

A Total Laparoscopic Approach Reduces the Infertility Rate After Ileal Pouch-Anal Anastomosis

A 2-Center Study

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Objective: To assess the infertility rate after laparoscopic ileal pouch-anal anastomosis (IPAA).

Background: Total proctocolectomy with IPAA is known to be associated with postoperative infertility in open surgery, which may be caused by pelvic adhesions affecting the fallopian tubes. However, fertility after laparoscopic IPAA has never been assessed.

Methods: All patients who underwent a total laparoscopic IPAA between 2000 and 2011 and were aged 45 years or less at the time of operation and 18 years or more at the time of data collection were included. The patients answered a fertility questionnaire by telephone. All demographic and perioperative data were prospectively collected. The results were compared with those of controls undergoing laparoscopic appendectomy.

Results: Sixty-three patients were included. The mean age at the time of surgery was 31 ± 9 years (range 14–44). IPAA was performed for ulcerative colitis in 73% of the cases and familial adenomatous polyposis in 17%. The mean follow-up after IPAA was 68 ± 33 months (range 6–136). Fifty-six patients answered the questionnaire (89%). Half of them already had a child before IPAA. Fifteen patients attempted pregnancy after IPAA, of which 11 (73%) were able to conceive, resulting in 10 ongoing pregnancies and 1 miscarriage. The global infertility rate was 27%. There was no difference in fertility over time compared with the 14 controls who attempted pregnancy during the same period (90% vs 86% at 36 months, $P = 0.397$).

Conclusions: The infertility rate appears to be lower after laparoscopic IPAA than after open surgery.

Keywords: fertility, ileal pouch-anal anastomosis, laparoscopy, proctocolectomy

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Since its first description by Parks and Nicholls in 1978,¹ total proctocolectomy with ileal pouch-anal anastomosis (IPAA) has become the operation of choice in the treatment of familial adenomatous polyposis² and ulcerative colitis.³ In both diseases, IPAA is mostly performed in young adults.^{4,5} Most patients with familial adenomatous polyposis develop polyps in the second and third decades of their life and eventual cancer by the age of 40 years, if left untreated.^{4,6} Ulcerative colitis has a peak incidence during early adult

life.⁵ In familial adenomatous polyposis, IPAA can be performed as a prophylactic surgery, or it can be performed in the case of dysplasia or cancer. In ulcerative colitis, IPAA is performed in the case of refractory colitis, rectal stenosis, dysplasia, cancer, or as a staged procedure in acute severe colitis.³ IPAA may also be applied to other inflammatory bowel diseases, such as indeterminate colitis or certain cases of colorectal Crohn's disease, as we proposed a few years ago.^{7,8}

IPAA is performed in young adults; therefore, this procedure is often performed in women of childbearing age. However, many studies have revealed female fertility issues after IPAA performed by open surgery.^{5,9–22} The infertility rates vary from one study to another (17% to 93%), but a recent meta-analysis found a rate of 63% and a relative risk of 3.9 for infertility after open IPAA.²² This disorder may be caused by postoperative pelvic adhesions that affect the fallopian tubes,^{10,23} as Oresland et al¹⁰ found a fallopian tube occlusion (1- or 2-sided) in 11 patients (52%) in a study that included 21 women with a hysterosalpingography after IPAA.

The laparoscopic approach, which has been demonstrated to be feasible for IPAA,^{24–27} appears to reduce postoperative adhesions^{28–30} and postoperative small bowel obstruction.³¹ Furthermore, decreased annular adhesions have been found after laparoscopic IPAA.²⁹ Therefore, there is a potential benefit to performing a laparoscopic IPAA in women of childbearing age.^{19,20,32,33} This procedure is commonly performed in the Departments of Colorectal Surgery and Gastrointestinal Surgery of Beaujon Hospital (Clichy) and Nord Hospital (Marseille), respectively, and was developed from a similar technique that has already been published in both departments.^{25,27,34,35} This technique aims to reduce the risk of adhesions with a total laparoscopic approach (ie, with no other incision than the stoma incision and no hand-assisted technique). To date, no publication has evaluated female infertility after laparoscopic IPAA. Thus, the aim of this study was to assess the female infertility rate after laparoscopic IPAA. The secondary objectives were to compare the infertility rate with that of a control group and to determine the prognostic factors of infertility after IPAA.

PATIENTS AND METHODS

Patient Population

This article describes a 2-center study conducted in the Department of Colorectal Surgery of Beaujon Hospital (Clichy) and the Department of Gastrointestinal Surgery of Nord Hospital (Marseille). All of the women who underwent total laparoscopic IPAA from January 2000 to May 2011 and were aged 45 years or less at the time of operation and 18 years or more at the time of data collection were included. Preoperative infertility was the only exclusion criterion.

