Robot-assisted laparoscopy for deep infiltrating endometriosis: international multicentric retrospective study

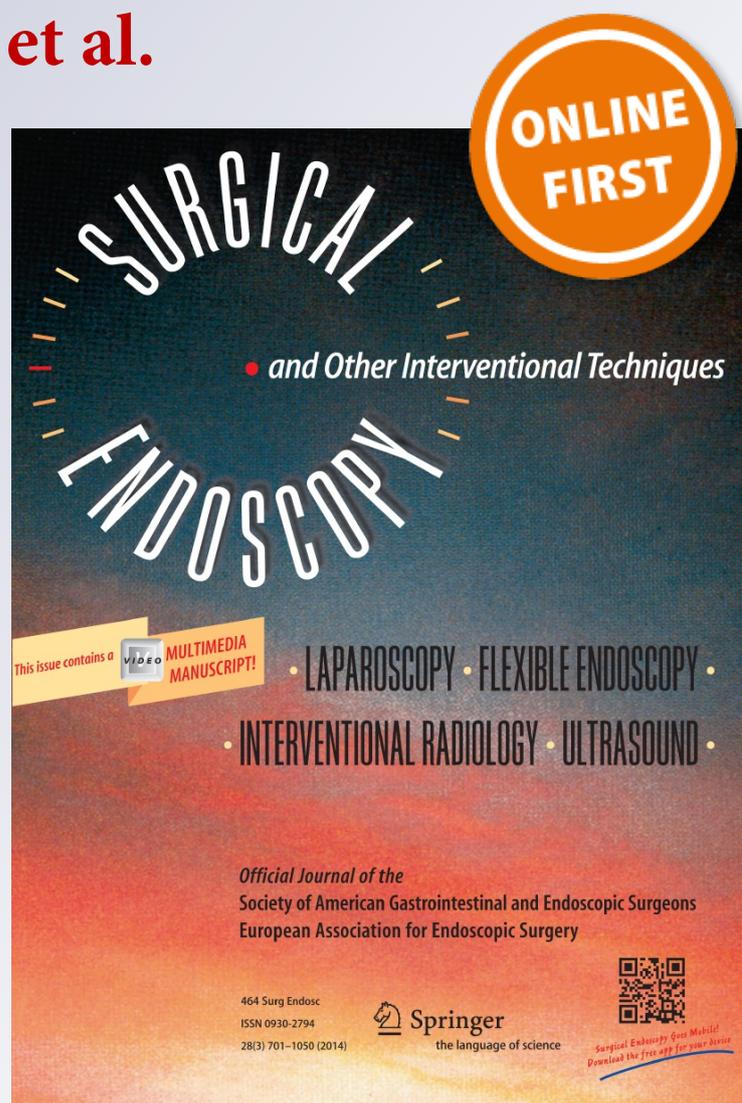Pierre Collinet, Pierre Leguevaque, Rosa Maria Neme, Vito Cela, Peter Barton-Smith, Thomas Hébert, Sandy Hanssens, Hirotaka Nishi, et al.

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Robot-assisted laparoscopy for deep infiltrating endometriosis: international multicentric retrospective study

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Peter Barton-Smith · Thomas Hébert · Sandy Hanssens · Hirotaka Nishi ·
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Abstract

Background This study aimed to assess the interest in robot-assisted laparoscopy for deep infiltrating endometriosis and to investigate the perioperative results.

Methods From November 2008 to April 2012, 164 women with stage 4 endometriosis who underwent robot-assisted laparoscopy (da Vinci Intuitive Surgical System) were included by to eight international participating clinical centers. This study evaluated the procedures performed, the duration of the intervention, the complications, the recurrence, and the impact on fertility.

