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ORIGINAL ARTICLE

# Laparoscopic robotic-assisted restorative proctocolectomy and ileal J-pouch-anorectal anastomosis in children

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## Abstract

**Purpose** Total proctocolectomy with ileal J-pouch-anorectal anastomosis (IPAA) remains the preferred surgical treatment for ulcerative colitis (UC) in children. Considering the well-known advantages of minimally invasive approach, and its main application for the deep pelvis, robotic surgery may be used in UC reconstructive procedures. The aim of the study is to report our experience with Robotic IPAA in children.

**Methods** Single surgeon experience on Robotic IPAA were prospectively included. Data on patient demographics, surgical details, complications, and length of stay (LOS), were collected.

**Results** Fifteen patients were included. Median age was 13.2 years, median body weight 45 kg. Median operative time was 240 min. Median LOS was 7 days and mean follow-up time 1 year. No intraoperative complication occurred. Five postoperative complications happened: 3 minors treated conservatively (CD I–II), 2 majors needing reintervention under anesthesia (CD IIIb). No mortality was observed.

**Conclusion** Our preliminary experience reveals that Robotic IPAA is a safe and feasible option for the surgical treatment of UC in children. A bigger patient sample and a long-term follow-up are needed to confirm our findings.

**Keywords** Pediatric robotic surgery · Ileal pouch–anal anastomosis · Restorative proctocolectomy · Ulcerative colitis surgery

## Introduction

Restorative proctocolectomy (RPC) is the gold standard surgical treatment for patients with ulcerative colitis (UC) unresponsive to medical therapy [1–4].

The reconstruction is the most important stage of the surgical treatment and the use of small bowel loops as reservoir is a widespread option, because it seems to reduce the occurrence of bowel movements, leading to a better quality of life [5, 6].

A minimally invasive surgery (MIS) should be always considered for these complex patients undergoing multiple and complex abdominopelvic procedures, to reduce the adhesions incidence and the rate of complications occurrence [2–4, 7, 8].

Many authors showed the effectiveness, feasibility, and safeness of laparoscopic surgery for RPC and in specific for the ileo-pouch–anal–anastomosis (IPAA), but the narrow and constrained space of the pelvis could limit the depth and the precision of the rectal dissection and the accuracy of pouch anastomosis [4, 9–11].

In the lasts 2 decades the robotic approach has been the main character of MIS board.

All the well-known advantages of robotic surgery have been widely described in literature [10–12], but further benefits in the case of IPAA include improved dexterity, instrumentation degrees of movements in a tight space and a tridimensional visualization that allows the hypogastric

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nerve bundles preservation and accurate dissection of the rectum, until 2 cm from the anus, allowing a major disease burden removal with a deep pouch anastomosis [1, 13, 14]. In the last years, many adult patients with UC have been treated with robotic IPAA, and few reports are available in literature. Despite this, there are no previous reports evaluating the use of Da Vinci technology to perform IPAA in children. Mattioli et al. in their preliminary experience with Da Vinci Robotic Surgery reported the first 5 children undergoing robotic IPAA [15]

Robotic surgery (RS) is an extremely versatile tool, being suitable for procedure in anatomic structures particularly difficult to address and technically challenging when approached with conventional minimally invasive surgery. During IPAA, rectal dissection can be easily carried down to the elevator ani with minimal traumatism of perirectal structures with RS, implying a consequently reduced probability of continence impairment. Furthermore, when performing a proctectomy, the surgeon should consider performing a deeper mucosectomy, without anal exteriorization, to achieve the best disease burden removal. An ultrashort anastomosis may later be performed with either hand–sewn or stapled. Even if the manual anastomosis seems to allow an endorectal mucosectomy with continence preservation by spearing the anal transitional zone, the stapled technique, reducing anal handlings and allowing a technique standardization, seems to decrease postoperative complication rate and to increase the clinical patient outcomes [3].

Unfortunately, these technical aspects are results of expert opinions, no high evidence studies nor randomized controlled trials are currently available in literature.