Data were collected from a prospective database. The data included the following: demographic data (such as age at the time of operation and at the time of the study), length of follow-up, body mass index, American Society of Anesthesiology score,³⁶ medical history, and number of operations performed prior to IPAA; preoperative data, such as the type of disease (ie, familial adenomatous polyposis,

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ulcerative colitis, or other inflammatory bowel disease), indication for surgery (ie, refractory colitis, rectal stenosis, acute severe colitis, dysplasia, cancer, or prophylactic surgery) and medical treatment within the 3 preoperative months (ie, steroids and immunosuppressive drugs, such as azathioprine and infliximab); perioperative data, such as the type of operation (ie, IPAA in 1, 2, or 3 stages: without a stoma, with a temporary stoma, or with proctectomy and a temporary stoma after subtotal colectomy in acute severe colitis), emergency surgery, type of anastomosis (ie, stapled or hand-sewn), covering-loop ileostomy, conversion to open surgery, perioperative complications, transfusion, number of units of blood transfused and operative time; and postoperative data, such as the length of stay and postoperative morbidity (according to Dindo's classification³⁷), including anastomotic leakage, sepsis, ileus, additional surgery, and mortality.

Surgical Procedure

Total proctocolectomy with IPAA was performed by a total laparoscopic approach in both departments, according to a similar and previously described procedure.^{25,27} In summary, 5 to 6 laparoscopic ports (5–12 mm) were used. Colon mobilization, vascular ligations, and rectal dissection down to the pelvic floor were conducted laparoscopically. Rectal dissection was performed close to the rectal wall for an optimal preservation of the pelvic anatomy and nerves (in the case of cancer, a total mesorectal excision was performed). In both departments, an ultrasonic scalpel (Harmonic; Ethicon, Issy les Moulineaux, France) was used to perform the pelvic dissection and an electrothermal bipolar device (Ligasure 10mm; Covidien, Elancourt, France) was used in cases of thick mesocolons in 1 department. An ileal pouch of 18 cm was created through a 5-cm incision across the right iliac fossa port, at the site of the future ileostomy. No other incision was made. A stapled anastomosis was typically performed, although a hand-sewn anastomosis was chosen for cancer or dysplasia of the lower rectum. Antiadhesive barriers were not routinely placed. A covering-loop ileostomy and a pelvic drain were placed at the end of the operation. The ileostomy was avoided in certain cases of familial adenomatous polyposis.

Questionnaire

Patients were called to answer a fertility questionnaire by telephone (Appendix 1). The questions asked collected demographic data, such as profession, socioeducational level, and marital status; preoperative data, including preoperative infertility and desire for later pregnancy at the time of the IPAA; and postoperative data, such as pregnancy attempts or reasons for abstention, postoperative pregnancy, time until pregnancy or time until failure, use of medically assisted procreation (MAP), and delivery method (vaginal delivery or C-section).

Outcome Definitions

Conversion to open surgery was defined as any unplanned incision or a planned incision longer than 6 cm.

Mortality was defined as death occurring in the hospital or within 30 days after surgery. Postoperative morbidity was defined as complications occurring in the hospital or within 30 days after surgery. Major complications were defined as those requiring surgical, radiological, or endoscopic intervention (Dindo III), life-threatening complications requiring intensive care management (Dindo IV), and death (Dindo V).³⁷ Sepsis was defined as having a fever higher than 38.5 °C or a leukocytosis count of more than 15,000 cells/mm³. The diagnosis of anastomotic leakage was confirmed by computed tomography with iodine injection and computed tomography enterography.

Pregnancy was defined as any pregnancy (childbirth, ongoing pregnancy, miscarriage, extra uterine pregnancy, or abortion) confirmed by an ultrasound scan.

The time until pregnancy was defined as the time (in months) of unprotected intercourse before pregnancy. The time until pregnancy in patients with an ongoing pregnancy after a miscarriage was defined as the time until the ongoing pregnancy. The time until failure was defined as the time (in months) of unprotected intercourse without any pregnancy occurring.

Infertility was defined as the inability to conceive despite regular unprotected intercourse. The infertility rates were given at 1, 2, and 3 years and as a global infertility rate. The infertility rates at 1, 2, and 3 years corresponded to the rate of patients who did not become pregnant after 1, 2, and 3 years of unprotected intercourse and excluded the patients who had shorter durations of unprotected intercourse. The global infertility rate did not exclude patients: it was calculated using the number of women who reported infertility as the numerator and the number of women who reported pregnancy attempts as the denominator. Only 1 attempt per patient was recorded. These definitions have been already used in previous studies on fertility after IPAA.^{5,18}

Assessment of Fertility

The controls were women who underwent laparoscopic appendectomy, as fertility after this procedure is known to remain unchanged compared with the general population.³⁸ These controls were matched for age at the time of operation and for the length of follow-up. The controls answered the same fertility questionnaire as the IPAA patients by telephone (Appendix 1).

