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ORIGINAL ARTICLE

Day case robotic ventral rectopexy compared with day case laparoscopic ventral rectopexy: a prospective study

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Abstract
Background Ventral rectopexy to the promontory has become one of the most strongly advocated surgical treatments for patients with full-thickness rectal prolapse and deep enterocele. Despite its challenges, laparoscopic ventral rectopexy with or without robotic assistance for selected patients can be performed with relatively minimal patient trauma thus creating the potential for same-day discharge. The aim of this prospective case–controlled study was to assess the feasibility, safety, and cost of day case robotic ventral rectopexy compared with routine day case laparoscopic ventral rectopexy.
Methods Between February 28, 2014 and March 3, 2015, 20 consecutive patients underwent day case laparoscopic ventral rectopexy for total rectal prolapse or deep enterocele at Michallon University Hospital, Grenoble. Patients were selected for day case surgery on the basis of motivation, favorable social circumstances, and general fitness. One out of every two patients underwent the robotic procedure ($n = 10$). Demographics, technical results, and costs were compared between both groups.
Results Patients from both groups were comparable in terms of demographics and technical results. Patients operated on with the robot had significantly less pain ($p = 0.045$). Robotic rectopexy was associated with longer median operative time (94 vs 52.5 min, $p < 0.001$) and higher costs (9088 vs 3729 euros per procedure, $p < 0.001$) than laparoscopic rectopexy.
Conclusions Day case robotic ventral rectopexy is feasible and safe, but results in longer operative time and higher costs than classical laparoscopic ventral rectopexy for full-thickness rectal prolapse and enterocele.

Keywords Rectal prolapse · Robotic surgery · Laparoscopy · Rectopexy · Day case surgery · Minimally invasive surgery

Introduction

Patients with rectal prolapse and enterocele are candidates for rectopexy to the promontory [1]. Laparoscopic rectopexy for total rectal prolapse or deep enterocele offers short-term advantages compared with the open approach: less abdominal discomfort, faster recovery, shorter hospital stay, and limited scarring [2–4]. Despite its challenges, laparoscopic anterior rectopexy for selected patients can be performed with relatively minimal patient trauma thus creating the opportunity for same-day discharge. We started to operate selected patients in an ambulatory setting [4]. We have reported our experience with a miniaturized robotic laparoscope holder for rectopexy, developed in an affiliated research unit (TIMC-GMCAO, Grenoble) in a prospective randomized trial [5]. The da Vinci Si robot

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(Intuitive Surgical Inc, Sunnyvale, CA, USA) was introduced in our hospital in January 2014. The aim of this study was to compare our first cases of fully robotic ventral rectopexy to standard laparoscopic cases for full-thickness rectal prolapse or deep enterocele in a day case surgery setting. As far as we know, these are the first consecutive cases of day case robotic-assisted anterior rectopexy reported to date.

Materials and methods

Patients

Between February 28, 2014 and March 3, 2015, all patients who underwent day case laparoscopic ventral rectopexy for total rectal prolapse or deep enterocele in our institution were included in the study. Patients were selected for day case surgery on the basis of motivation, favorable social status, and general fitness. One out of every two patients underwent the procedure with the four-armed robot da Vinci Si. All the procedures were performed by a single consultant (JLF). Nonambulatory ventral rectopexy, recurrent rectal prolapse, and more complex multicompartmental pelvic floor disorders were excluded from this study.

Preoperatively, a complete history was taken and a physical examination was performed. Full-thickness rectal prolapse was diagnosed in the standing, prone, and stooping position during straining. Deep grade 3 and 4 enteroceles were diagnosed by clinical examination. Dynamic video defecography (cysto-colpo-defecography in women) was performed in all patients prior to the procedure in order to confirm exteriorized rectal prolapse or deep enterocele. The radiological technique has already been described in a previous article [6]. All patients underwent proctosigmoidoscopy, anorectal manometry, endoanal ultrasound, and radiological colonic transit time testing.

Patients gave their consent after thorough explanation of the condition and the surgical treatment and ethical approval was received from the local institutional board. All patients were told about usual postoperative complications and specifically warned of a possibly longer hospital stay.

All patients were systematically called the day before operation by a nurse in the ambulatory unit.

Operations were planned as a first or second start in the morning and completed by midday, if possible.

