segmental resection and reanastomosis. Patients with low rectal bowel endometriosis were aware of the possibility of colonic pouch reconstruction with optional temporary protective ileostoma.

Although there are no data to promote hormonal treatment prior to surgery to improve the success of surgery (Muzi et al., 1996; Kennedy et al., 2005), patients received GnRH–analogue treatment 3 months prior to surgery, as in our experience surgery is facilitated in a “dry” pelvis minimally affected by inflammation and/or hypervascularization.

Preoperative bowel preparation

All 45 patients had full mechanical bowel preparation using Fleet PhosphoSoda® (Wolfs, Belgium) (2 × 45 ml) on the day before surgery, in order to avoid potential stool soiling of the abdominal cavity in the case of bowel wall perforation during the CO2 laser resection of endometriosis and in order to be prepared for the rare situation of low rectosigmoid resection with colon pouch and temporary ileostoma (Bretagnol et al., 2010).

Operative procedure

Our multidisciplinary three-step operative procedure for patients with extensive DIE with colorectal extension has been described in detail previously (Meuleman et al., 2009). After the induction of anaesthesia, double J stents were placed by the urologist for patients meeting at least one of the following conditions: ovarian fossa surgery in the case of endometriomas >4 cm, ureteral surgery in the case of peri-ureteral endometriosis with or without displacement, narrowing or stenosis of the ureters and in case of extensive endometriosis/frozen pelvis (at least one previous pelvic surgery for endometriosis in most cases) where ureters serve as reference points in the pelvis. All visible endometriosis was excised with a CO2 laser (Lumenis Inc., USA: Compact 40W CO2 laser) at a power density of 15 Watt Super pulse. The laser was used at such a low power to prevent thermal damage to the surrounding tissue (minimal risk of adhesion formation), to work comfortably at the border of healthy and diseased tissue, and to avoid complications (leakage of ureters/bladder/bowel). Normal anatomic relationships and normal function of the pelvic organs were restored as much as possible. If perforation of the vaginal fold occurred, it was laparoscopically sutured by the reproductive surgeon (C.M.). The presence of endometriosis was scored and staged according to the rAFS...

After excision of all endometriotic lesions by the reproductive surgeon, the urologist evaluated the ureters and bladder. In the case of extensive vesico-uterine de-peritonealisation, the bladder was filled with blue dye. If the blue colour was visible through the bladder wall (seromuscular injury), the urologist placed reinforcement sutures on the bladder wall laparoscopically. A perforation of the bladder or a ureter injury was also sutured laparoscopically by the urologist.

Subsequently, the colorectal surgeon evaluated the integrity of the rectosigmoid colon. The decision to perform a bowel resection and reanastomosis was taken in the following conditions: large direct full-thickness trauma to the colorectal wall which was too extensive to be sutured without impact on the functionality of the bowel, extensive lesion to the bowel wall musculature in the absence of full-thickness damage but with impact on functionality and extensive lateral dissection compromising the colorectal wall vascularity and/or innervation. Different types of laparoscopic bowel resection were performed, dependent on the type, location and extension of the lesion (see the ‘Results’ section). Bowel dissection was conducted solely inside the mesorectum, as close to the bowel as possible, to preserve the sympathetic fibres. Only nerve fibres of the resected bowel segment were cut in order to minimize denervation; however, if nerve branches were impacted in an endometriotic/fibrotic nodule, they were sacrificed as part of our radical excision of endometriotic tissue.

A histological examination was performed on all resected tissue specimens.

Post-operative procedure

Our post-operative procedure and follow-up have been described in detail previously (Meuleman et al., 2009).

Questionnaires

All patients were asked to complete the Oxford Endometriosis Quality of Life questionnaire (Jones et al., 2001), a sexual activity questionnaire (Thirlaway et al., 1996), visual analogue scales (VASs) for dysmenorrhoea, chronic pelvic pain and deep dyspareunia, and to answer questions about medication and fertility in order to compare their status before surgery and at the moment of the evaluation (December 2007), as described previously (Meuleman et al., 2009).

