Surgical treatment of ulcerative colitis: Ileorectal vs ileal pouch-anal anastomosis

Daniele Scoglio, Usama Ahmed Ali, Alessandro Fichera

Total proctocolectomy with ileal pouch-anal anastomosis (IPAA) is the current gold standard in the surgical treatment of ulcerative colitis (UC) refractory to medical management. A procedure of significant magnitude carries its own risks including anastomotic failure, pelvic sepsis and a low rate of neoplastic degeneration over time. Recent studies have shown that total colectomy with ileorectal anastomosis (IRA) has been associated with good long-term functional results in a selected group of UC patients amenable to undergo a strict surveillance for the relatively high risk of cancer in the rectum. This manuscript will review and compare the most recent literature on IRA and IPAA as it pertains to postoperative morbidity and mortality, failure rates, functional outcomes and cancer risk.

INTRODUCTION

The main goals of surgical treatment for ulcerative colitis (UC) are not only to alleviate symptoms and minimize cancer risk but also to obtain good functional outcomes and improve quality of life. Until the 1950s total proctocolectomy with end-ileostomy (TPC) was the only available procedure for UC patients failing medical management. In the 1940s reports of subtotal colectomy with ileorectal anastomosis (IRA) as an alternative to TPC in selected patients were first published [1]. During the 1950s and 1960s, Aylett [2] became the leading proponent of this procedure describing it as a way to avoid a permanent stoma. At that time IRA represented a valid alternative to TPC in high selected patients with minimal rectal inflammation. It was a less invasive operation, performed in one
stage and not requiring pelvic dissection with the associated risk of sexual dysfunction[11-13].

In 1978, Parks et al[3] described an ileal pouch-anal anastomosis (IPAA). Since then, IPAA has become the procedure of choice for patients affected by UC with excellent long-term functional results, low risk of persistent cuff inflammation or neoplastic degeneration in the retained rectum[7,8]. Consequently, many surgeons have abandoned IRA in favor of IPAA and TPC has remained an option for patients not candidates for IPAA. The counterargument is that IRA, as a major procedure, carries its own risks including anastomotic failure and pelvic sepsis that could result in poor pouch function, pouchitis and infertility in young women, as well as pelvic nerve damage and portal vein thrombosis[14-16]. In addition few cases of cancer have been reported arising not only in the anal transitional zone but also in the pouch itself[17,18].

Interestingly, recent series[11-14] of selected UC patients undergoing IRA showed long-term functional results similar to IPAA.

The aim of the current study was to review and compare the most recent literature on IRA and IPAA as it pertains to postoperative morbidity and mortality, failure rates, functional outcomes and cancer risk. It will help surgeons to provide a tailored treatment for UC patients.

### ILEORECTAL ANASTOMOSIS

Chronic UC begins in the rectum and extends proximally in a continuous fashion. The severity of the disease also seems to be higher distally with the exception of fulminant pancolitis presentation. However, distal disease is sometimes alleviated by topical treatment and patients with minimal rectal involvement and no dysplastic changes in the rectum could be considered for IRA. Furthermore, an adequate rectal compliance and a normal anal sphincters function are critical for good long-term results. These functions can easily be assessed by digital rectal examination but more accurately by rigid/flexible proctoscopy and manometry. Patients with poor sphincter function, severe rectal disease, and non-distensible rectum should not be offered an IRA. On the contrary, patients with colitis associated colorectal cancer and advanced metastatic disease may benefit from an IRA because of their short life expectancy and the palliative nature of their treatment.

Several studies[11,13,15-17] have shown IRA for UC to be safe, with low postoperative morbidity and mortality. During the years, overall morbidity has been reported between 8% and 28% and mortality between 0% and 4% (Table 1). These studies including the work of Elton et al[18] and Andersson et al[19], focused their attention on postoperative complications including small bowel obstruction, anastomotic leak and abdominal abscess. The fatal events were due to anastomotic leak and subsequent sepsis and to a pulmonary embolism.