The centralization of this complex pediatric disease could allow not only the surgeon technical skills upgrade, pushing the procedure further until the best balance between disease removal and continence preservation is reached, but could allow also to establish a research protocol to investigate the surgical tricks that grant the best outcomes for the patients.

Our report is a continuous prospective observational study of patients treated in two pediatric surgical units by one single surgeon. Therefore, the aim of the study is to describe our preliminary experience with Robotic IPAA in pediatric patients with UC.

## Methods

### Data collection

We prospectively included all the patients who underwent robotic IPAA for complicated and unresponsive UC in two periods of time (2015–2016 and 2019–2021) operated in two different pediatric surgical department by the same pediatric surgeon.

The following data for each patient were recordered: patient demographics, overall docking time, overall length of surgery, intraoperative and postoperative complications [16, 17], and length of hospital stay (LOS), were evaluated, and collected in an electronic database. Descriptive statistics were reported as absolute frequencies and percentages. Median and ranges were used to describe semiquantitative and quantitative variables.

## Results

### Patient characteristics

A total of 15 pediatric patients, 10 females and 5 males, were treated. Median age at surgery was 13.2 years (range 3.6–16.3 years), median weight was 45 kg (range 13–82 kg).

Diagnosis was made at a median age of 13 years (ranging between 2.6 and 15.8 years). Two patients (13%) were diagnosed before the age of 6 and, therefore, defined as very early onset inflammatory bowel disease (VEO-IBD), in one diagnosis was made before 10 years of age and identified as early onset IBD.

All data were summarized in Table 1.

### Perioperative results

Surgery was indicated for medically intractable UC in all patients. The procedures were performed in three stages in 13 patients (87%) and in two stages in 2 patient (13%). All patients underwent a first stage laparoscopic subtotal colectomy with ileostomy before IPAA, median of 5.9 months (range 2.1–12.6 months).

Docking time lasted a median of 20 min (range 15–30 min). Console time lasted a median of 100 min (range 75–140 min). Overall surgery lasted a median of 240 min (range 150–400 min).

No patients required transfusion during or after surgery. The median LOS was 7 days (range 3–15 days). The median follow-up time was 1 year (range 0.1–6.2 years).

### Complications

No intraoperative complications or conversions occurred during robotic IPAA. Five (33%) postoperative complications happened during the study period: 3 (20%) were minor complications treated conservatively (Clavien–Dindo I–II), 2 (13%) were major complications needed a surgical reintervention under general anesthesia (Clavien–Dindo IIIb).

Fever occurred in one patient after surgery, and it was managed conservatively (Clavien–Dindo I). Two child had episodes anal bleeding, managed with success using topical mesalazina (Clavien–Dindo II). One of them, about 1

**Table 1** Patients demographics, operative and postoperative complications, duration of surgery, and length of hospital stay, follow-up time

| Patient N° | Age at Surgery (years) | Sex | Weight (Kg) | Open Conversion | Intraoperative Complications (Satava) | | | Postoperative Complications (Clavien–Dindo) | | | | | | Surgical Timing (minutes) | LOS | Follow-up time (years) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | SI | SII | SII | CD I | CD II | CD IIIa | CD IIIb | CD V | CD IV | | | |
| 1 | 16.3 | M | 69.0 | No | | | | | | | | | | 225 | 11 | 2.3 |
| 2 | 16.2 | M | 45.0 | No | | | | | Anal bleeding | | | | | 185 | 10 | 1.1 |
| 3 | 13.9 | M | 55.0 | No | | | | | | | | | | 270 | 4 | 0.3 |
| 4 | 11.8 | F | 36.8 | No | | | | | Anal bleeding | | Intestinal occlusion (adhesions)—1 month after IPAA | | | 240 | 15 | 0.3 |
| 5 | 15.3 | F | 58.0 | No | | | | | | | | | | 165 | 7 | 0.1 |
| 6 | 12.1 | F | 60.0 | No | | | | | | | | | | 150 | 10 | 0.1 |
| 7 | 14.7 | M | 42.0 | No | | | | Fever | | | | | | 185 | 10 | 1.0 |
| 8 | 11.4 | F | 32.0 | No | | | | | | | | | | 215 | 4 | 0.6 |
| 9 | 3.6 | F | 13.0 | No | | | | | | | | | | 205 | 7 | 0.3 |
| 10 | 13.2 | F | 47.0 | No | | | | | | | | | | 250 | 12 | 0.1 |
| 11 | 15.6 | F | 47.0 | No | | | | | | | | | | 240 | 3 | 6.2 |
| 12 | 4.3 | F | 17.0 | No | | | | | | | | | | 325 | 6 | 5.9 |
| 13 | 13.2 | F | 43.0 | No | | | | | | | Intestinal occlusion (adhesions)—2 days after IPAA | | | 270 | 3 | 5.9 |
| 14 | 15.5 | M | 82.0 | No | | | | | | | | | | 400 | 9 | 5.9 |
| 15 | 8.9 | F | 18.0 | No | | | | | | | | | | 305 | 5 | 5.4 |