Statistical analysis

The paired Wilcoxon tests were used to compare scores before and after surgery. A correction for multiple testing was applied using a step-down Bonferroni procedure. P-values were two-sided and considered significant if less than 0.05. Analyses were performed using the statistical package SAS (version 9.1). The cumulative pregnancy rate and the cumulative recurrence rate for endometriosis were calculated using life table analysis.

Results

Results were obtained from patient questionnaires (QOL scores, sexual satisfaction scores, the three VAS pain scores, pregnancy rates), telephone calls for those patients who had not returned the questionnaires (pregnancy rates and recurrences) and medical chart reviews (patient characteristics, presenting symptoms, pre-, per- and post-operative care, histology, complication rate, recurrence rate, reintervention rate and pregnancy rate).

Questionnaire response rate

The response rate to the questionnaires was 67% (30 of 45). Patients not responding to the questionnaires (15 of 45, 33%) were contacted by telephone an independent investigator (A.B.) who was not part of the clinical team and were asked about post-operative complications, surgical reinterventions and fertility. Lack of interest and/or lack of time were cited as the reason for not completing the questionnaires but all patients agreed to answer by telephone the above-mentioned questions and these answers were also entered into our database and analysed.

Patient characteristics

Patient characteristics are summarized in Table I.

Preoperative tests

According to the preoperative report of a vaginal examination, available in the clinical file of 34 of the 45 patients, a nodule was felt in the fornix posterior in 29 of 34 patients. The five patients with a ‘negative’ vaginal examination included one obese patient (body mass index 37 kg/m², inconclusive clinical examination) and four patients with evidence of bowel endometriosis based on a barium enema (n = 1, intramural bowel invasion) or surgical history (n = 3 with existing bowel nodules/involvement and n = 1 with frozen pelvis).

A gynaecological transvaginal ultrasound, performed by a gynaecologist with special skills in pelvic ultrasound, was abnormal in 35 of 37 cases, showing either an endometriotic nodule in the fornix posterior (n = 22 of 37 or 60%), and/or a frozen pelvis (21 of 37 or 57%), and/or ovarian cysts compatible with endometriosis (16 of 37 or 43%.

### Table 1 Characteristics and presenting symptoms of study patients with DIE (n = 45).

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>n</th>
<th>(%   )</th>
</tr>
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<tbody>
<tr>
<td>Age [years; median (range)]</td>
<td>30</td>
<td>(18 – 42)</td>
</tr>
<tr>
<td>Pain only [n (%)]</td>
<td>5</td>
<td>(11)</td>
</tr>
<tr>
<td>Pregnancy wish impossible to fulfill [n]</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>No further pregnancy wish [n]</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Pain + pregnancy wish [n (%)]</td>
<td>40</td>
<td>(89)</td>
</tr>
<tr>
<td>Active pregnancy wish [n]</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>Primary infertility [n]</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>Secondary infertility [n]</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Passive pregnancy wish [n]</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Primary infertility [n]</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Secondary infertility [n]</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Chronic pelvic pain [n (%)]</td>
<td>26</td>
<td>(58)</td>
</tr>
<tr>
<td>Dysmenorrhoea [n (%)]</td>
<td>44</td>
<td>(98)</td>
</tr>
<tr>
<td>Dyspareunia [n (%)]</td>
<td>27</td>
<td>(60)</td>
</tr>
<tr>
<td>Constipation/diarrhoea [n (%)]</td>
<td>26</td>
<td>(58)</td>
</tr>
<tr>
<td>Dyschezia [n (%)]</td>
<td>40</td>
<td>(89)</td>
</tr>
<tr>
<td>Cyclical rectal bleeding [n (%)]</td>
<td>7</td>
<td>(15)</td>
</tr>
<tr>
<td>Dysuria [n (%)]</td>
<td>13</td>
<td>(29)</td>
</tr>
<tr>
<td>Referred [n (%)]</td>
<td>32</td>
<td>(71)</td>
</tr>
<tr>
<td>Own initiative [n (%)]</td>
<td>13</td>
<td>(29)</td>
</tr>
<tr>
<td>Previous surgical treatment [n (%)]</td>
<td>39</td>
<td>(87)</td>
</tr>
</tbody>
</table>
seven bilateral and nine unilateral), i.e. adnexal masses with ground glass echogenicity of the cyst fluid, one to four locules without papillations and with detectable blood flow (Van Holsbeke et al., 2010). The two patients without endometriotic nodules, ovarian endometriomas or frozen pelvis on pelvic ultrasound demonstrated mural invasion of the sigmoid and rectosigmoid, respectively, on a bowel barium enema with double contrast.