The majority of published data has included mainly primary anastomosis with leak rates ranging from 2% to 9%[11,13,15-20]. Diverting ileostomies have been utilized in selective cases at the surgeon discretion. Turnbull[21] suggested that preservation of grossly involved rectosigmoid colon was the main cause of IRA failure. In his opinion an anastomosis at 6 cm or less above peritoneal reflection improved rectal inflammation during the first months and reduced the likelihood of IRA failure.

IRA does not involve extensive pelvic dissection, unlike IPAA or TPC, minimizing the risk of sexual and urinary dysfunction. Hence, higher fertility rates may be expected in IRA patients compared to IPAA although definitive studies providing evidence for better fertility rates in UC patients are lacking. Thus, colectomy with IRA could be considered when treating women in their reproductive age[22].

Some authors[2,11,13,15,18,22] have shown acceptable long-term success rate after IRA. Ayllett[2] in 1966 reported on a total of 300 cases operated on over a ten-year period with only 7% failure rates. Lepistö et al[23] and Pastore et al[24] reported a cumulative probability of having a functioning IRA at five years of 84%. Elton et al[18] had 88% success in their 18 patients, but the follow-up in that study was shorter. Ten year cumulative success (69%) in Lepistö’s series[23] was higher than reported by Leijonmarck et al[13] (51%) in 1990. At 20-years the current probability of having a functioning IRA has ranged between 46% and 69%[25]. One recent study proposed by da Luz Moreira et al[21] from Cleveland Clinic, compared 22 IRA with 66 IPAA patients matched for age, gender, and follow-up time, including IRAs performed in the past 25 years showed a cumulative probability of having a functioning IRA at 5, 10, 15 and 20 years of 81, 74, 56


---

**Table 1 Morbidity and mortality after ileorectal anastomosis**

| Series                  | Period      | n  | Anastomotic leak (%) | Proctitis (%) | Need for proctectomy (%) | Overall morbidity (%) | Mortality (%) |
|------------------------|-------------|----|----------------------|--------------|--------------------------|-----------------------|--------------|
| da Luz Moreira et al[21]| 1971-2006   | 86 | 2.3                  | 28.0         | 53                       | 8                     | 0            |
| Leijonmarck et al[13]  | 1955-1984   | 51 | 3.9                  | 45.1         | 57                       | 16                    | 4            |
| Pastore et al[22]      | 1974-1990   | 48 | 4.4                  | 10.4         | 17                       | 22.9                  | 0            |
| Börjesson et al[24]    | 1997-2003   | 32 | 3.1                  | 9.3          | 12                       | 28                    | 0            |
| Grundset et al[25]     | 1957-1977   | 89 | 9.1                  | 11.2         | 21                       | 21                    | 0            |
| Elton et al[18]        | 1990-1999   | 18 | 5.6                  | 11.0         | 17                       | 22.2                  | 0            |
| Andersson et al[19]    | 1992-2006   | 105| 2.8                  | 8.6          | 13.3                     | 12.4                  | 0            |
| Lepistö et al[23]      | 1978-2000   | 20 | -                    | 45.0         | 35                       | -                     | 0            |
| Oakley et al[24]       | 1960-1982   | 288| -                    | 41.0         | 55.2                     | 4.2                   |              |
The highest degree of dysplasia was considered. Johnson et al [8] had shown in 1983 that the probability of developing rectal adenocarcinoma after a diagnosis of mild or severe dysplasia in IRA patients reached 42% at nine years from diagnosis. The rate of dysplasia and cancer, in patients with UC, increases with time and leaving the rectum in place contributes to the increased risk. The overall cumulative probability of rectal dysplasia in the retained rectum increases from 9% at 10 years to 25% at 20 years [11]. The overall incidence of rectal cancer after an IRA varies in the literature based on length of follow-up, ranging from 0% to 18%. Grundfest et al [7] reported on four patients who developed carcinoma of the rectum during their study period (4.8% at 8-year follow-up), although he estimated the risk of rectal cancer to be 13% at more than 25 years of follow-up. Oakley et al [9] found nine patients with rectal cancer in the stump (3.1%) at an 8-year follow-up while Andersson et al [10] showed an overall risk of cancer of 1.9% at a 5.4-year follow-up. However, some series reported higher rates of degeneration as Baker et al [11] who described, in 1978, a cumulative cancer risk of 6% after 20 years rising to 18% after 35 years in a series of 374 unselected patients. In da Luz Moreira's series [11], the cumulative probability of developing dysplasia and cancer was 7%, 9%, 20% and 25% and 0%, 2%, 5% and 14% at 5, 10, 15 and 20 years respectively. On the other hand, Leijonmarck et al [12] and Lepistö et al [13] had reported no case of cancer in more recent series at 13 and 18-year follow-up, respectively. Pastore et al [14] showed a cumulative probability of remaining free of cancer around 85.5% at 12 years (95%CI: 57.7%-100%).