Statistical Analysis

The quantitative data were reported as the means \pm standard deviation and range. Patients with postoperative pregnancy were compared with patients with failure of pregnancy to determine prognostic factors of infertility after IPAA. Normally distributed quantitative data were analyzed with the Student *t* test, and the Mann-Whitney test was used otherwise. The qualitative data were reported as the number of patients (percentage of patients) and were compared using Pearson χ^2 test or Fisher exact test, as appropriate. The cumulative percentages of pregnancy after IPAA were plotted using the Kaplan-Meier method and compared with those of controls using the log-rank test.

The tests were always 2-sided, and the level of statistical significance was set at $P < 0.05$. The analysis was performed using the Statistical Package for the Social Sciences software (SPSS, version 17.0; Chicago, IL).

RESULTS

In total, 63 women undergoing laparoscopic IPAA were included. Their demographic data are reported in Table 1. The mean follow-up time was 68 \pm 33 months (range 6–136 months). The perioperative data are listed in Table 2. The indications for IPAA are reported in Figure 1. Ulcerative colitis was the most frequent disease and affected 46 patients (73%), whereas 11 patients (17%) presented with familial adenomatous polyposis. Finally, IPAA for Crohn's disease was performed in 4 patients (6%). Among the 51 patients with inflammatory bowel disease, refractory colitis was the main indication (43%). Within 3 preoperative months, 29 patients (46%) had received steroids, and 28 (44%) had received immunosuppressive drugs. Most patients received a stapled anastomosis (97%) and a covering-loop ileostomy (92%). Conversion to open surgery occurred in 4 cases (6%) because of major adhesions, exposure issues, colic perforation, and common mesentery in which a small bowel twist was suspected. No patient had antiadhesive barriers. Seven major complications were observed (11%): 2 abscesses requiring percutaneous drainage by ultrasound or computed tomography scan (3%) and 4 additional surgeries (6%), including 3 open procedures (peritonitis

TABLE 1. Demographic Data for 63 Women Who Underwent Laparoscopic Ileal Pouch-Anal Anastomosis

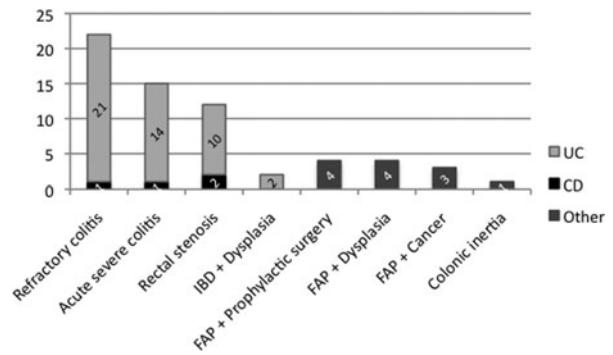
Age at the time of surgery, years (range)	31 ± 9 (14–44)
Current age, years (range)	37 ± 9 (19–51)
Follow-up, months (range)	68 ± 33 (6–136)
Follow-up > 1 year, n (%)	59 (94%)
Socioeducational level*, %	
High school diploma	16.5%
2nd-year university level	21%
4th-year university level	16.5%
Without high school diploma	46%
BMI, kg/m ² (range)	21 ± 3 (16–30)
Smoking*, %	21%
ASA score (range)	2 (1–3)
Medical history, n (%)	
Surgery	26 (41%)
Cardiovascular	2 (3%)
Pulmonary	4 (6%)
Neurological	2 (3%)
Diabetes mellitus	1 (2%)
Number of operations before IPAA (range)	1.3 ± 0.6 (1–3)

*The socioeducational level and smoking rates were calculated for the 56 patients who answered the questionnaire. Number of operations excludes subtotal colectomy. BMI, body mass index; ASA, American Society of Anaesthesiology. The data are reported as the means ± standard deviation and range.

TABLE 2. Perioperative Data for 63 Women Who Underwent Laparoscopic Ileal Pouch-Anal Anastomosis

Type of Disease, n (%)	
UC	46 (73%)
FAP	11 (17%)
CD	4 (6%)
Indeterminate colitis	1 (2%)
Colonic inertia	1 (2%)
Procedure performed, n (%)	
TP	37 (59%)
Staged procedure	26 (41%)
Emergency, n (%)	10 (16%)
Ileostomy, n (%)	58 (92%)
Stapled anastomosis, n (%)	61 (97%)
Conversion to open surgery, n (%)	4 (6%)
Transfusion, n (%)	2 (3%)
Units of blood amount (range)	2 (0–2)
Operative time, minutes (range)	316 ± 101 (130–40)
Postoperative complications, n (%)	26 (41%)
Major	7 (11%)
Ileus	8 (13%)
Sepsis (wound, pelvic, other)	16 (25%)
Anastomotic leakage with pelvic sepsis	10 (16%)
Additional surgery, n (%)	4 (6%)
Mortality, n (%)	0 (0%)
Length of stay, days (range)	13 ± 6 (8–46)

UC, ulcerative colitis; FAP, familial adenomatous polyposis; CD, Crohn's disease; TP, total proctocolectomy; staged procedure: proctectomy after subtotal colectomy. The data are reported as the means ± standard deviation and range.