A bowel barium enema with double contrast, performed in 40 of 45 patients, clearly demonstrated mural invasion of the bowel wall in 35 of the 40 (88%) patients, at the level of the sigmoid colon (n = 11), recto-sigmoid junction (n = 21) or upper rectum (n = 3). The 5 of the 40 patients with normal findings as per protocol on X-ray; all had a bowel barium enema performed in a peripheral hospital. Although these radiographies were deemed to be of insufficient quality to determine possible endometriotic bowel involvement, these patients were still predicted to have significant bowel involvement according to their clinical examination or previous surgical history demonstrating significant bowel endometriosis (n = 2) or bowel endometriotic nodule(s) (n = 3). In the 5 of the 45 patients without a preoperative bowel barium enema, bowel endometriosis had been demonstrated during previous diagnostic laparoscopy (n = 4) or abdominal computerised tomography scan (n = 1) and was confirmed during final curative surgery.

Preoperative intravenous pyelogram, performed in 41 of the 45 patients, was abnormal in 14 of the 41 (34%) showing ureter dislocation (n = 14), diminished expansion of the pelvic segment (n = 10), left-sided hydro-uretero-nephrosis (n = 1) or unilateral ureteral stenosis (n = 1).

Intra-operative staging of endometriosis and surgical procedures

Except for one patient with rAFS stage III (score: 30), all patients had endometriosis rAFS stage IV (44 of 45) with a mean score of 85 ± 24 (range: 30–126). All surgical procedures performed are listed in Table II.

The reproductive surgeon performed a complete resection of all macroscopically visible endometriosis tissue present in the pelvis. Excision of endometriotic nodules on rectum or rectosigmoid was performed with (n = 26) or without (n = 19) the aim to preserve bowel wall integrity, depending on nodule depth. As 88% of the preoperative barium enemas performed demonstrated intramural invasion, a perforation rate of 42% (19 of 45) at complete excision of all affected tissue is acceptable.

The colorectal surgeon performed a bowel resection because sputtering of the bowel wall was judged to be unsafe after bowel perforation following excision of endometriotic nodules (n = 19) or the bowel wall was judged to be too deeply damaged or weakened over a relatively large surface area (n = 26) after excision of bowel endometriotic nodules without opening the bowel wall.

In all cases, bowel resection and reanastomosis was preferred over bowel suture in order to prevent post-operative bowel perforation (short term) and bowel narrowing (long term). Bowel resection with reanastomosis (n = 45) was carried out as sigmoid (n = 5) or high recto-sigmoid (n = 37) resection with end-to-end reanastomosis or as low rectosigmoid resection with colonic J-pouch in three other patients with low rectal endometriotic nodules, in order to promote the recovery of the rectal reservoir function, since an end-to-end reanastomosis at such a low rectal level would compromise this function for at least 6–12 months after the operation. In one of these three patients, a temporary covering ileostoma was made to prevent formation of a rectovaginal fistula and this was closed at 3 months after surgery.

Duration of multidisciplinary intervention with bowel resection

The median total operation time was 420 (range: 240–600) min, including 10 (range: 0–90) min for the urologist, 240 (range: 80–390) min for the reproductive surgeon and 120 (range: 50–300) min for the colorectal surgeon.