Most patients who develop rectal cancer in the retained rectum presented at an advanced stage (stage III-IV) suggesting the possibility of a more aggressive biology and making close surveillance imperative [11,27]. For instance, in Baker's study 62% of patients who had developed rectal cancer died within three years of diagnosis. Johnson et al [11] reported a total of 10 rectal cancers, 8 of which had either nodal or distant metastases. The patients in the series reported by Oakley et al [9] fared better, with just 2 of 9 patients with rectal cancer dying over a 22-year time period. Rectal biopsies taken from multiple sites every 6 to 12 mo are advised following IRA in UC patients. If dysplasia is found, completion proctectomy is indicated. Patients with long standing UC who are not able or willing to undergo surveillance should not be offered an IRA. It is also important to emphasize that colectomy with IRA should not be offered to patients with preexisting dysplasia or cancer due to the increased risk of further neoplastic degeneration [26]. In addition, the presence of dysplasia or cancer in the resected colon should cause particular concern about the fate of the remaining rectum suggesting that a completion proctectomy would be indicated in these cases. In fact, Oakley et al [9] reported on five surviving patients who had cancer in their colonic specimens; three of the five were found on follow-up to have cancer or severe dysplasia in the rectal remnant. Grundfest et al [7] described nine patients...
with a colitis-associated colon cancer or severe dysplasia who underwent subtotal colectomy, eight of whom survived; of the eight, five developed severe dysplasia or cancer in the retained rectum.

ILEAL POUCH-ANAL ANASTOMOSIS

Restorative proctocolectomy with IPAA is currently the procedure of choice for the surgical treatment of UC. The main reason for its popularity is its avoidance of a permanent stoma with stable functional results and good quality of life. In over 30 years of its existence, the IPAA has undergone several refinements in the quest of achieving optimal results. Examples include different shapes of the pouch, different anastomotic techniques, use of defunctioning ileostomy and various dissection methods. Surgeons have also obtained greater experience and familiarity with the technique, which has also benefited outcomes.

A large body of literature exists on the outcomes of IPAA. Most studies, however, are retrospective cohorts reporting outcomes from a single institution. Due to large variations between studies, an overview is needed for reliably assessment of the IPAA outcomes. A meta-analysis of 43 observational studies, all published before 2000, has provided pooled estimates of complications and functional outcomes after IPAA. This meta-analysis showed a pouch failure risk of 6.8% (95% CI: 5.4%-8.4%), increasing to 8.5% (95% CI: 5.4%-13.2%) when only patients with a minimal follow-up of 5 years were considered. Other pouch related complications were also studied. Pelvic sepsis and pouch fistulas, both major post-operative complications, were observed in 9.5% (95% CI: 8.2%-10.9%) and 5.5% (95% CI: 4.3%-7.0%), respectively. Sexual dysfunction was present in 3.4% (95% CI: 2.7%-4.7%), while pouchitis was reported in 18.8% (95% CI: 15.7%-22.4%).

