


# Fluorescence of Deep Infiltrating Endometriosis During Laparoscopic Surgery: A Preliminary Report on 6 Cases

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## Abstract

**Background.** The standard treatment of rectovaginal deep infiltrating endometriosis nodules (RVDIEN) consists in their surgical removal. RVDIEN are anatomically neovascularized. Indocyanine green (ICG) reveals vascularized structures when becoming fluorescent after exposure to near-infrared (NIR) light. This study aims to evaluate if fluorescence-guided surgery can improve the laparoscopic resection of RVDIEN, thus avoiding a rectal perforation. **Materials and Methods.** Patients with a symptomatic RVDIEN, scheduled for a laparoscopic rectal shaving, were enrolled in the study. Technically, the RVDIEN was targeted and removed with the help of the NIR imager device Image 1 Spies (Karl Storz GmbH & Co KG, Tuttlingen, Germany) or Visera Elite II (Olympus Europe SE & Co KG, Hamburg, Germany), after an intraoperative, intravenous injection of ICG (0.25 mg/kg). **Results.** Six patients underwent a fluorescence-guided laparoscopic shaving procedure for the treatment of a nonobstructive RVDIEN. Fluorescence of the RVDIEN was observed in all the patients. In one patient, once the main lesion was removed, the posterior vaginal fornix still appeared fluorescent and was removed. No intraoperative rectal perforation occurred. The postoperative hospital stay was 2 days. No postoperative rectovaginal fistula occurred within a median follow-up of 16 months (range = 2–23 months). **Conclusion.** In this preliminary study, fluorescence-guided laparoscopy appeared to help in separating the RVDIEN from the healthy rectal tissue, without rectal perforation. Moreover, this technique was helpful in deciding if the resection needed to be enlarged to the posterior vaginal fornix.

## Keywords

image-guided surgery, gynecologic laparoscopy, colorectal surgery

## Introduction

Deep infiltrating endometriosis (DIE) of the rectovaginal septum is a chronic disease associated with pelvic pain, deep dyspareunia, and different digestive symptoms, such as terminal constipation, rectal bleeding, and/or dyschezia. These symptoms deeply affect patients' quality of life.

Because rectovaginal DIE nodules (RVDIEN) partially consist of stromal fibrotic tissue that do not respond to hormonal therapies, their surgical removal is recommended if the disease is symptomatic.<sup>1,2</sup> Two main surgical procedures can be considered: the radical approach, which involves colorectal resection with removal of the rectal segment affected by the disease, and the conservative approach, which involves nodule excision. Nodule

excision can be performed without opening the rectum (shaving) or by removing the nodule along with the surrounding rectal wall (full thickness or disc excision).<sup>2</sup> So far, most of the patients with RVDIEN are managed by colorectal resection,<sup>3</sup> but short- and long-term postoperative complications appear to be consistent and affect patients' quality of life.<sup>1,3,4</sup> Some authors have recently

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encouraged a more frequent use of the conservative approach.<sup>4,5</sup>

Neovascularization of RVDIEN is a part of their pathogenesis. Endometriosis cells highly express VEGF.<sup>6</sup> Blood vessel density is increased and VEGF-A and VEGF receptor 2 are more often expressed in the stroma around the glands of RVDIEN than in samples obtained from ovarian endometriosis or superficial peritoneal endometriosis.<sup>7</sup>

Indocyanine green (ICG) has been used to determine the vascularization of different anatomical structures.<sup>8</sup> ICG becomes fluorescent once excited with a specific wavelength light in the near-infrared (NIR) spectrum. This technology has been integrated to Da Vinci devices (Intuitive Surgical Inc, Sunnyvale, CA) as well as to different conventional laparoscopic devices like Image 1 Spies (Karl Storz GmbH & Co KG, Tuttlingen, Germany) and Visera Elite II (Olympus Europe SE & Co KG, Hamburg, Germany). Based on the neovascularization of endometriotic lesions, intraoperative detection of the lesions using NIR imager technology has also been described.<sup>9,10</sup>

We recently reported a new technique of minimal invasive resection of RVDIEN (Fastrez M, De Neef A, Rozenberg S, Dapri G, Cadière GB, unpublished data), adapted from Possover et al<sup>11</sup> and Kondo et al.<sup>12</sup> The aim of the present study was to evaluate if fluorescence-guided surgery can improve the laparoscopic resection of RVDIEN and avoid a rectal perforation.

## Materials and Methods

Patients aged 18 years or older, with a symptomatic RVDIEN, for whom a laparoscopic shaving procedure was indicated, were eligible to enter this study. Exclusion criteria were the following: pregnancy or possible pregnancy, abnormal PAP test within a 3-year period before screening of the patient, and presence of suspected endometrial, cervical, and/or ovarian malignancy. All patients underwent preoperative standardized symptoms and signs assessment, a pelvic magnetic resonance imaging (MRI) and a double-contrast barium enema (DCBE). Based on the DCBE results, patients with no suspicion of rectal muscularis involvement by the RVDIEN were selected to enter the study.<sup>13</sup> The study was approved by the institutional review board (Ref No. AK/15-12-134/4588AD). All the patients signed an informed consent form.