Results The average operative time was 180 min. The main complications were laparotomy ($n = 1$, 0.6 %), sutured bowel injury ($n = 2$, 1.2 %), transfusion for a 2,300-ml bleed ($n = 1$), prolonged urinary catheterization ($n = 1$, 0.6 %), ureter-bladder anastomotic leak ($n = 1$, 0.6 %), and ureteral fistula after ureterolysis ($n = 2$, 1.2 %). The reoperation rate was 1.8 % ($n = 3$). The mean follow-up period was 10.2 months. A full recovery was experienced by 86.7 % (98/113) of the patients. After surgery, 41.2 % (42/102) of the patients had a desire for pregnancy, and 28.2 % (11/39) of them became pregnant.

Conclusion This study analyzed the largest series of robot-assisted laparoscopies for deep infiltrating endometriosis published in the literature. No increase in surgical time, blood loss, or intra- or postoperative complications was observed. The interest in robot-assisted laparoscopy for deep infiltrating endometriosis seems to be promising.

Deep-infiltrating endometriosis (DIE) is characterized by endometriotic lesions infiltrating the retroperitoneum or the wall of the pelvic organs [1, 2]. Its prevalence is difficult to evaluate because in the literature, the populations studied are most often not comparable. Moreover, both the

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diagnostic criteria and the methods of treatment vary from one team to another [3–6].

Endometriosis affects about 10–15 % of women of childbearing age [7, 8], with the rate reaching 50 % for infertile women [9] and with DIE affecting 20 % of endometriosis patients. Adequate management of this disease represents a real challenge on both the ethical and public health levels because of its physical, social, and psychological consequences. In fact, 50 % of women with confirmed DIE report chronic pelvic pain [10]. It also can be responsible for symptoms such as deep dyspareunia, menometrorrhagia, and infertility. Although some women can be asymptomatic, the symptoms exhibited by patients (particularly urinary and digestive symptoms) often show a good correlation with the location and infiltration of the lesion found (expressed as dysuria, dyschezia, tenesmus, diarrhea, dyschezia) [11]. Professionals have therefore agreed on recommending a multidisciplinary approach to its management.

The preoperative paraclinical investigations of DIE should include a mapping of lesions by both imaging and diagnostic laparoscopy. As the standard diagnostic test (grade A), diagnostic laparoscopy must be preceded by an adapted assessment and must be associated with a possibly concomitant therapeutic laparoscopy [2, 12]. If DIE is responsible for chronic pelvic pain and if medical management fails, the use of surgical treatment then is necessary according to the Agence Française de Sécurité Sanitaire des Produits de Santé recommendations for good practice (2005) [13].

The place of laparotomy in the management of DIE is difficult to assess because literature on the subject is scarce. However, although the surgical approach currently recommended for this indication is the laparoscopic one [14], because of its reduced morbidity, laparotomy still is preferred by many surgical teams. The surgery must be performed by trained operators, possibly with a one-time complete resection, and if necessary, with resection of the involved organs [12, 14, 15]. Although DIE is a benign disease, in most cases, a combined multidisciplinary team of gynecologic, urologic, and digestive surgeons is needed due to the complexity, and this type of surgery should be undertaken only after the patient's informed consent based on an understanding of the potential risks and benefits of these procedures.

Currently, robotic technology and telemanipulation systems represent the latest developments in minimally invasive surgery and have revolutionized conventional laparoscopy by offering improved ergonomics for the surgeon, three-dimensional visualization of the operating field, greater precision, and fine instrumentation, with six degrees of freedom allowing increased maneuverability of the instruments [16]. In addition, working of these systems is intuitive [17, 18], and the learning curve is rapid for surgeons who master conventional laparoscopy [19].

However, no recommendation and very few bibliographic data exist to obtain information on the use of robot-assisted laparoscopy in cases of DIE [20–24]. Thus, we intended to assess the interest in robot-assisted laparoscopic DIE nodule resection and to study the perioperative results. This was the first study to investigate an international series of robot-assisted laparoscopies for resection of deep endometriotic lesions in women experiencing stage 4 endometriosis.