A recent meta-analysis, including 53 studies published after 2000, showed significant improvements in these results. The overall rate of pouch failure was significantly reduced to 4.3% (95% CI: 3.5%-5.3%), and pouch failure after at least 5 years of follow-up was 4.7% (95% CI: 3.4%-6.4%). An improvement was also seen in most other complications. Pelvic sepsis, pouch fistula and sexual dysfunction were reported in 7.5% (95% CI: 6.1%-9.1%), 4.5% (95% CI: 3.5%-5.7%) and 3.0% (95% CI: 1.7%-5.2%) of patients. The only complication showing a substantial increase was pouchitis, with a rate of 26.8% (95% CI: 21.0%-33.5%).

Thus it seems that the rate of complications after IPAA has declined over time (Table 2). The authors of the meta-analyses have noticed that the decline was largest in the earlier period of the IPAA, but seems to have continued over time. Nonetheless, IPAA remains a complex surgery with substantial risk of morbidity. The high rate of pouchitis is also worrisome, since this complication can affect functional outcomes, quality of life and might also increase risk of dysplasia in the pouch. It should be noted that the meta-analyses discussed above did not distinguish between acute and chronic pouchitis, which is an important distinction in terms of course and health implications.

Functional outcomes after IPAA were similar in studies published before and after 2000. Average frequency of bowel movements per 24 h was 5.9 (95% CI: 5.0-6.9), of which 1.5 (95% CI: 1.0-2.1) overnight. Mild and severe faecal incontinence were reported in 14.3% (7.3%-25.9%) and 6.1% (2.9%-12.3%) of patients, respectively. The authors conclude that functional outcomes of IPAA may be determined by an intrinsic limitation of the IPAA procedure, rather than growing expertise or technical refinement. This is in line with other studies showing no improvement in functional outcomes based on technical developments, such as type of anastomosis or laparoscopic approach. However, most patients consider the functional outcome after IPAA to be highly satisfactory, with good quality of life and social functionality that are comparable to those in a healthy reference population. As expected, achieving these adequate quality of life scores was highly correlated with achieving of good functional outcomes.

Cancer risk

The IPAA has as an important advantage the removal of the whole colon and virtually the entire rectum as part of the procedure. This minimizes chances of colon and rectal cancer in this high-risk population. A proctocolectomy should be considered almost mandatory when dysplasia is present. Even when only low-grade dysplasia has been identified by colonoscopy, the risk remains substantial. In such patients, studies show a risk of concomitant cancer or high-grade dysplasia of 15% and a 5-year progression rate of up to 54% if not operated on.

When a double-stapled approach for IPAA is used, a mucosal remnant at the anal transition zone (ATZ) is left in place. The risk of cancer in this area is a matter of controversy. In three series with long-term follow-up focused on this outcome, dysplasia and cancer in the anal transitional zone after stapled pouch surgery was found to be infrequent. Dysplasia was observed in 8/178

### Table 2 Morbidity and mortality after ileal pouch-anal anastomosis

| Period                        | No. of studies | No. of patients | Pelvic sepsis (%) | Pouch failure (%) | Pouchitis (%) | Mortality (%) |
|-------------------------------|----------------|-----------------|-------------------|-------------------|--------------|---------------|
| Meta-analysis studies < 2000  | 43             | 9317            | 9.5 (8.2-10.9)     | 6.8 (5.8-8.4)     | 18.8 (15.7-22.4) | -             |
| Meta-analysis studies ≥ 2000  | 53             | 14966           | 7.5 (6.1-9.1)      | 4.3 (3.5-5.3)     | 26.8 (21.0-33.5) | 0 (0-2.9)     |
| IRA | IPAA |
|-----|------|
| **Advantages** | **Disadvantages** |
| Easier operation | Need for maintenance therapy |
| Lower infertility rate | Risk of recurrent/persistent disease |
| Lower risk of urinary and sexual dysfunction | Higher risk of neoplastic degeneration |
| Fewer bowel movements per day | Need for strict surveillance |
| Better continence | More dietary and work restrictions |

| IRA | IPAA |
|-----|------|
| **Lower risk of cancer** | **Major operation** |
| **No need for medical therapy** | **Risk of postoperative complications** (pelvic nerves damage, pelvic sepsis, portal vein thrombosis) |
| **Less urgency** | **Pouchitis** |

(4.4%), 7/210 (3.3%) and 0/135 (0%) after at least 10 years of follow-up. In most of these cases, dysplasia developed in the first 2 to 3 years and often disappeared on repeated biopsies. None of the series found cancer in the ATZ after such prolonged follow-up. These data strongly emphasize the extent to which IPAA minimizes the risk of cancer.