### Fluorescence-Guided Laparoscopic Surgery

Patients underwent bowel preparation consisting of a 5-day fiber-free diet and 2 complete intestinal enemas on the day before surgery. Patients were offered to undergo

laparoscopic surgery after an intravenous injection of fluorescing dye ICG (0.25 mg/kg), performed at the time of skin's incision. The peritoneal cavity was inspected and all the endometriosis lesions were described, using the American Society for Reproductive Medicine classification.<sup>14</sup>

Superficial peritoneal endometriosis lesions were removed using monopolar coagulation and patients with endometrioma underwent cystectomy.

RVDIEN were targeted with the help of the image-guided surgery device, Image 1 Spies (Karl Storz GmbH & Co KG) or Visera Elite II (Olympus Europe SE & Co KG). The rectum with the RVDIEN "en bloc" was mobilized from the posterior vaginal cul-de-sac in order to perform a facilitated rectal shaving far from the deep pelvis, following the technique described by Fastrez et al (unpublished data).

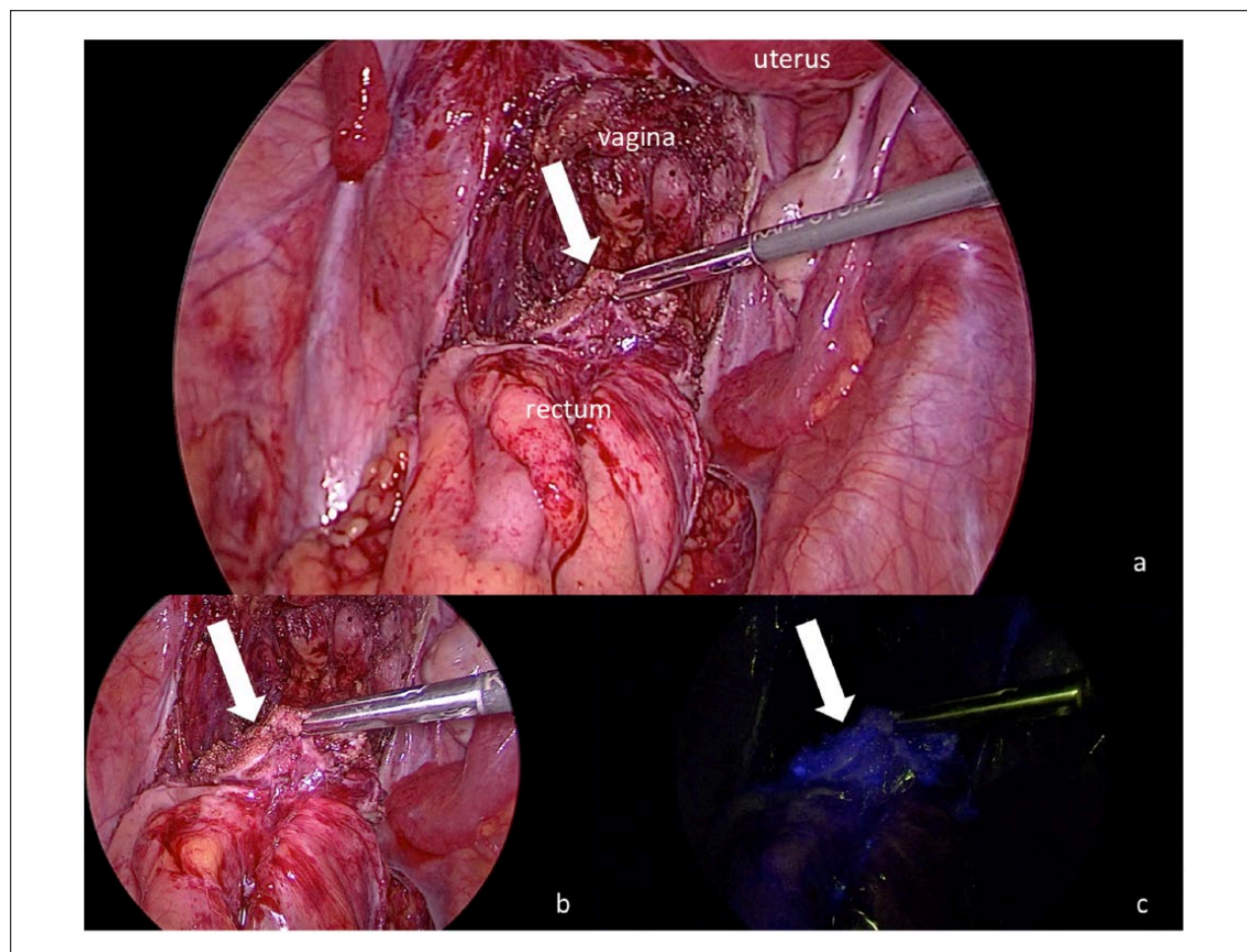
## Results

Six patients were included in the present study. The NIR imager device Image 1 Spies (Karl Storz GmbH & Co KG) was used in the first 5 cases, and the Visera Elite II (Olympus Europe SE & Co KG) in the latter one.