**FIGURE 1.** Indications for laparoscopic IPAA in 63 women. IBD, inflammatory bowel disease; UC, ulcerative colitis; CD, Crohn's disease; FAP, familial adenomatous polyposis.

on an anastomotic leakage, small bowel perforation, and hemoperitoneum) and a proctologic examination for major pouch stercorous retention.

Fertility

Out of 63 subjects, 56 patients (89%) answered the fertility questionnaire. Forty-five (80%) were living with a partner. At the time of the IPAA, half of the patients had at least 1 child, and 27 (48%) planned to become pregnant in the future. The mean age at childbirth was 25 ± 5 years (range 19–30). Before the IPAA, 3 patients (5%) had miscarried, including 2 patients (4%) with multiple miscarriages, and 2 patients (2%) had an abortion or an extra uterine pregnancy (2%). Three patients (5%) exhibited preoperative infertility and were excluded from the postoperative statistics. This infertility was caused by early menopause resulting from ovarian insufficiency, uterine malformation caused by in utero diethylstilboestrol exposure, and a failure to become pregnant after 4 preoperative years of attempts.

Thus, among 15 patients who attempted pregnancy after IPAA, 11 (73%) became pregnant (Table 3). Nine of these patients had ulcerative colitis (82%), and the 2 others had either familial adenomatous polyposis or Crohn's disease. Five (45%) were primiparae. All nine patients achieved natural pregnancies. One patient (6%) miscarried during her first quarter, and 10 patients (67%) had an ongoing pregnancy at the time of the survey. Two of these patients had miscarried after the IPAA but before their ongoing pregnancies. All of the deliveries were performed by planned C-sections. The cumulative proportion of pregnancies over time is reported in Figure 2. The global infertility rate was 27% (4/15), whereas the infertility rates at 1, 2, and 3 years were 41%, 21%, and 10%, respectively. Two patients have resorted to MAP and are currently entering a protocol of in-vitro fertilization. An infertility check-up found a fallopian tube obstruction in one case and intrauterine synechiae in the other; both of these patients had already borne a child before undergoing IPAA, and they were 30 and 43 years old, respectively. No prognostic factor of infertility was found in the univariate analysis among the 15 patients who attempted pregnancy (Table 4). In particular, ulcerative colitis, maternal age, prior immunotherapy, and pelvic sepsis were not associated with enhanced infertility ($P = 1$, $P = 0.51$, $P = 0.28$, and $P = 0.18$, respectively). None of the 15 patients were smoking at the time of the pregnancy attempts.

If we had included the 3 preoperatively infertile patients, we would have gotten the following results: 2 of these 3 patients resorted to medically assisted procreation after IPAA. Both got pregnant but

TABLE 3. Postoperative Fertility in 56 Women Who Answered the Fertility Questionnaire After Undergoing Laparoscopic Ileal Pouch-Anal Anastomosis

Patients who attempted pregnancy, n	15
Patients who did not attempt pregnancy, n	41
Reason*, n (%)	
Primi-multipara	14 (37%)
Disease	9 (24%)
Too young	7 (18%)
Single	4 (11%)
Too old	3 (8%)
Partner refusal	1 (3%)
Does not wish to answer	2 (5%)
Spontaneous pregnancy, n (%)	11 (73%)
Ongoing pregnancy, n (%)	10 (67%)
Miscarriage, n (%)	1 (6%)
Abortion, n (%)	0 (0%)
Extra uterine pregnancy, n (%)	0 (0%)
Age at first childbirth (range)	26 ± 5 (19–35)
Time until pregnancy, months (range)	11 ± 12 (1–35)
Time until failure, months (range)	20 ± 29 (2–72)
MAP, n (%)	2 (13%)
Pregnancy	0 (0%)
Miscarriage	0 (0%)

*Question asked to 38 patients, ie, excluding the 15 pregnancy attempts and the 3 patients with preoperative infertility. Time until failure indicates time without pregnancy despite unprotected intercourse. MAP indicates medically assisted procreation (2 patients just began a MAP protocol). The data are reported as the means ± standard deviation and range.