The best evidence regarding the development of dysplasia and adenocarcinoma after IPAA can be obtained from a recent study from the Cleveland Clinic [44], in which 3203 patients undergoing an IPAA from 1984 to 2009 were analyzed. Cumulative incidences for pouch neoplasia at 5, 10, 15, 20, and 25 years were 0.9%, 1.3%, 1.9%, 4.2%, and 5.1%, respectively. Overall, 23 patients (0.72%) developed dysplasia, while 11 (0.36%) developed adenocarcinoma of the pouch and/or the ATZ. Risk factors for pouch neoplasia were also evaluated. Preoperative established cancer [hazard ratios (HR) = 13.43, 95%CI: 3.96-45.53, P < 0.001] or dysplasia (HR = 3.62, 95%CI: 1.59-8.23, P = 0.002) were the only independent factors associated with increased risk of pouch neoplasia. Mucosectomy did not protect against this risk, and the rate of pouch cancer was actually higher after mucosectomy with a rate of 1.3% (6/451) compared to 0.3% (9/2734) after the double-stapled approach. The authors [44] concluded that the risk for neoplasia in patients with UC and IPAA is small, and that it is mainly determined by the presence of preoperative dysplasia or cancer.

Additionally, in a review of literature, 26 published case reports were identified between 1984 and 2008 [45]. Certain observations from this review are noteworthy. First, of the 26 carcinomas, 14 (52%) arose from rectal mucosa or from the anal transition zone, while 6 (23%) were from ileal pouch mucosa. Second, adenocarcinomas developed after mucosectomy in 17 patients, and after a double-stapled approach in 8 patients (1 case not reported). Also worth noting, the indication for the IPAA was due to neoplasia in 19 patients (9 cancers and 10 dysplasia) and non-neoplasia in 6 patients. The median time for development of pouch lesions was the shortest in patients operated on for cancer (median 3 years), compared to a median of 6.5 in the other patients. This review is in line with results from the above mentioned study, and further establishes the following conclusions: (1) the low number of reported cases; (2) cancer can develop both after mucosectomy or double-stapled approach; and (3) the close relationship between surgery for neoplasia and development of cancer. The review was not able to estimate the incidence of cancer after IPAA, since the total number of IPAA cases was not stated in most case reports. Branco et al [45] did publish their own case as part of this review, which was the first case they observed in a cohort of 520 patients (0.2%) from 1978 to 2008. This percentage is also in line with the Cleveland study [44].

Despite this seemingly small risk, surveillance of selected patients has been recommended by some authors [46,47]. This approach might especially be important in UC patients with dysplasia or cancer present at time of surgery, or patients with retained rectal mucosa and active inflammation (i.e., cuffitis). Also the presence of chronic pouchitis might be a valid indication for surveillance, since this has been associated with increased risk of low-grade dysplasia (odds ratio 13.48, P < 0.02), as well as high-grade dysplasia (366 vs 0/210, P = 0.01) [48].

**CONCLUSION**

In the current era IPAA is the preferred approach for patients with UC requiring surgical treatment. The removal of all diseased mucosa and the lower risk of cancer after IPAA compared to IRA are the main advantages of this technique (Table 3). Therefore, IPAA should certainly be performed when the rectum is actively involved in the disease or when dysplasia or cancer are present in any part of the colon or rectum. Nonetheless, there is still a role for IRA and TPC for selected patients and for patients not candidates for IPAA.