Surgical technique

Standardized ventral rectopexy has been described in a previous article [2]. All patients were prepared with a 200 ml enema and received a single dose of cefoxitin (2 g intravenously) on induction. A Foley catheter was routinely inserted before surgery and removed at the end of the operation. Laparoscopy was performed through four ports. The table was tilted in marked Trendelenburg to facilitate small bowel retraction. The anterior aspect of the promontory was then exposed on the right side of the mesosigmoid using a hook dissector with monopolar diathermy, on a surface measuring 3 cm wide and 2 cm high, making sure not to damage the superior hypogastric plexus. The peritoneum of the pouch of Douglas was excised with the hook to free 8 cm of the anterior rectal muscular wall and the entire posterior vaginal wall in female patients, reaching the pelvic floor. No posterior or lateral dissection of the rectum was performed, to avoid any nerve damage. Two synthetic meshes measuring 20 × 1.5 cm (Parietex Prosup, Covidien, United States Surgical, Norwalk, CT, USA) were, respectively, fixed on the left and right anterior aspect of the lower rectum using five 4-mm titanium staples (Endo Universal 65° 4.0 mm, ref 173054, Covidien, United States Surgical, Norwalk, CT, USA) and fixed together to the right side of the promontory using three spiked chromium staples (Protack 5.0 mm, ref 174006, Covidien, United States Surgical, Norwalk, CT, USA). Last, the peritoneum was closed with continuous nonabsorbable suture over the meshes to isolate them from the abdominal cavity and create a shallow neo-pouch of Douglas. No drain was left in place. Intra-abdominal injection and port-site local anesthetic blocks were performed at the end of the procedure using 30 ml of 7.5 % ropivacaine in order to reduce postoperative pain. Other authors perform a similar procedure and called it "ventral" or "anterior" rectopexy [7]. In robotic-assisted laparoscopic rectopexy patients, the same technique was used, including monopolar dissection, removal of the peritoneal pouch, and mesh positioning and fixation. The four-armed robotic cart was docked on the left of the patient. The 10-mm robotic camera port was placed in the umbilicus. Two 8-mm robotic ports were inserted in the right and left iliac fossa and controlled hemotely by the surgeon. Another 12-mm port was placed in the right flank to allow the assistant (BT, SB, PYS, PAW or FR) to use suction if necessary, to remove the peritoneum once freed, to introduce the meshes, and to use the staplers.

Postoperative course and data collection

Patients' demographics, preoperative details (home setting, distance from home to hospital, previous operations, relevant past history, clinical and diagnostic findings, body mass index, American Society of Anesthesiologists (ASA) score, indication for surgery), operative data (operative time from skin incision to closure, operating room occupancy

duration), postoperative complications, length of hospital stay, and reason for any delays in discharge were prospectively collected. Patients were discharged the same day, if possible, with a standard analgesia protocol comprising ibuprofen 100 mg twice a day for 2 days, tramadol 100 mg twice a day for 7 days, and paracetamol with codeine on demand, but less than 2000 mg per day, for 7 days. Laxatives were also prescribed; paraffin oil, one spoon three times a day for 7 days, and glycerin suppository if necessary. A "first day" telephone questionnaire was designed to assess patient satisfaction for all day case surgery cases, for any kind of surgery, including laparoscopic or robotic-assisted laparoscopic rectopexy. The following information was collected: patient satisfaction; problems with early discharge, if any; degree of maximal pain during the first day at home using a visual analog scale (0 for no pain, 10 for unbearable pain); postoperative complications including pain, nausea, vomiting, headache, bleeding, and urinary retention; any additional comments. In case of pain over 4/10 or a complication, the surgeon was asked to call back the patient, for eventual readmission.

Costs were calculated by using costs for hospital admission, treatment, material costs during surgery, and time spent in the operating room per procedure including salary costs for attending surgeons, anesthesiologists, registrars, and nurses.

Patients were systematically reviewed at 30 days for study purposes. They were scheduled for follow-ups at 6, 12 months, and then annually for 5 years (the general policy in our colorectal unit).

Statistical analysis

Metric data were presented as median and range. Statistical analysis was performed by using SPSS 12 (SPSS Inc, Chicago, IL, USA). Fisher's test (conditions for Chi-square not satisfied) was used to compare nominal data between groups for female gender, pelvic surgery history, accompanied situation, significant past medical history, ASA score 1 or 2, indication external prolapse, complications, and hospital admission. A Mann–Whitney U nonparametric test for two independent samples was used to compare age, body mass index, operative time, room occupancy, length of stay, maximal pain, and costs. $p < 0.05$ was defined as being statistically significant.

Results

Patient characteristics

Ten patients (10 women) with a median age of 35.5 years (range 15–68 years) underwent a day case laparoscopic ventral rectopexy as described. They were compared to 10 patients (9 women and 1 man) with a median age of 57 years (range 20–73 years) who underwent day case robotic rectopexy as described.

The demographics of the cohort are reported in Table 1. There was no statistical difference between the two groups even in terms of age, despite a tendency for there to be younger patients in the laparoscopic group.