Post-operative complications

Average duration of hospital stay was 7 (range: 4–15) days. Postoperative complications within 6 weeks after the intervention occurred in two patients (2 of 45, 4.4%) but did not require a surgical reintervention. The first patient, who had normal plasma C-reactive protein and leukocyte levels at discharge from the hospital 8 days after the operation, needed readmission to the hospital 6 weeks after surgery owing to pelvic inflammatory disease, was treated with broad spectrum intravenous antibiotics and required laparoscopic salpingectomy for hydropsalpinx 1 year after the operation. The second patient developed an atomic neurogenic urinary bladder necessitating intermittent urethral

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Percentage</th>
<th>Left</th>
<th>Right</th>
<th>Bilateral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ureter stent</td>
<td>96% (43/45)</td>
<td>0</td>
<td>1</td>
<td>42</td>
</tr>
<tr>
<td>Ureter suture</td>
<td>2% (1/45)</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Bladder suture</td>
<td>7% (3/45)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sigmoid resection</td>
<td>11% (5/45)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>High Rectosigmoid resection (with end-to-end anastomosis)</td>
<td>82% (37/45)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Low Rectosigmoid resection (with Colon pouch)</td>
<td>7% (3/45)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appendectomy</td>
<td>9% (4/45)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Small bowel resection</td>
<td>0% (0/45)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Protective ileostoma (temporarily)</td>
<td>2% (1/45)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cystectomy</td>
<td>42% (19/45)</td>
<td>7</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Oophorectomy</td>
<td>2% (1/45)</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Salpingectomy</td>
<td>38% (17/45)</td>
<td>14</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Salpingostomy</td>
<td>7% (3/45)</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Resection fornix posterior</td>
<td>16% (7/45)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ureterolysis</td>
<td>91% (41/45)</td>
<td>4</td>
<td>2</td>
<td>35</td>
</tr>
<tr>
<td>Adhesiolysis</td>
<td>100% (45/45)</td>
<td></td>
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</table>

Bowel endometriosis: laparoscopic segmental resection

Surgical procedures performed during multidisciplinary resection of endometriosis in study patients (n = 45).
catheterisation during the first 10 weeks after the operation. Subsequently, the patient urinated every 2 h, without need for catheterisation and with a limited but acceptable degree of stress incontinence. Nine months after the operation, this patient became pregnant spontaneously and the baby was delivered by Caesarean section.

Histology
Endometrial glands and stroma were found in all resected endometriosis tissue specimens removed from the pelvis and from the bowel, illustrating that all 45 patients had histologically confirmed pelvic and bowel endometriosis. The length (median 13 cm, range: 8–22 cm) of the resected bowel specimens was available in 43 of 45 cases. Histological examination of the bowel resection specimens demonstrated remaining (microscopic) endometriotic foci (endometrial glands and stroma) in 91% (41 of 45) that were located in the subserosal area with subserosal invasion till the muscularis in 6% (3 of 45), in the muscularis area in 53% (24 of 45) and in the submucosal area in 31% (14 of 45). Intramucosal or transmucosal remaining (microscopic) endometriotic foci were not observed.

The four bowel specimens without remaining (microscopic) endometriotic foci were marked by a large perforation after excision of an endometriotic nodule (histologically positive for endometriosis) with endometriotic extension to the bowel muscularis area (n = 2) or to the bowel submucosal area (n = 2). In these four cases, full thickness discoid excision had in fact been performed by the reproductive surgeon but the large defect left after this excision was judged by the colorectal surgeon to be too extensive to be treated with a bowel suture and therefore resection and reanastomosis was performed of the bowel segment involved in the endometriotic process.

Positive section margins were diagnosed in 22% (10 of 45) of the resected specimens. Only 1 of these 10 patients developed recurrence of endometriosis (the first case with histologically proven recurrence of endometriosis is in the ‘Reintervention and recurrence’ section, below).

In two patients, lymph nodes that were incidentally resected during the bowel resection procedure were histologically positive for endometriosis.

Pain, general satisfaction and QOL after surgery
Assessment was performed at a median follow up of 27 (range: 16–40) months. Significant post-operative improvement was observed for the VAS scores related to chronic pelvic pain, dysmenorrhoea and deep dyspareunia (P-value < 0.0001; Table III). Statistical analysis of the QOL questionnaires showed a significant improvement in both general health and quality of professional life (P < 0.0001), pain (P < 0.0001) and emotional wellbeing (P < 0.0001) and a significant reduction in perceived lack of control (P < 0.0001) and need of social support (P < 0.0001). The sexual activity questionnaire showed a significant post-operative improvement in sexual pleasure (P = 0.009) and frequency of sexual activity (P = 0.003) and a significant reduction in discomfort during sexual intercourse (P = 0.026).