Materials and methods

Retrospectively, all patients with histologically confirmed stage 4 endometriosis managed by robot-assisted laparoscopy (da Vinci Intuitive Surgical System, Sunnyvale, CA, USA) were included from the eight centers that participated in the study: France (Lille, Toulouse, Tours), Belgium (Liège), Italy (Pisa), England (Guildford), Brazil (São Paulo), and Japan (Tokyo). Patients with stage 1–3 endometriosis were excluded.
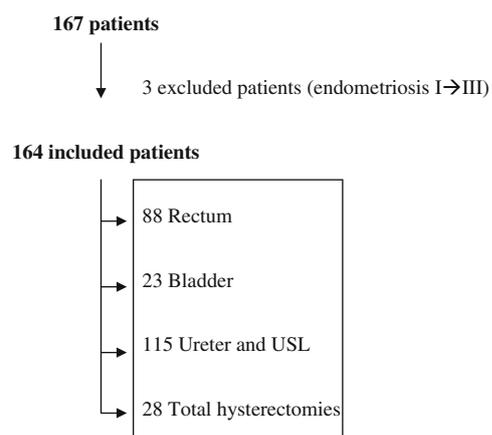
This study was conducted in collaboration with the French society Chirurgie Robotique Gynécologique and the Society of European Robotic Gynecological Surgery. Each patient received an information letter concerning registration and robot-assisted laparoscopic surgery preoperatively. Due to the study design (retrospective and multicentric), no ethical approval was requested.

All the patients had undergone surgery by gynecologic surgeons trained in the laparoscopic procedure, on the basis of one per center. The disease description was divided into four groups according to the location of the nodule (rectum, bladder, ureter, and uterosacral ligaments) and included patients who also had undergone simultaneous hysterectomy. Most of the patients had nodules in more than one location and were included in several groups. The use of three or four robotic arms depended on the anatomic difficulties encountered.

Data were collected by analysis of patient records. There was no selection for the use of the robot. The choice was left to the surgeon based on his experience and the availability of the robot. The criteria for the study included surgical history, symptoms, pre- and post-operative medical treatment, intraoperative assessment, duration of intervention, procedures performed, complications, recurrence, and impact on fertility.

Statistical analysis

Data were collected anonymously from an Excel database and analyzed using the statistical analysis system (Cary, USA) version 9.2 software. They are presented as percentage and/or mean ± standard deviation for continuous variables and as discrete variables for rates.

167 patients

↓ 3 excluded patients (endometriosis I→III)

164 included patients

→ 88 Rectum

→ 23 Bladder

→ 115 Ureter and USL

→ 28 Total hysterectomies

Fig. 1 Distribution of included patients. *USL* uterosacral ligaments

Table 1 Patients' characteristics and symptoms

| Characteristics	n (%)
No. of cases	164
Age: years (range)	34.1 ± 7.3 (20–61)
BMI: kg/m^2 (range)	24.4 ± 8.2 (17.3–38.6)
History of endometriosis surgery	35 (29.8)
Nulliparous	80 (71.4)
Primiparous or multiparous	32 (28.6)
Infertility (years)	35 ± 3.0 (20.8)
Symptoms	
Dysmenorrhea	98 (58.3)
Chronic pelvic pain	68 (40.5)
Dyspareunia	80 (47.6)
Menometrorrhagia	21 (12.5)
Urinary functional signs	20 (11.9)
Digestive functional signs	47 (28)
Preoperative hormonal treatment by GnRH agonists	29 (17.3)

BMI body mass index; *GnRH* gonadotropin-releasing hormone

Results

From November 2008 to April 2012, 167 patients underwent robot-assisted laparoscopy. The study excluded 3 patients with stage 2 endometriosis, leaving a study cohort of 164 patients. The mean age of the patients was 34.1 years (range 20–61 years) (Fig. 1. Of the women in this study, 33 % (n = 39) had undergone previous surgery, and 29.8 % (n = 35) had a history of ovarian surgery for endometriosis. The characteristics of the patients are listed in Table 1.