month after the IPAA procedure, had an episode of occlusion due to a volvulus treated with derotation and closure of the stoma (Clavien–Dindo IIIb). The second one, 2 days after IPAA procedure had an episode of bowel subocclusion treated with laparoscopic adhesiolysis and ileostomy closure (Clavien–Dindo IIIb).

No life threating complication or death occurred during the study period.

## Surgical technique

Subtotal colectomy with ileostomy were performed with the laparoscopic approach. Robotic proctectomy with IPAA was carried out after a median time of 6 months.

A preoperative, intraoperative, and postoperative Enhanced Recovery After Gastrointestinal Surgery (ERAS) protocol was used for all the patients [18].

All cases are discussed by a multidisciplinary team, the operative team was composed by a pediatric surgeon with experience in surgery for inflammatory bowel disease at the robotic console and a robotic trained surgeon and resident at the patient side. Dedicated robotic nurse team and anesthetist were included in the staff.

The OR setting and access placement are discussed the day before the procedure (Figs. 1, 2).

The patient was placed in supine position, with legs spread apart, allowing a contemporary abdomen and perineum exposure (Fig. 3).

Ileostomy is dissected free from the fascia using sharp dissection and electrocautery and a linear stapler is used to close the terminal ileum. This is folded back and pulled down to the pubis to assess whether it easily reaches the anal plane once the pouch has been created. A 4–6 cm J-pouch is constructed using linear stapler, then mesentery incisions are performed on the anterior and posterior sides to gain a tension-free ileal pouch. An incision is made on the base of the pouch and the circular stapler anvil is positioned inside. The blind limb of the pouch and the linear staple line are then oversewn together (Fig. 4).

The pouch with the anvil is released back into the abdomen, and the 12-mm Airseal trocar is positioned as extra working port. Four robotic ports are placed under direct visualization on umbilical transverse line, each trocar is placed 4–6 cm apart to prevent robotic arms conflicts (Fig. 5).

The patient is placed into a steep Trendelenburg position to allow the small bowel to fall cephalad, exposing the pelvis and the Da Vinci Surgical System is then docked (Fig. 2).

The proctectomy starts dissecting the presacral space first from the posterior side to preserve the hypogastric nerves (Fig. 6). It is important to pull the rectal stump to provide an appropriate tension to facilitate the dissection. It continues laterally with the mesentery detachment and finally the anterior dissection (Fig. 7).

After the visualization of the pelvic floor, the rectum is transanally exposed with a rectal probe to allow an accurate dissection (until 3–2 cm from the external anal sphincter) and an anastomosis over the anorectal junction, with cautious to not to harm the sphincter complex (Fig. 8). The rectum is transected, and the pouch is stapled to the anal canal (Figs. 9 and 10). The robotic system is undocked, the rectum stump is removed through the ileostomy site and a tension free diverting loop ileostomy (around 20–40 cm proximal from the pouch) is created. The nasogastric tube was removed after the procedure.