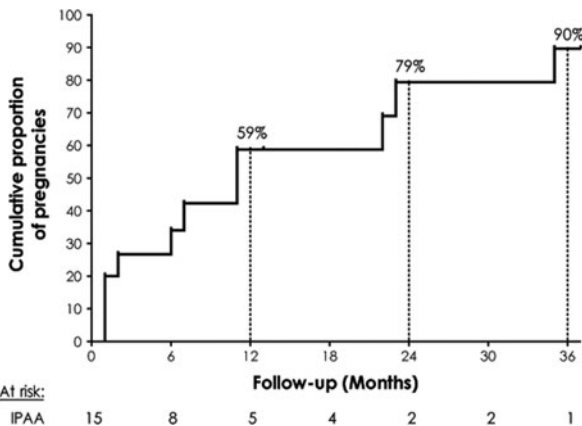


FIGURE 2. Time until pregnancy in 15 women attempting pregnancy after undergoing laparoscopic IPAA (Kaplan-Meier).

experienced miscarriages, one before 1 year of attempts and the other after 1 year. Taking into account these patients, the global infertility rate would decrease from 27% to 24%, and the 1-year infertility rate would increase from 41% to 43%.

Assessment of Fertility

Sixty-one controls were matched to the IPAA group. The mean age at the time of appendectomy was 30 ± 7 years (range 16–40), and the mean follow-up was 63 ± 34 months (range 5–138). The 2 groups were comparable according to these 2 matching criteria (*P* = 0.24 and *P* = 0.38, respectively). Twenty-five patients (41%) answered the fertility questionnaire. Twenty percent smoked at the time of

operation versus 21% in the IPAA group. Fourteen controls attempted pregnancy, which was significantly higher than the percentage in the IPAA group (14/25 = 56% vs. 15/56 = 27%; *P* = 0.011). Ten ongoing pregnancies (71%) and 2 miscarriages were observed (14%) in the control group. One patient resorted to in-vitro fertilization, and 2 patients (14%) failed to become pregnant. There was no significant difference between the IPAA group and the control group in terms of fertility in time (*P* = 0.397) (Fig. 3).

DISCUSSION

Our study found an infertility rate of only 27% after total laparoscopic IPAA. Sixty-three patients were included in this study, with ulcerative colitis in 73% of the cases and familial adenomatous polyposis in 17%. At the mean follow-up of 68 months after IPAA, 15 women had attempted pregnancy, and 11 (73%) were able to conceive naturally. There was no difference in fertility over time relative to the 14 controls who attempted to become pregnant after laparoscopic appendectomy during the same period (*P* = 0.397). Upon comparison with the results of previous meta-analyses,^{5,20} our findings suggest that the infertility rate after laparoscopic IPAA may be lower than that after open IPAA. These new data should be included in the preoperative discussions for IPAA in young women.

IPAA is currently the operation of choice in most patients with ulcerative colitis and familial adenomatous polyposis who require surgery.^{2,3} This procedure is the only treatment that eliminates the inflammatory and oncological risks in the colonic and rectal segments. IPAA may also be proposed in selected cases of colorectal Crohn’s disease, although this indication is still controversial.^{7,8} In the majority of cases, IPAA is performed in young adults,^{4,5} as familial adenomatous polyposis leads to cancer by the age of 40 years if left untreated, and ulcerative colitis and Crohn’s disease both have a peak incidence during early adult life. Functional outcomes, including fertility, are therefore paramount for these patients.⁴

The classical approach for IPAA is open surgery. However, several studies raised the issue of infertility after open IPAA.^{5,9–19,39} Pelvic adhesions may be responsible for postoperative infertility. According to Drollette et al,⁴⁰ adhesions are responsible for 15% to 20% of female infertility, as pelvic adhesions could be associated with fallopian tube occlusion.^{10,23} Two studies assessed these fallopian anomalies by performing a hysterosalpingography after open total proctocolectomy (with IPAA or permanent terminal ileostomy); these studies found fallopian anomalies in 52% to 81% of the cases, including 1- or 2-sided fallopian occlusions.^{10,23} The infertility rate after open IPAA varies from one study to another (17%–93%), but all of the previous studies found much higher infertility rates than in the general population (Table 5).^{5,9–19,39} This variability may be explained by several factors: the definition of infertility is not the same in all studies (global infertility or 1-year infertility); the population assessed is not always the same with regard to age and type of disease; in the Scandinavian studies of Olsen et al,^{14,15,39} contrary to all the other series, each pregnancy of each patient was taken into account (this methodology may explain the increased differences between IPAA groups and controls, as hyperfertile controls might induce a bias, thereby falsely increasing the relative infertility of IPAA patients); finally, the small size of certain series may contribute to this disparity. Nevertheless, 3 meta-analyses concluded that infertility was increased after open IPAA.^{20–22} Waljee et al²⁰ found an infertility rate of 48% and an relative risk of 3.2. In the meta-analysis of Cornish et al,²¹ the global infertility rate was 43%, and the most recent meta-analysis of Rajaratnam et al²² found an infertility rate of 63% (relative risk = 3.9). Because ileorectal anastomosis appears to be associated with a fertility rate similar to that of the general population,¹⁵ several authors indicated that ileorectal anastomosis should be selected rather than IPAA in young women with ulcerative colitis or familial