One patient did not present any RVDIEN during laparoscopic exploration: the preoperative clinical examination and MRI interpreted the "kissing ovaries" on the posterior uterine isthmus as a RVDIEN, but this hypothesis was not confirmed after having freed the 2 ovaries. RVDIEN, as well as peritoneal lesions, appeared fluorescent in every case. Ovarian endometriotic cysts were not fluorescent. The limits between the fluorescent RVDIEN and the nonfluorescent rectum were very clear (Figure 1). A shaving procedure was performed in 5 patients. In one case, after the shaving was performed, although no vaginal lesion was digitally palpated, the posterior vaginal cul-de-sac appeared fluorescent and was therefore removed. The opened vagina was closed using separate "figure of 8" suture by Polysorb 1 (Covidien, Dublin, Ireland). The vagina was opened in 2 cases. No rectal perforation occurred during the shaving procedure. The postoperative hospital stay was 2 days. No postoperative rectovaginal fistula occurred within a median follow-up of 16 months (range = 2-23).

## Discussion

Fluorescence-guided surgery has already several applications, in gastrointestinal surgery, to improve the detection of different lesions (eg, hepatic metastases in colorectal cancer).<sup>15</sup> It is also used in gynecologic oncology for the detection of sentinel lymph node in cervical and endometrial cancer.<sup>16,17</sup>



**Figure 1.** (a) Laparoscopic view of the pelvis, with the RVDIEN (see arrow) remaining attached to the rectum. (b) Closer view of the RVDIEN (see arrow) attached to the rectum. (c) Fluorescent RVDIEN (see arrow) attached to nonfluorescent rectum in NIR mode.

In the field of endometriosis, fluorescence-guided surgery has been first described by Levey in a case report for the detection of superficial peritoneal endometriosis.<sup>9</sup> Park and Farnam proposed its utilization for the intraoperative visualization of the ureter during the dissection of DIE.<sup>18</sup> Guan et al reported the first case of fluorescence-guided robot assisted, single-site laparoscopy for the management of deep endometriosis of the rectum.<sup>10</sup>

In this preliminary series, we applied fluorescence-guided laparoscopy to the surgical excision of RVDIEN, which appears as an example of how to apply new technologies to the difficult surgical management of RVDIEN.

The debate concerning the choice of the best surgical approach in the treatment of RVDIEN is far from being over. Several authors prefer the conservative approach, because the radical approach is associated with more intra- and postoperative morbidity.<sup>1,2,5</sup> Intraoperative rectal perforation is reported, especially when it is

concomitant with the opening of the vagina, to lead to more frequent postoperative complications such as rectovaginal fistula.<sup>3</sup>

On the other hand, improvement of symptoms is achieved thanks to the complete excision of endometriotic implants.<sup>19-21</sup> Moreover, in order to decrease the risk of recurrence, it is fundamental to remove all endometriotic tissue.<sup>22</sup> Meuleman et al reported a significantly lower risk of recurrence in the radically treated patients' group (2.5%) than in the conservatively managed group (5.7%).<sup>3</sup> Nevertheless, there are not enough comparative studies in the literature, confirming the higher risk of recurrence in patients managed by conservative surgery.

The completeness of surgery is important but a rate up to 15% of positive bowel margins has been reported after colorectal resection.<sup>5</sup> Endometriosis lesions could indeed infiltrate the large bowel preferentially along the nerves,

even at a distance from the palpated lesion<sup>23</sup> and may spread laterally to the point of serosal invasion, possibly explaining the positive margins after resection.<sup>3</sup> It seems that a complete macroscopic resection is important but microscopic margins are not to be achieved in order to improve symptoms and to decrease the recurrence rate.<sup>5</sup>

Our hypothesis is that the fluorescence-guided surgery could help in a complete resection, without being too invasive for the patient. In our preliminary experience, fluorescence imaging helped to achieve a macroscopic complete resection of the disease, without rectal perforation, in all the cases. The technique can probably be applied also to patients with preoperatively suspected muscularis involvement on DCBE, in order to offer more chances to be treated by shaving procedure.

Finally, despite this promising first experience, larger clinical trials, with long-term follow-up, are needed to confirm the usefulness and clinical results of this novel technique.

### Author Contributions

Study concept and design: Maxime Fastrez

Acquisition of data: Auriane De Neef, Romain Barbieux

Analysis and interpretation: Guy-Bernard Cadière, Pierre Bourgeois, Maxime Fastrez, Auriane De Neef

Study supervision: Giovanni Dapri

### Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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