The main symptom described by the patients was dysmenorrhea (58.3 %, n = 98). Functional gastrointestinal
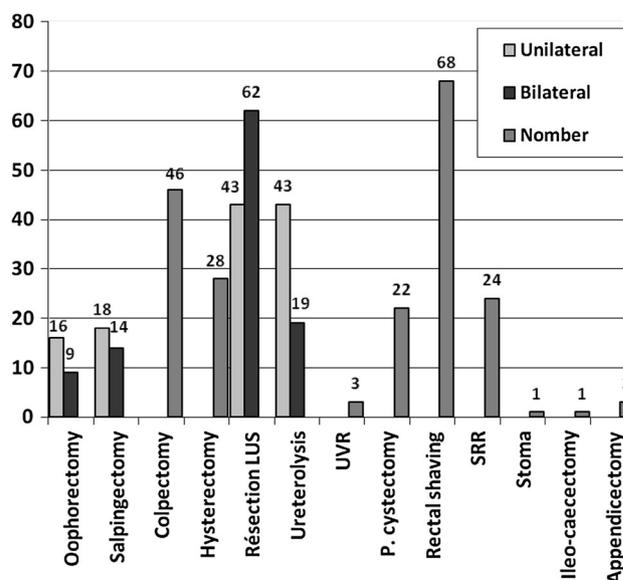
Fig. 2 Types of surgical procedures. *UVR* ureterovesical reimplantation, *P. Cystectomy* partial cystectomy, *SRR* segmental recal resection

signs and disorders were observed in 28 % of the patients (n = 47), and 11.9 % (n = 20) presented with urinary symptoms. In this cohort of patients, 21 % (n = 35) were infertile, and the mean duration of infertility was 3 years.

Before surgery, a mapping of endometriosis lesions was performed. Preoperative magnetic resonance imaging was performed for 61.9 % of the patients (n = 104), and in cases of doubt about a urinary or digestive lesion, urinary analysis (3.6 %, n = 6) and transrectal ultrasound (10.7 %, n = 18) were performed, respectively. Ureteral stents were placed preoperatively in 24 cases (35.3 %) (unilaterally in 17 cases and bilaterally in 7 cases). The types of procedures performed are listed in Fig. 2.

The study included 88 patients in the rectum group (54 %), 23 in the bladder group (14 %), 11 in the ureter and uterosacral ligaments group (70 %), and 28 in the total hysterectomy group (17 %). For 74 patients (45.1 %) multiple surgical procedures were performed.

The number of robotic arms used varied depending on the operator and the type of intervention, with most cases managed using three robotic arms (Table 2). The robot was side-docked on the left side in 78.5 % of the cases. The average operative time was 180 ± 77.2 min, and the median time with the console was 137.6 ± 80.6 min. The size of the deep endometriosis lesions was 2.50 mm.

In the rectum group, 79 % (37/47) of the patients had gastrointestinal symptoms compared with 21 % (10/47) of the patients who had no gastrointestinal disorders (p = 1.4.10^{-9}). The main complications experienced in this group are listed in Table 2. A laparotomy conversion was performed during a segmental rectal resection. Two

Table 2 Results and main complications

	Rectum 88	Bladder 23	Ureter+USL 115	Hysterecomy 28	Total 164
Trocars	3.12	3.78	3.16	2.92	3.24
Operative time (min)	188.2 ± 75.7	207.2 ± 85.5	183.9 ± 83.6	198.5 ± 94.9	180 ± 77.2
Blood loss (ml)	127.5 ± 293.3	57.6 ± 251.8	118.6 ± 289	88.2 ± 139.7	85.1 ± 241.3
Main complications	1 Conversion to laparotomy	1 Vesicovaginal hematoma (4.3 %)	2 Ureteral fistulas	None	
	1 Blood transfusion of red blood cells	1 Case of prolonged self-catheterization	1 Wound dehiscence after ureterovesical reimplantation		
	2 Sutured rectal wounds (1.2 %)				
Hospital stay (days)	4.2 ± 2.7	5.1 ± 2.5	3.7 ± 3.0	4.0 ± 3.1	4.0 ± 2.8
Follow-up (months)	11.4 ± 8.6	9.7 ± 7.5	9.8 ± 8.2	12.7 ± 8.2	10.2 ± 8.5
Recurrence: n (%)	9/88 (10.2)	2/23 (8.7)	11/115 (9.6)	2/115 (7.1)	12/102 (11.8)
Delay (months)	0.5 ± 4.9	19.5 ± 1.5	5.8 ± 5.2	7.7 ± 1.2	6.9 ± 9.3
Subsequent fertility: n (%)	8/88 (10.2)	0	8/75 (10.7)	0	13/97 (13.4)