Fertility outcome after surgery
Fertility outcome after surgery was assessed in 28 patients who actively wanted to become pregnant after surgery and who had either primary (n = 23 of 28, 82%) or secondary infertility (n = 5 of 28, 18%). Thirteen out of 28 patients became pregnant (pregnancy rate of 46%) during a median follow-up period of 27 months (range: 16–40 months) after surgery, resulting in a cumulative pregnancy rate (life table analysis) of 7, 29 and 47% after 1, 2 and 3 years, respectively. One patient was pregnant twice, and one patient had a miscarriage. Pregnancy occurred spontaneously (n = 8) or after IVF (n = 5) in patients with either primary (10 of 13) or secondary (3 of 13) infertility.

Reintervention and recurrence
Recurrent/persistent complaints suggestive of endometriosis were the indication for a new laparoscopy in 5 of the 45 patients (11%), resulting in a cumulative reintervention rate (life table analysis) of 4.4, 6.6 and 11% after 1, 2 and 3 years, respectively.

In three of these five patients, no evidence for endometriosis was observed during reintervention. In the first patient, laparoscopic salpingectomy was performed for hydrosalpinx 12 months after surgery (the first case described in ‘Post-operative complications’ section). The second patient had a hysterectomy after 17 months because of persisting pain and vaginal bleeding which were unresponsive to hormonal therapy. The third patient had laparoscopic adhesiolysis for pain symptoms related to a pseudo-peritoneal cyst 31 months after surgery.

Histologically proven recurrence of endometriosis occurred only in two patients, resulting in a total recurrence rate of 4% (2 of 45) and a cumulative endometriosis recurrence rate of 2.2 and 4.4% after 1 and 3 years, respectively. The first patient, with anterior resection at initial surgery and microscopic endometriosis at the distal resection margin, had a normal pelvis except for a small endometriotic nodule at the staple line resected during repeat laparoscopy for recurrent pain 14

Table III  Comparison of pre- and post-operative VAS pain symptom scores in patients undergoing laparoscopic segmental bowel resection and reanastomosis performed at the end of a CO2 laser laparoscopic radical excision of endometriosis with colorectal wall invasion.

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Pre-operative score [median (range)] (n = 29)</th>
<th>Post-operative score [median (range)] (n = 30)</th>
<th>P-value (paired Wilcoxon test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic pelvic pain</td>
<td>61 (0–100)</td>
<td>2 (0–43)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Dysmenorrhoea</td>
<td>92 (0–100)</td>
<td>13.50 (0–70)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Dyspareunia</td>
<td>28 (0–95)</td>
<td>1 (0–63)</td>
<td>&lt;0.0001</td>
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</table>
months after initial surgery. In the second patient, a left endometriotic ovarian cyst was diagnosed before IVF and cysctectomy and adhesiolysis of minor pelvic adhesions was performed during repeat laparoscopy 32 months after initial surgery.

**Discussion**

In a selected group of patients with DIE and colorectal wall invasion which was mostly (87%; 39 of 45) recurrent after at least one previous surgery, we demonstrated a favourable clinical outcome after a laparoscopic CO2 laser radical excision of DIE combined with segmental bowel resection and reanastomosis. Our results demonstrate a better outcome than reported in our systematic review (Meuleman et al., 2011), in another review (Darai et al., 2007) and in large case series (Ruffo et al., 2010) with respect to conversion to laparotomy (0 versus 7–8% [Darai et al., 2007]), complications requiring surgical intervention (0 versus 4.5% [Meuleman et al., 2011]), 6.5% (Darai et al., 2007) or 8.3% (Ruffo et al., 2010), pregnancy rate [H6 versus 39% (Meuleman et al., 2011) or 44.6% (Darai et al., 2007)] and endometriosis recurrence rate [4 versus 6% (Meuleman et al., 2011)].