During the same 12-month period, 12 further patients underwent a ventral rectopexy but did not meet the inclusion criteria: 10 patients underwent a laparoscopic ventral rectopexy to the promontory for total rectal prolapse or enterocele with a conventional hospitalization of 2 days or more, because of social or medical reasons, or for a more complex pelvic floor disorder; another patient had an uneventful day case laparoscopic rectopexy to the promontory for a recurrent full-thickness rectal prolapse that was initially treated by laparoscopic rectopexy in another institution; the last patient, aged 83, underwent an anterior rectopexy to the promontory by laparotomy because of the previous failure of a laparoscopic approach in our institution due to multiple severe abdominal adhesions.

Operative and perioperative morbidity

A 68-year-old female patient from the laparoscopic group presented with intraoperative bleeding on the left anterior side of the lower rectum during removal of the peritoneum that was easily treated with electrocautery. The estimated blood loss was only about 40 milliliters. No further surgical complication was observed in this series.

There was no postoperative mortality. There was no 30-day postoperative morbidity. No recurrence was observed at 1 month. Surgical outcomes after laparoscopic and robotic-assisted ventral rectopexy are reported in Table 2. Operative time was clearly and significantly longer in the robotic-assisted laparoscopic group ($p = 0.01$).

Costs

When comparing the costs of the procedures (Table 3), robotic-assisted rectopexy appeared to be significantly more expensive than laparoscopic rectopexy ($p < 0.001$).

Discussion

The advantages of laparoscopic rectopexy over open surgery for exteriorized rectal prolapse are now well documented [2–4, 8–12]. The procedure has been proven to be as effective as open rectopexy in terms of clinical results,

Table 1 Demographics of patients undergoing laparoscopic or robotic-assisted anterior rectopexy

Patients	Laparoscopic surgery	Robotic surgery	*p*
Number = 20	10	10	
Female gender	10	9	0.474
Median age in years (range)	35.5 (15–68)	57 (20–73)	0.121
Pelvic surgery history	3[a]	5[b]	0.370
Accompanied	7	8	0.582
Significant past medical history	6[c]	8[d]	0.303
Median BMI in kg/m^2(range)	21.5 (18.1–28.1)	20.6 (18–27.3)	0.806
ASA 1 (ASA 2)	4 (6)	3 (6)	>0.999
Indication: external prolapse	7	8	>0.999

BMI body mass index, *ASA* American society of anesthesiologists

[a] 1 Stapled transanal rectal resection (STARR) procedure, one hysterectomy, and one caesarian section; [b] 5 hysterectomies

[c] 2 Anorexia nervosa, one diabetes mellitus, one sacral fracture S3, one hydatiform mole, one hip prosthesis

[d] 3 Hypertensions, one Arnold neuralgia, one nasal skin carcinoma, one nervous breakdown, one schizophrenia, and one removal of pituitary adenoma

Table 2 Surgical outcome after laparoscopic or robotic anterior rectopexy

Patients	Laparoscopic surgery	Robotic surgery	*p*
N = 20	10	10	
Median operative time (range)	52.5 (38–103)	94 (78–150)	0.001
Median room occupancy (range)	144.5 (123–169)	254 (222–339)	0.001
Surgical complications	1 (bleeding)	0	>0.999
Conversion	0	0	NS
Reoperation	0	0	NS
Median LOS (range)	11 (7.75–79.5)	11 (8.15–32.2)	0.967
Median maximal pain day 1 (range)	3.5 (2–7)	2 (0–6)	0.045
Hospital admission	4[a]	2[b]	0.628
Postoperative complications	0	0	NS

LOS length of stay, in hours

[a] Pain (n = 3) and urinary retention (n = 1) in the laparoscopic group

[b] Pain (n = 1) and urinary retention and vomiting (n = 1) in the robotic group

functional results, and recurrence rate. There are significant reductions in postoperative pain, hospital stay, recovery time, time until return to work, and length of scar. Most of the 175 patients from our previous published series were discharged from the colorectal unit the day after the procedure and four of them even went home on the same day, as day care surgery patients [4]. Nowadays, the tendency in our institution is to routinely offer a day case procedure to the patients with full-thickness rectal prolapse and deep enterocele who fulfill the inclusion criteria for ambulatory surgery. The use of the Da Vinci robot did not change our policy.

The preliminary results of our series of patients operated on for full-thickness rectal prolapse or symptomatic deep enterocele using ventral laparoscopic rectopexy and Douglassectomy with the Da Vinci robot showed that management in a day case surgery setting is effective and safe. This study also showed a significantly longer operative time and total time in the operating theater with the robot. We also demonstrated a higher cost with the robot. Many authors have compared robotic-assisted laparoscopic ventral rectopexy to laparoscopic ventral rectopexy in terms of feasibility, safety [13–16], cost [17], and functional results [18]. They did not mention adverse effects due to the use of the Da Vinci robot. Results of robotic-assisted laparoscopic rectopexy for rectal prolapse in the long-term [19], and particularly in elderly patients [20], reported in the literature did not include any negative impact of the use of the robot.