Total abdominal colectomy with IRA is justified in UC patients with normal anal sphincters tone without severe perineal disease, and spared and distensible rectum with no evidence of dysplasia or cancer at the time of intervention. It can be also proposed to young women as a possible interim procedure based on concerns for infertility after IPAA.

The risk of cancer is of particular concern in the comparison between these two techniques. Current evi-
dence shows a large variation in the reported rates of cancer after IRA from 0% to 8%. For IPAA, this risk is much smaller, and two large series have shown a rate of cancer of about 0.3%. Few studies have calculated the cumulative risk of cancer as well. Similarly, estimated cumulative risk of cancer after 20 years was higher after IRA (6% to 14%) compared to IPAA (4.2%) (Table 4).

Therefore, every patient undergoing IRA should be informed about the risk of recurrent proctitis and cancer in long standing disease. They have to fully understand the need for meticulous surveillance and agree to comply with at least yearly endoscopy with rectal biopsies. Unless these conditions are met, patients should not be offered an IRA. Also, patients with widely metastatic colorectal cancer may benefit from an IRA as a palliative procedure.

Functional results seem to be better after IRA with lower frequency of bowel movements and less night-time seepage but with more urgency compared to patients with an IPAA. The overall quality of life is similar, although the IRA group has significantly more dietary and work restrictions[13].

Finally, TPC still remains the procedure of choice in patients with impaired anal sphincter function and high-risk of pouch failure.

REFERENCES

1 Baker WN. The results of ileorectal anastomosis at St Mark’s Hospital from 1953 to 1968. Gut 1970; 11: 235-239 [PMID: 5423903 DOI: 10.1136/gut.11.3.235]

2 Aylett SO. Three hundred cases of diffuse ulcerative colitis treated by total colectomy and ileo-rectal anastomosis. Br Med J 1966; 1: 1001-1005 [PMID: 5909842 DOI: 10.1136/ bmj.1.5494.1001]

3 Hueting WE, Gooszen HG, van Laarhoven CJ. Sexual function and continence after ileo pouch anal anastomosis: a comparison between a meta-analysis and a questionnaire survey. Int J Colorectal Dis 2004; 19: 215-218 [PMID: 14564464 DOI: 10.1007/s00384-003-0543-7]

4 Gorgun E, Remzi FH, Goldberg JM, Thornton J, Bast J, Hull TL, Loparo B, Fazio WV. Fertility is reduced after restorative proctocolectomy with ileal pouch anal anastomosis: a study of 300 patients. Surgery 2004; 136: 795-803 [PMID: 15467664 DOI: 10.1016/j.surg.2004.06.018]

5 Waljee A, Waljee J, Morris AM, Higgin PDS. Threefold increased risk of infertility: a meta-analysis of infertility after ileal pouch anastomosis in ulcerative colitis. Gut 2006; 55: 1575-1580 [PMID: 1672130 DOI: 10.1136/gut.2005.090816]

6 Parks AG, Nicholls RJ. Proctocolectomy without ileostomy for ulcerative colitis. Br Med J 1979; 2: 85-88 [PMID: 6675728 DOI: 10.1136/bmj.2.6130.868-88]

7 Remzi FH, Fazio VW, Delaney CP, Preen M, Ormsby A, Baker J, O’Riordan MG, Strong SA, Church JM, Petras RE, Gramlich T, Lavery IC. Dysplasia of the anal transitional zone after ileal pouch-anal anastomosis: results of prospective evaluation after a minimum of ten years. Dis Colon Rectum 2007; 50: 691-703 [PMID: 17245515 DOI: 10.1007/s10350-006-8482-2]

8 Das P, Johnson MW, Tekkis P, Nicholls RJ. Risk of dysplasia and adenocarcinoma following restorative proctocolectomy for ulcerative colitis. Colorectal Dis 2007; 9: 15-27 [PMID: 17181842 DOI: 10.1111/j.1463-1318.2006.01148.x]

9 Remzi FH, Fazio VW, Oncel M, Baker ME, Church JM, Ooi BS, Connor JT, Preen M, Einstein D. Portal vein thrombi after restorative proctocolectomy. Surgery 2002; 132: 655-661; discussion 661-662 [PMID: 12407380 DOI: 10.1067/ mry.2002.127689]