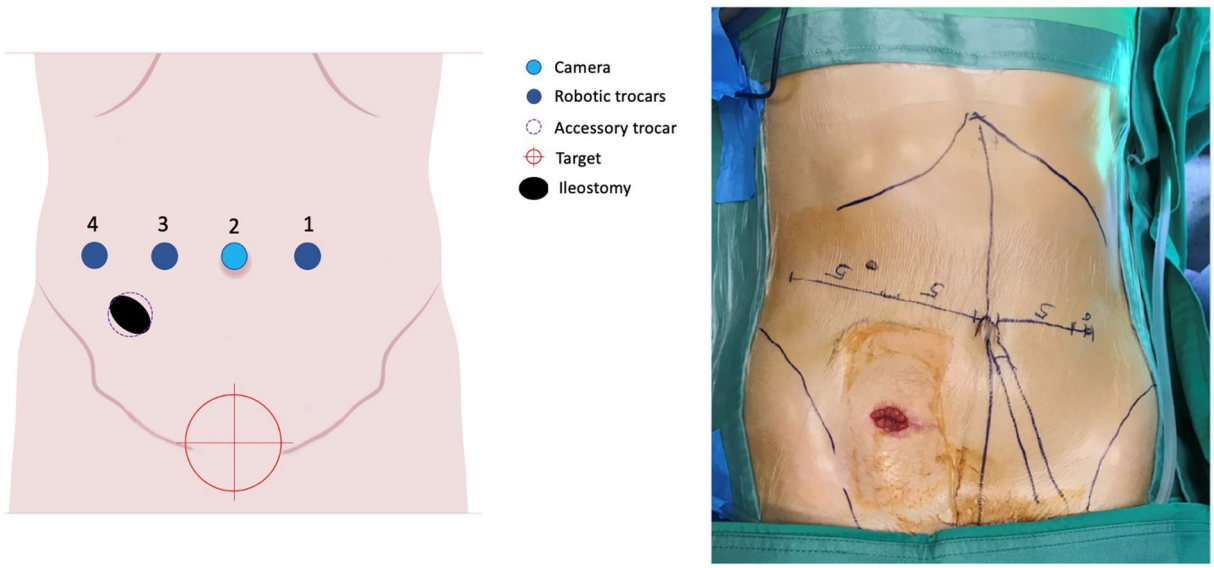


**Fig. 1** Access placement

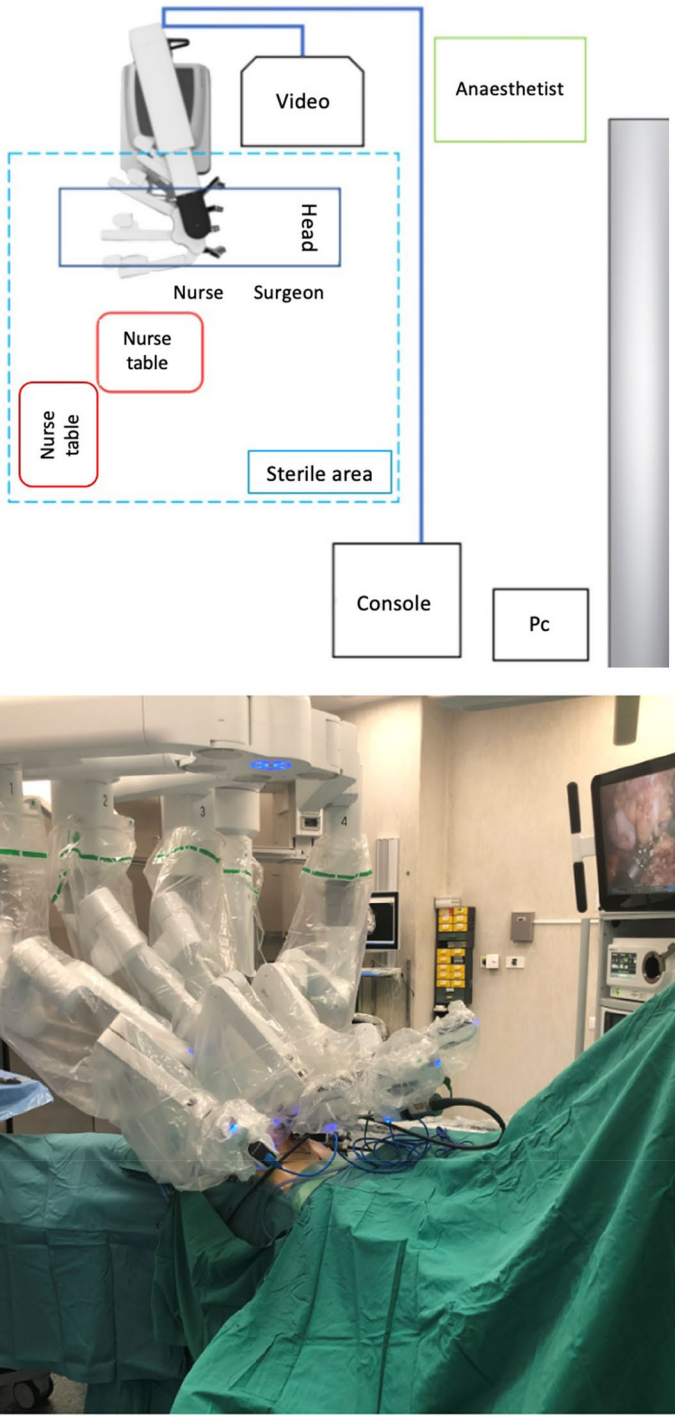


**Fig. 2** Operative room setting

Antibiotic prophylaxis comprised ceftazidime and metronidazole for a total of three doses.

Postoperative analgesia was administered first via an epidural catheter or elastomeric pump, later with intravenous paracetamol.

Feeding started once the bowel movement started and discharge was when the patient recovered completely mobilization, feeding and bowel function.

**Fig. 3** Patient positioning

## Discussion

Since the advent of minimally invasive surgery, a great enthusiasm has been showed worldwide by adult and pediatric surgeons towards this new surgical approach conferring important advantages over the traditional open surgery, such as shorter hospital stay, less risk of short-term complications, and increased recovery. It was applied in a wide procedure range, even in complex and reconstructive surgery, such as RP for UC. However, boundaries linked to confined and narrowed space, such as pelvis, arose an increased risk of IPAA failure due to a long residue rectum and the risk for nerves damage.

These drawbacks have been overcome with the advent of robotic technique [19].

IPAA construction was introduced with the idea to supplement the anal function, reducing the stool frequency. Nowadays, it is considered the standard procedure for surgical management of UC, even in children. It is important to provide the best standard of care especially for this complex and fine reconstructive procedure, because it heavily influences the quality of life of pediatric and adolescent patients.