USL uterosacral ligaments

rectal injuries occurred during rectal shaving. The one was sutured, and the other needed a segmental rectal resection without stomia. The patients had no fistulas or abscesses. This group also had increased blood loss (127.5 ± 293 ml; median 30 ml; range 5–2,300 ml) and one case of severe bleeding (2,300 ml) during a bowel resection, requiring blood transfusion.

In the bladder group, 55 % (11/20) of the patients had urinary symptoms compared with 21 % (9/20) of the patients without urinary disorders ($p = 0.27$). The complications in this group included a vesicovaginal hematoma after a partial cysectomy and one patient who required intermittent self-catheterization for 6 months. No reoperations or fistulas occurred.

In the ureter and uterosacral ligaments group (115 patients), two ureteral fistulas occurred. The first case occurred after rectal shaving and ureterolysis, and the second case occurred after a partial cystectomy and ureterovesical reimplantation. In the latter case, a wound dehiscence required a second ureterovesical reimplantation.

In the total hysterectomy group (28 patients), 28 % of the patients ($n = 46$) required partial colpectomy due to vaginal endometriosis infiltration, and no major complications occurred.

The overall reoperation rate was 1.8 % ($n = 3$). The surgeries involved drainage of an abscess wall, two ureterovesical reimplantations, and a ureteric fistula. No complication related to the long and steep Trendelenburg position occurred during the robotic surgery.

The average size of the largest endometriosis nodule was 2.5 cm (range 0.4–5.5 cm). In six cases, the histologic examination showed nonspecific fibrosis and did not exhibit endometriotic glands or stroma. However, the diagnosis of endometriosis was strongly suspected preoperatively and confirmed visually during the operation by the surgeon. The patients in five of these cases had a history endometriosis with confirmed histologic evidence.

The mean follow-up period was 10.2 ± 8.5 months. Among these patients, 86.7 % (98/113) had complete recovery, 12.3 % (14/113) had persistent postoperative pain, 3.5 % (4/113) had postoperative urinary symptoms, and 5.3 % (6/113) had postoperative gastrointestinal symptoms. Concerning fertility, 41.2 % (42/102) of the patients had a desire for pregnancy, and 28.2 % (11/39) of them became pregnant after surgery.

Discussion

This report describes the largest series of robot-assisted laparoscopies for deep infiltrating endometriosis, which demonstrated the feasibility of the procedure. Several authors have reported single cases of robot-assisted laparoscopic DIE nodule resection. In 2008, Chammas et al. [22] described a partial cystectomy performed with ovarian cystectomy, resection of a rectal nodule without digestive bypass, and peritoneal multiple resections. The intervention, performed with the da Vinci system, lasted 185 min, a duration near our mean operative time. Nezhat and Rogers [20] reported a trachelectomy performed for chronic pelvic pain with metrorrhagia that occurred after subtotal abdominal hysterectomy, with findings of adhesions and many deep pelvic endometriosis lesions. The same team also performed a partial cystectomy for invasive bladder

endometriosis [21]. These early publications demonstrated the feasibility of robot-assisted laparoscopy for DIE.

More recently, Nezhat et al. [24] published a series of 78 cases comparing conventional ($n = 38$) and robot-assisted laparoscopic ($n = 40$) resection of endometriosis whatever the stage of the disease. This study is the only comparative analysis of endometriosis. In this study, only 5 % (2/40) of the patients had stage 4 endometriosis. Robot-assisted surgeries were longer (191 vs 159 min), but the complication rates and blood loss were comparable between the two groups. In our series, the average duration of the procedure was similar to that mentioned by Nezhat et al. [24], but all our patients had stage 4 endometriosis. The mean blood loss was comparable with that in the literature data [24, 25].