TABLE 4. Univariate Analysis of Prognostic Factors of Infertility After Laparoscopic Ileal Pouch-Anal Anastomosis in 15 Women Who Attempted Pregnancy

	Pregnancy n = 11	Failure n = 4	P
Age at the time of surgery, years (range)	28 ± 7 (18–37)	31 ± 8 (22–42)	0.51
Current age, years (range)	34 ± 7 (22–47)	40 ± 9 (30–51)	0.43
BMI, kg/m ² (range)	22 ± 4 (18–30)	21 ± 6 (16–29)	0.31
Smoking, n (%)	0 (0%)	0 (0%)	1
ASA score (range)	2 (1–2)	2 (2–3)	0.20
Preoperative treatment, n (%)			
Steroids	7 (64%)	2 (50%)	1
Immunosuppressive drugs	7 (64%)	1 (25%)	0.28
Emergency, n (%)	2 (18%)	0 (0%)	1
Procedure: one-stage TP, n (%)	7 (64%)	3 (75%)	1
Type of disease, n (%)			
UC	9 (82%)	3 (75%)	1
CD	1 (9%)	0 (0%)	1
FAP	1 (9%)	0 (0%)	1
Indication, n (%)			
Cancer	1 (9%)	0 (0%)	1
Dysplasia	0 (0%)	0 (0%)	1
Refractory colitis	6 (55%)	2 (50%)	1
Acute severe colitis	3 (27%)	1 (25%)	1
Rectal stenosis	2 (18%)	1 (25%)	1
Desmoid tumor, n (%)	1 (9%)	0 (0%)	1
Stapled anastomosis, n (%)	11 (100%)	4 (100%)	1
Conversion to open surgery, n (%)	1 (9%)	0 (0%)	1
Transfusion, n (%)	0 (0%)	0 (0%)	1
Operative time, minutes (range)	301 ± 120 (130–500)	378 ± 53 (300–420)	0.20
Postoperative complications, n (%)			
Major	2 (18%)	1 (25%)	1
Pelvic sepsis	1 (9%)	2 (50%)	0.18
Additional surgery, n (%)	1 (9%)	0 (0%)	1

BMI, body mass index; ASA, American Society of Anaesthesiology; UC, ulcerative colitis; FAP, familial adenomatous polyposis; CD, Crohn's disease; TP, total proctocolectomy. The data are reported as the means ± standard deviation and range.

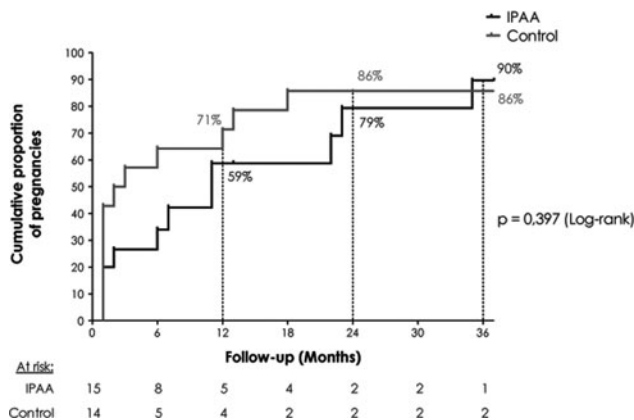


FIGURE 3. Time until pregnancy in 15 women attempting pregnancy after undergoing laparoscopic IPAA compared with 14 controls who underwent laparoscopic appendectomy (Kaplan-Meier).

adenomatous polyposis. However, ileorectal anastomosis cannot be performed under several local conditions, such as severe proctitis and rectal stenosis. Finally, the ileorectal anastomosis indications should be well delimited because the inflammatory and oncological risks persist in the rectal segment. A third procedure, beyond open IPAA and

ileorectal anastomosis, should therefore be proposed to these young women when their rectum cannot be preserved.