The best quality of life achievements relates to multiple concepts. The traumatism of perirectal structures could influence either the pouch or erectile and sexual function. A fine rectal dissection and a clear visualization of pelvic nerves and perineal muscle is mandatory to achieve continence and maintain a good sexual function [20–22]. Robotic surgery helps to achieve these goals carrying the rectal dissection down to the perineal muscle with magnification and better visualization of anatomical levels and structures. Furthermore, a deeper dissection, until the dental line and the elevator ani muscle, allows a major disease burden removal, resulting in a better care of underlying disease, lower risk of proctitis and dysplasia, and an improved quality of life [23].

In addition, a complete mucosectomy protects against pelvic abscess in non-diverting patients, because the anastomosis is covered by the anorectal muscles cuff [24, 25]. In the last two children we performed, a fine rectal dissection with a deep mucosectomy, allowing the surgeon to perform an ileal J-Pouch anal anastomosis without the loop ileostomy. Postoperatively the anastomosis was secured by a transanal tube pouch decompression.

Gorfine et al. found the non-diverting patients complication rate and functional outcome like those patients undergoing diverting ileostomy [25].

A healthy overall condition and nutrition status, young age, low comorbidity, surgeon practice, good pouch blood supply, and no anastomotic tension seems to be the criteria to assess when performing an IPAA without the loop ileostomy [26].