We could not demonstrate any superiority of robotic-assisted laparoscopic ventral rectopexy over laparoscopic anterior rectopexy for total rectal prolapse or deep

Table 3 Costs for one laparoscopic and one robotic anterior rectopexy procedure (in €)

Items	Laparoscopic surgery	Robotic surgery	*p*
Instruments and disposables			
Ports	90.00	122.00	
Endo universal 65°®	232.00	232.00	
Protack®	221.00	221.00	
Meshes	45.00	45.00	
Stitches	13.00	13.00	
Intuitive instruments® 0.00	1275.00		
Miscellaneous	29.00	37.00	
Total	630.00	1945.00	<0.001
Median cost of room occupancy (range)[a]	1014 (863–1186)	1783 (1558–2380)	<0.001
Median human resources (range)[b]	1113 (947–1301)	2261 (1976–2314)	<0.001
Robotic maintenance[c]	0.00	2127	<0.001
Admission[d]	972	972	NS
Postoperative complications	0	0	NS
Total cost per procedure	3729	9088	<0.001

[a] Cost for using the operating room at our institution: 7.02 € per minute

[b] Cost for operating room human resources: 7.70 € per minute including one surgeon, one anesthetist, two nurses, one registrar

[c] Not included: amortization, in disfavor of the robot (laparoscopic column around 150,000 €—Da Vinci robot around 2,500,000 €)

[d] Cost for the hospital stay (11 h in both groups). Pain killers and other medications (for example laxatives, enemas, suppositories) costs to treat patients "on demand" were not included

enterocele in terms of technical results. The reason why the registered pain on day 1 was significantly lower in the robotic-assisted laparoscopic group than in the laparoscopic group is unclear and might be well due to the low sample size and to the presence of a psychiatric patient in the laparoscopic group with an unreliable pain score. Another explanation could be that the duration of the robotic-assisted surgery necessitated more analgesic drugs, thus possibly decreasing the pain level on day 1.

Robotic ventral rectopexy was more time-consuming than the laparoscopic rectopexy. We must emphasize the fact that we started using the Da Vinci robot at the end of February 2014 and that this series includes a learning curve of the robotic technique for the consultant surgeon. The systematic use of the Da Vinci robot will possibly lead to a shorter operative time and a reduction of the costs. Perrenot et al. [19] explained that the learning curve with robot-assisted laparoscopic rectopexy for rectal prolapse is completed after 18 patients have been operated on.

In a very recent review on technical and functional results of ventral rectopexy for full-thickness rectal prolapse, we stated that in the long term, complication rate, recurrence rate, outcome in terms of de novo constipation and anal incontinence show that laparoscopic anterior rectopexy is an effective procedure for the treatment of patients with total rectal prolapse [21]. Advantages of the robotic ventral rectopexy over the well-described laparoscopic ventral rectopexy for treatment of rectal prolapse and enterocele still need to be evaluated in further studies.

This study has the following limitations: It is a single-center experience, the initial robotic experience of the consultant surgeon is included with its learning curve, and the number of targeted cases is small. However, while more experience may decrease the theater occupancy time and instrument costs, the maintenance costs will always remain high, making the robotic approach more expensive. Further prospective trials comparing robotic and laparoscopic ventral rectopexy, particularly in a day case setting, should include technical and functional results, recurrence rate, and total cost.

Conclusions

Day case robotic-assisted laparoscopic ventral rectopexy to the promontory is feasible and safe, but seems more time-consuming and more expensive than the laparoscopic technique at the beginning of the learning curve. The short-term results are comparable with those of laparoscopy.

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Compliance with ethical standards

Conflict of interest Prof. Jean-Luc Faucheron received honoraria for punctual interventions, punctual consultancies and had some reimbursed travels and prepaid subscriptions for meetings from AMI, Covidien, Medtronic, Ethicon, MSD, Legrand, and Johnson & Johnson. Dr. Fabian Reche has a commercial relationship with Endocontrol as a consultant and has been reimbursed for travel and meeting subscriptions by Covidien, Baxter, AMI, and Leo Pharma. Drs. Sandrine Barbois, Bertrand Trilling, Pierre-Yves Sage, and Pierre-Alexandre Waroquet have no conflicts of interest to disclose.

Ethical approval All procedures performed in this study were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments.

Informed consent For this study, patients have signed an informed consent.

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