Although the benefit of the laparoscopic approach has been widely demonstrated in colorectal surgery,⁴¹ the advantages of laparoscopy over open surgery in IPAA have only recently been found in 2 meta-analyses.^{24,26} Laparoscopic IPAA is associated with reduced operative blood loss, a decreased time until bowel movements and a regular diet, a decreased length of stay, and better cosmetic results than open IPAA. Regarding the operative time, which is longer in laparoscopic IPAA, Lefevre et al²⁵ showed a significant decrease after the first 40 cases. Moreover, laparoscopy appears to decrease the postoperative small-bowel obstruction rate.³¹ Recently, it has also been suggested in a multivariate analysis that the laparoscopic approach significantly reduces postoperative morbidity.⁴² The additional surgery rate, readmission rate, and mortality are similar for both approaches. The laparoscopic approach is, therefore, associated with better postoperative results than open surgery in IPAA. However, no publication has evaluated female fertility after laparoscopic IPAA, although laparoscopy appears to cause fewer postoperative adhesions. One study performed in swine³⁰ and 2 studies performed in humans support this hypothesis.^{28,29} Moreover, when evaluating annexial adhesions after laparoscopic IPAA by performing a laparoscopy at the time of continuity restoration, Indar et al²⁹ found that 71% of the patients were free of annexial adhesions, and that no patient had bilateral adhesions; these findings suggest a trend toward decreased annexial adhesions in laparoscopic IPAA compared with open IPAA.¹⁰ Thus, there is a potential benefit to performing a laparoscopic IPAA in women of childbearing age.^{19,20,32,33}

TABLE 5. Fertility After Open Ileal Pouch-Anal Anastomosis: Original Studies and Meta-Analyses

Original Studies	Year	Patients, n	Op. Age, Years	Disease	Data	Pregnancy Attempts, n	Definition	Infertility, %	Comparison
Metcalfe et al ⁹	1986	50	-	UC + FAP	I	8	Global infertility	25%	-
Oresland et al ¹⁰	1994	21	23-38	UC + FAP	I	14	Global infertility	93%	-
Counihan et al ¹¹	1994	206	-	UC + FAP	Q	37	1-year infertility	48%	< MT
Sjogren and Poppen ¹²	1995	30	-	UC	I	20	-	25%	< MT
Tiainen et al ¹³	1999	51	-	UC	Q	10	1-year infertility	20%	< MT
Olsen et al ¹⁴	2002	290	15-39	UC	Q	149*	Probability of pregnancy/month of attempt	82%	MT GP
Olsen et al ¹⁵	2003	230	<40	FAP	Q	42*	Probability of pregnancy/month of attempt	54%	< GP > UC
Gorgun et al ¹⁶	2004	300	15-44	UC + FAP	Q	135	1-year infertility	56%	< MT
Johnson et al ¹⁷	2004	153	18-44	UC	Q	66	Global infertility	44%	< MT
Lepisto et al ¹⁸	2007	160	18-40	UC	Q	54	1-year infertility	53%	< app
Nieuwenhuis et al ¹⁹	2010	138	-	FAP	Q	-	-	17%	< GP = IRA
Cornish et al ²	2011	306	-	IBD + FAP	Q	57	Global infertility	55%	-
Meta-Analyses	Year	Patients, n	Op. Age, Years	Disease	Data	Pregnancy Attempts, n	Definition	Infertility, %	Comparison
Waljee et al ²⁰	2006	481	-	UC + FAP	-	-	Global infertility	48%	RR = 3.2/GP
Cornish et al ²¹	2007	650	-	UC + FAP	-	-	Global infertility	43%	-
Rajaratnam et al ²²	2011	1076	-	UC + FAP	-	457	Global infertility	63%	RR = 3.9/GP

*Olsen et al data stand for all pregnancies of all patients. UC indicates ulcerative colitis; FAP, familial adenomatous polyposis; IBD, inflammatory bowel disease; I, oral interview; Q, posted questionnaire; MT, medical treatment; GP, general population; app, population with appendectomy; IRA, ileo-rectal anastomosis; RR, relative risk.

This study is the first assessment of women's fertility after laparoscopic IPAA. Although we did not compare our patients with women undergoing open IPAA, our results appear to show a lower infertility rate after laparoscopic IPAA than after open IPAA. The global infertility rate was 27%, and the 1-year infertility rate was 41% in our study; these rates are lower than those of the largest series for open surgery (global infertility rates of 44%–55%^{3,17} and 1-year infertility rates of 53%–56%^{16,18}). While designing this study, we wondered if excluding patients who were infertile preoperatively would bias the sample. Nevertheless, we concluded that given the small size of the sample, including these patients could also bias our results. However, taking into account preoperatively infertile patients, the global infertility rate would decrease from 27% to 24%, and the 1-year infertility rate would increase from 41% to 43%. These rates are still lower than those of the largest series for open surgery. Thus, including these patients would not have changed our conclusions. Moreover, the rates given in Table 5 take into account the pregnancies obtained with medically assisted procreation, whereas all of the pregnancies reported in our study were natural (except for the preoperatively infertile patients). This lower infertility rate may be explained by the total laparoscopic approach and the operative technique of dissection level with the rectum, which allows an optimal preservation of the pelvic anatomy. To our knowledge, only 1 study, presented at the European Society of Coloproctology's sixth meeting and still unpublished, also assessed fertility after a laparoscopic approach; Bartels et al⁴³ compared 27 pregnancy attempts after laparoscopic IPAA with 23 after open IPAA and appeared to find a better preservation of fertility after laparoscopy ($P = 0.023$). Although the laparoscopic IPAA was hand-assisted in that study, its findings and ours suggest a similar benefit. We could not design such a study, as laparoscopy was almost exclusive for IPAA in our departments. Thus, we do not have our own institutional controls for the rate of infertility using open surgery, and our control group was composed of women undergoing laparoscopic appendectomy. This choice was made for 3 reasons. First, we could not obtain a representative sample of the general population, as such a sample would have required far too many individuals. Second, Andersson et al³⁸ found no decrease in fertility after appendectomy, even in the case of a perforated appendix. Last, this type of control group has already been used in a fertility study.¹⁸ There was no difference in terms of infertility over time between the IPAA group and the control group (10% vs 14% at 3 years; $P = 0.397$). Furthermore, a survey of 1204 French women showed an infertility rate of 34% at 1 year and 16% at 2 years.⁴⁴ These rates are similar to those of our control group (29% at 1 year and 14% at 2 years, respectively) and hence strengthen our own results. Finally, our results and those of Bartels et al⁴³ indicate that improved fertility is another advantage of the laparoscopic approach over open surgery in IPAA.