Nezhat et al. [24] did not show any benefit of robot-assisted laparoscopic resection for stages 1 and 2 endometriosis and therefore recommended such surgery for the most severe DIE cases (stages 3 and 4). The robotic to laparotomy conversion rate seems to be lower than the laparoscopy to laparotomy conversion rate, as shown in both Nezhat et al. [24] (0 %) and the current series (0.6 %), compared with 10 % rate in the literature for laparoscopy [14, 26, 27]), suggesting a possible robotic advantage for these young women who have often undergone many surgical procedures.

Finally, in 2011, Brudie et al. [28] published a series of 80 patients who underwent surgery by robot-assisted laparoscopy for stage 4 endometriosis. The mean operating time was shorter than in our series (115 min), but the procedures were less complex (77.6 % hysterectomies, 36.3 % ureterolyses, no rectal shaving, no bowel resection, no partial cystectomy, and no ureterovesical reimplantation). The authors had to resort to laparotomy conversions for 5 % of their patients compared with 0.6 % in our series. Bleeding was comparable in the two series, and no cases of transfusion were noted in the series of Brudie et al. [28]. Their 1.3 % reoperation rate also was comparable with the rate in our study.

The main disadvantages of robot-assisted surgery are nevertheless still valid. High cost and, for the time being, limited accessibility hamper a proper assessment of the learning curve. But if the lack of tactile feedback was criticized during the initial use of the robot, improvement of the image thanks to the three-dimensional vision fills in the gap and increases the accuracy of delicate dissection around sensitive structures such as the bladder or the rectum without compromising the detection of lesions.

In view of our results, robot-assisted laparoscopy seems to have a place in the surgical treatment of stage 4 DIE. If the initial operating time seems longer, it is shortened with surgical experience. In addition, although the docking procedure inevitably lengthens the setup, the console advantages of robot-assisted laparoscopy make it possible to reduce the subsequent operating time, which can only be of advantage to the patient. The complications in the short and medium terms that we observed have been described for similar procedures regardless of the surgical approach. We also observed a decrease in laparotomy conversions (0.6 %, $n = 1$), and few complications requiring reoperation (1.8 %, $n = 3$).

The complication rates in our study were consistent with those described in the literature for conventional laparoscopy [29]. The morbidity remains low for such complex procedures. In addition, the many advantages of robot-assisted laparoscopy may encourage more suitably trained surgeons to use a minimally invasive approach in the management of complex cases for which they might previously have used laparotomy. This study did not evaluate the quality of life experienced by the patients. It would be useful for future prospective studies to incorporate pre- and postoperative scores.

The patients were followed for an average of 10.2 months, and longer-term evaluation is needed. This explains, in particular, the lower fertility rates after surgery in our series compared with those in the literature (28.2 % in our series vs 23–69 % in the literature [29–31]). This also may explain the lower recurrence rate (10.2 % in our study vs 30 % in the literature [32]).

Ideally, a direct comparison of robot-assisted and standard laparoscopy for DIE nodule resection is required to assess the benefits of the new robotic technology for patients compared with the recommended conventional surgical approach. The advantage of the robot-assisted approach is likely to be centered around the improved precision of the surgical procedure for these complex cases.

Conclusion

To our knowledge, this study investigated the largest series of robot-assisted laparoscopies for DIE published in the literature. The interest in robot-assisted laparoscopy for DIE seems to be promising, and no increases in surgical time, blood loss, or intra- and postoperative complications were observed. It appears to reduce the rates of conversion to laparotomy and of laparotomy itself.

Probably, DIE is one of the best indications for robot-assisted laparoscopy in gynecologic surgery. However, our study was not comparative, and the benefits for patients still need to be confirmed. To this end, studies comparing standard laparoscopy and robot-assisted laparoscopy for each type of procedure (rectal shaving or segmental rectal resection, partial cystectomy, resection of uterosacral ligaments ± ureterolysis) are needed.

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