When coming to the safety issue, we must address conversion rates, intraoperative and postoperative complication. No conversions occurred in our experience. Three minor complications treated conservatively (Clavien–Dindo I–II) and two major complications needing surgical reintervention under general anesthesia (Clavien–Dindo IIIb), occurred in our series. It is important to underline that only 2 of

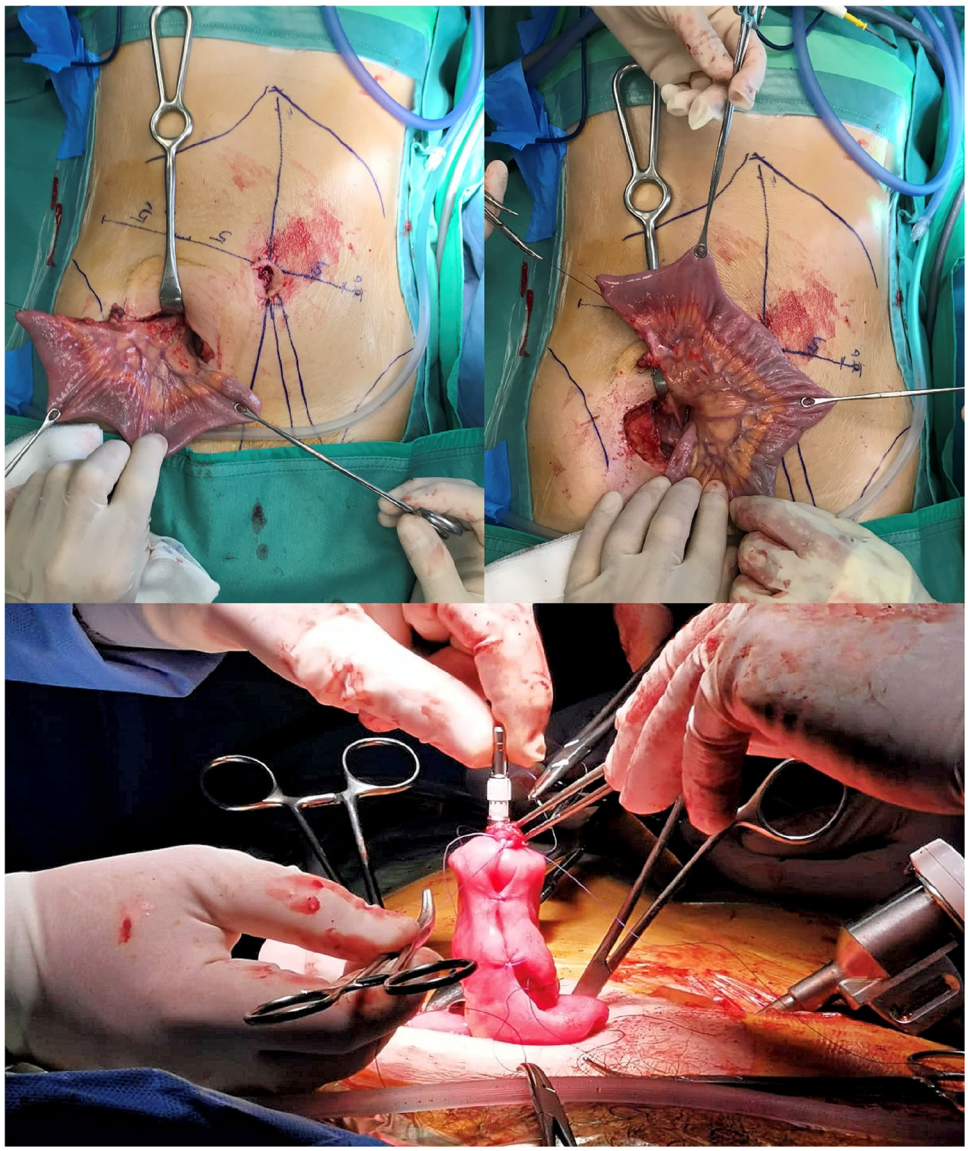

**Fig. 4** Pouch distance assessment and open ileal J-Pouch construction

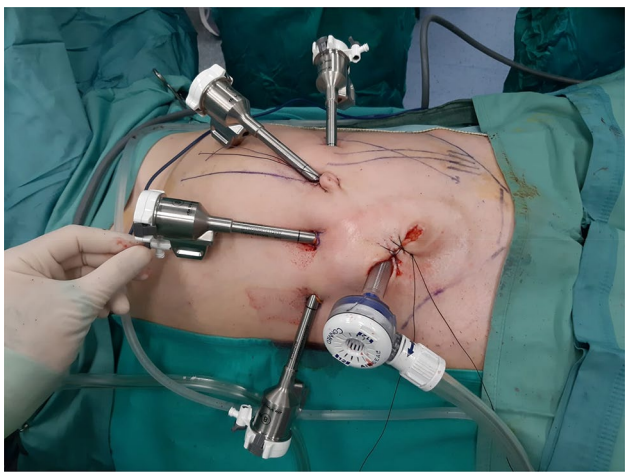

**Fig. 5** Trocar positioning

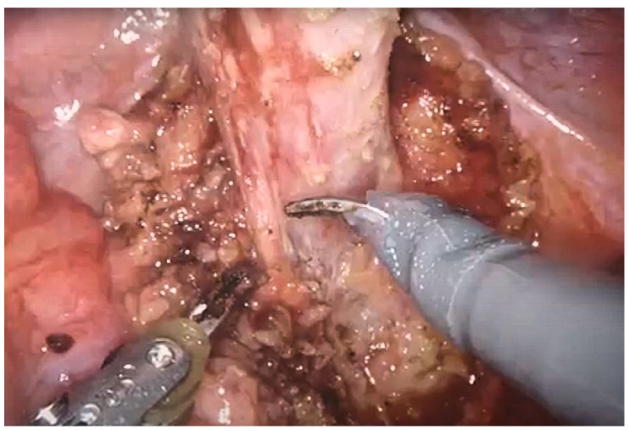

**Fig. 6** Proctectomy: posterior dissection of the rectal stump

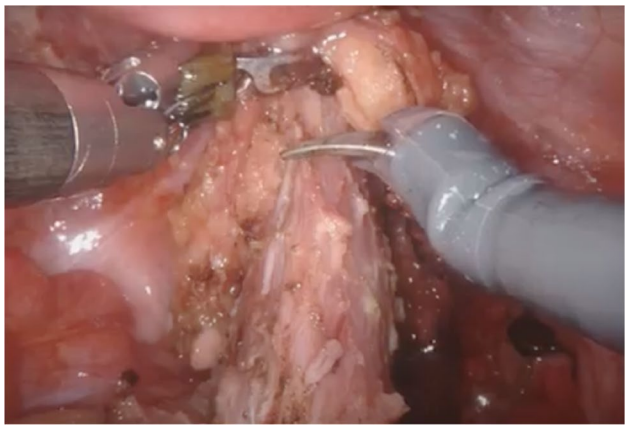

**Fig. 7** Proctectomy: anterior dissection of the rectal stump

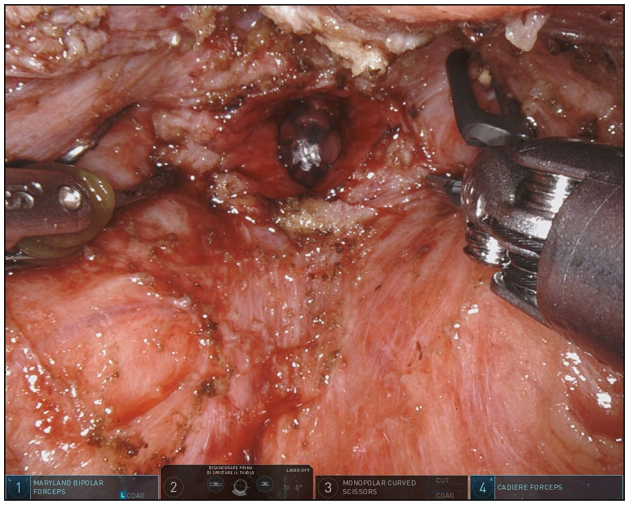


**Fig. 8** Transanally exposure of the rectum, within a rectal probe, at the elevator ani muscle level

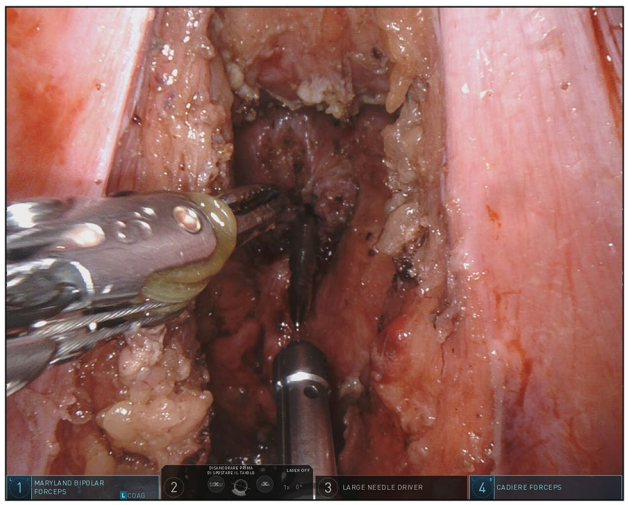


**Fig. 9** Circular stapler positioning, inside the rectum, in the center of the pelvic floor

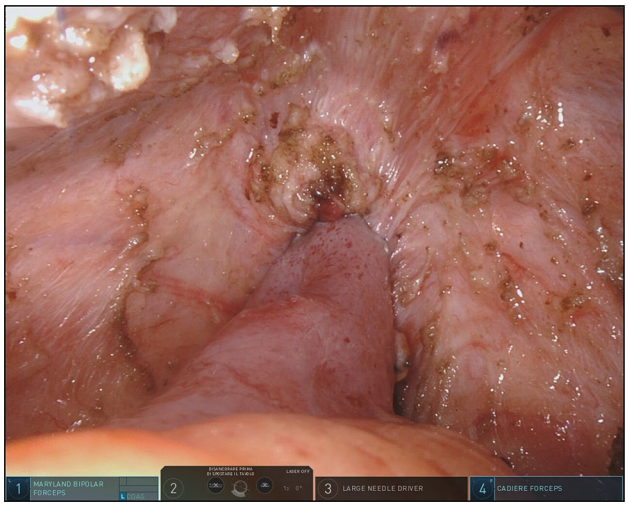