Regarding prognostic factors of infertility after IPAA, Olsen et al¹⁵ found a significantly higher infertility rate after IPAA for ulcerative colitis than for FAP ($P = 0.001$). This result was not found in our study, but this discrepancy may be explained by the fact that only 1 patient with familial adenomatous polyposis attempted pregnancy after IPAA in our series. Pelvic sepsis was not a significant prognostic factor of infertility in our study ($P = 0.18$). However, 50% of infertile patients presented with pelvic sepsis versus 9% of the fertile patients: larger samples may therefore have demonstrated significance. Gorgun et al¹⁶ found that preoperative transfusion was associated with significantly higher infertility, possibly because a transfused patient might have had a wider and more difficult dissection during surgery. In our study, no patients who attempted pregnancy were transfused during surgery. A recent meta-analysis²⁴ suggested a possible reduction of blood loss after laparoscopic IPAA: reduced blood loss might be another explanation for the superior fertility rate after the laparoscopic approach compared with open surgery.

Medically assisted procreation has classically played a major role in pregnancies after open IPAA; patients resort to MAP in 15% to 51% of the cases in the literature.^{5,14,16–18,39} Cornish et al⁵ described a success rate for MAP equivalent to that of the general population after open IPAA. However, these authors also revealed that less than half of the patients willing to have a child were eventually sent for MAP because of a lack of information and multidisciplinary management between gastroenterologists, surgeons, and gynecologists. This criticism appears to be legitimate, as in this study, no patients had resorted to MAP after 1 year despite unsuccessful attempts. Moreover, 1 of the 2 patients who began an in-vitro fertilization protocol had sustained unsuccessful attempts at pregnancy for more than 6 years, and 4 patients (36%) waited longer than 1 year before succeeding in becoming pregnant. Thus, the results of Cornish et al,⁵ as well as ours, suggest that women who have undergone IPAA should resort to MAP before the classical 12 months of delay.

In conclusion, at a time when 2 meta-analyses and a large comparative study^{24,26,42} have identified several advantages of laparoscopy over open surgery in IPAA (less operative blood loss, decreased time until bowel movements and a regular diet, decreased length of stay, improved cosmetic results, and lower morbidity), this study shows another potential benefit of laparoscopy: a fertility rate that may be superior to that achievable after open IPAA. Thus, we recommend that the laparoscopic approach should be proposed to young women requiring IPAA.

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APPENDIX 1: Fertility questionnaire submitted by phone to the patients undergoing ileal pouch-anal anastomosis and to the control patients.

- What is your profession? What is your highest academic degree (high school diploma, second- or third-year university level, fourth-year university level or higher)?
- Are you single or in a relationship?
- Before your operation, had you already been pregnant? Did you have:
 - Children? (If so, how many?)
 - Miscarriages? (If so, how many?)
 - Extra uterine pregnancy?
 - Abortion?
 - Did you have any difficulty in becoming pregnant before the operation? (If so, which type of difficulty?)
- How old were you when you had your first child?
- At the time of the operation, did you wish to have a child later?
- After the operation, did you try to become pregnant? (If not, why not?)
- Do (did) you smoke while trying to become pregnant?
- Did you become pregnant after the operation? Was it an ongoing pregnancy, or did you have a miscarriage?
- Was your pregnancy spontaneous, or did you have to resort to medically assisted procreation?
- Did you have a vaginal delivery or a C-section? (If the latter, was the C-section planned or performed as an emergency measure after an attempted vaginal delivery?)
- How long did it take to become pregnant after you stopped your contraception? If you did not become pregnant, how long did you try?