The current study adds novel and relevant data as it reports clearly defined outcome variables (complications, pain, fertility, QOL, recurrence) in a well-characterized group of patients after laparoscopic intervention by a multidisciplinary surgical team without conversion to laparotomy when compared with the current literature in this field (Meuleman et al., 2011). Furthermore, we used a patient-based VAS to assess pain [used in less than 20% of studies (Meuleman et al., 2011)] and had a follow-up period of more than 24 months [reported in less than 50% of studies (Meuleman et al., 2011)]. According to the current consensus (Vincent et al., 2010), a patient-based 11-point Numerical Rating Score, in which the pre- and postoperative symptoms are given by the patient, allows a better evaluation of the post-operative pain situation as well as the evaluation of de novo pain symptoms possibly associated with a specific type of surgery, when compared with the rating of symptom prevalence and severity by others (physicians, nurses) who may be biased themselves or may introduce bias among patients. Additionally, we also reported data on QOL as well as recurrence and fertility using life table analysis. According to our systematic review on surgical treatment of bowel endometriosis (Meuleman et al., 2011), data on QOL were reported in only 10% of studies, on fertility outcome in less than 40% of studies and on recurrence in less than 45% of studies. Moreover, life table analysis of fertility outcome data was previously used only in our pilot study (Meuleman et al., 2009) and in two other studies (Coronado et al., 1990; Ferrero et al., 2009; Meuleman et al., 2009, 2011; Stepniewska et al., 2009). This is surprising in view of the fact that it has been generally accepted for more than 20 years (Olive, 1986) that life table analysis is the best way to calculate the fertility outcome as it controls for the duration of follow-up and drop-out rates.

Invasive surgery for endometriosis with bowel resection and reanastomosis has a positive effect on fertility, as we observed a cumulative pregnancy rate of ~50% within 3 years. Remarkably, life table analysis has been used in only 4 of 21 studies reporting fertility outcome after surgery for endometriosis with colorectal extension, as reviewed recently (Coronado et al., 1990; Ferrero et al., 2009; Meuleman et al., 2009, 2011; Stepniewska et al., 2009). This is likely that bowel resection and reanastomosis leaves behind less microscopic disease (Remorgida et al., 2005; Roman et al., 2009), possibly resulting in lower recurrence rates (Stepniewska et al., 2009; Meuleman et al., 2011) when compared with simple resection of a fibrotic bowel nodule because bowel endometriosis, rather than having the shape of a plaque, may follow the enterocele system (Anaf et al., 2004), may spread laterally to the point of serosal invasion (Remorgida et al., 2005) and has a multifocal and multicentric nature (Redwine and Wright, 2001; Kavallaris et al., 2003; Keckstein and Wiesinger, 2005; Remorgida et al., 2007). On the other hand, even where rectal segmental resection is performed, endometriotic foci may be found on and outside the limits of the digestive resection, as we (Meuleman et al., 2009) and others (Roman et al., 2009) have shown.
In conclusion, pain, sexual function and QOL improve significantly and are associated with a good fertility rate and a low complication and recurrence rate after a CO\textsubscript{2} laser laparoscopic radical excision of endometriosis with colorectal wall invasion combined with laparoscopic segmental bowel resection and reanastomosis.

**Authors’ roles**

C.M. (Reproductive Surgeon of the multidisciplinary surgical endometriosis team): conception and design of study, acquisition of data and analysis and interpretation x of data; drafting the article; final approval.

C.T. (Reproductive Surgeon, surgical assistant of the first author): acquisition of data and interpretation of data; revising the article; final approval. A.D. (Colorectal Surgeon of the multidisciplinary surgical endometriosis team): acquisition of data and interpretation of data; revising the article; final approval. A.B. (Study Assistant): acquisition of data; revising the article; final approval. B.C. (Urologist of the multidisciplinary surgical endometriosis team): acquisition of data; revising the article; final approval. I.V. (Head of the Department of Gynaecology, co-promoter of the study): interpretation of data; revising the article; final approval. I.V. (Head of the Department of Gynaecology, co-promoter of the study): interpretation of data; revising the article; final approval. F.P. (Head of the Department of Abdominal Surgery, co-promoter of the study): interpretation of data; revising the article; final approval. I.V. (Head of the Department of Gynaecology, co-promoter of the study): interpretation of data; revising the article; final approval. T.D. (Coordinator of the Leuven University Fertility Center, promoter of the study): interpretation of data; revising the article; final approval.

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