**Fig. 10** Ileal–J-pouch–anal anastomosis

complications were strictly related to the pouch surgery, anal bleeding is a symptom related to the presence of disease burden. We found that this complication occurred in two patients that had mucosectomy with IPAA over the dentate line, with more residual disease.

For the two major complications, is well known that small bowel obstruction is one of the most common complication in abdominal surgery, at least 25% require readmission for symptoms of intestinal blockage and half of these require surgical intervention [27]. Minimally invasive surgery seems to decrease the occurrence of adhesions formation during IPAA procedure, reducing the risk of intestinal occlusion [28, 29].

The complication rate in our case series (33%) resemble with what is described in the literature for laparoscopic surgery, complication rate of 5–47% [23, 30–32], and lower than 19–70% of open procedure [33, 34].

Another important aspect to take into consideration is related to the age of onset of the disease, in fact, two patients treated were less than 6 years. In these patients, the reconstructive surgery, given the size and limited space, is very complex to perform laparoscopically, but thanks to the support of the robotic system it can be performed more easily.

## Conclusion

The first limitation of the study is the small patient sample, because the surgical therapy for UC is not very common, especially in children. Second, the enrolment for robotic IPAA was not randomized, but mostly based on robotic system availability thus making comparison with laparoscopic group poorly reliable.

However, as mentioned above, our results confirmed that the superior dexterity and visualization provided by robotic system, especially in very small cavity, allowing a more complete rectal dissection, make robotic IPAA particularly suitable for pediatric patients.

One of the most important aspect to analyze when a new surgical approach is being studied is the outcome within a long-term follow-up.

This is the first study reporting the experience on robotic IPAA for UC in children. Our series reveals that the robotic procedure in pediatric patients is a safe and feasible option for the surgical treatment of UC. A bigger patient sample and a long-term follow-up are needed to confirm our findings.

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