10 Sagap I, Remzi FH, Hammel JP, Fazio VW. Factors associated with failure in managing pelvic sepsis after ileal pouch-anal anastomosis (IPAA)–a multivariate analysis. Surgery 2006; 140: 691-703; discussion 703-704 [PMID: 17011918 DOI: 10.1016/j.surg.2006.07.015]

11 da Luz Moreira A, Kiran RP, Lavery I. Clinical outcomes of ileorectal anastomosis for ulcerative colitis. Br J Surg 2010; 97: 65-69 [PMID: 20013930 DOI: 10.1002/bjs.6809]

12 Oakley JR, Jagelman DG, Fazio VW, Lavery IC,Weakley FL, Easley K, Farmer RG. Complications and quality of life after ileorectal anastomosis for ulcerative colitis. Am J Surg 1985; 149: 23-30 [PMID: 3966637 DOI: 10.1016/ S0002-9610(85)80004-0]

13 Leijonmarck CE, Löfberg R, Ost A, Hellers G. Long-term results of ileorectal anastomosis in ulcerative colitis in Stockhol nm County. Dis Colon Rectum 1990; 33: 195-200 [PMID: 2311462 DOI: 10.1007/BF02134178]

14 Grüner OP, Flatmark A, Naas R, Fretheim B, Gjone E. Ileorectal anastomosis in ulcerative colitis. Results in 57 patients. Scand J Gastroenterol 1975; 10: 641-646 [PMID: 1179158]

15 Pastore RL, Wolf BG, Hedge D. Total abdominal colectomy and ileorectal anastomosis for inflammatory bowel disease. Dis Colon Rectum 1997; 40: 1455-1464 [PMID: 9407985 DOI: 10.1053/rect.1997.0043]

Table 4 Risk of cancer after ileorectal vs ileal pouch-anal anastomosis in ulcerative colitis

| Ileorectal anastomosis | n | Follow-up average (yr) | Overall cancer rate (%) | Estimated cumulative risk after 20 years (%) |
|------------------------|---|-----------------------|------------------------|-------------------------------------------|
| da Luz Moreira et al[4] | 86 | 9 | 8 | 14 |
| Leijonmarck et al[8] | 51 | 13 | 0 | - |
| Pastore et al[8] | 48 | 6.3 | 2 | 14.3 |
| Börjesson et al[9] | 32 | 3.5 | 0 | - |
| Grundfest et al[7] | 89 | 8 | 4.8 | 5 ± 3.5 |
| Elton et al[10] | 1800-1999 | 2.6 | - | - |
| Andersson et al[10] | 105 | 5.4 | - | 2.1 |
| Lepistö et al[11] | 278-2000 | 18 | 0 | - |
| Oakley et al[12] | 288 | 8.2 | 3.1 | - |
| Baker et al[13] | 1952-1976 | ≥ 10 | 5.9 | 6 ± 2 |
| Ileo-pouch anal anastomosis | | | | |
| Karr et al[14] | 1984-2009 | ± 12 | 0.4 | 4 |
| Branco et al[15] | 1978-2008 | ± 15 | 0.2 | - |

1 Cumulative risk at 12 years (rather than 20).
Börjesson L, Lundstam U, Oresland T, Brevinge H, Hultén L. The place for colectomy and ileorectal anastomosis: a valid surgical option for ulcerative colitis? *Tech Coloproctol* 2006; 10: 237-241; discussion 241 [PMID: 16996910 DOI: 10.1007/s10151-006-0286-x]

Grundfest SF, Fazio V, Weiss RA, Jagelman D, Lavery I, Weakley FL, Turnbull RB. The risk of cancer following colectomy and ileorectal anastomosis for extensive mucosal ulcerative colitis. *Ann Surg* 1981; 193: 9-14 [PMID: 7458456 DOI: 10.1097/00000568-198101000-00002]

Elton C, Makin G, Hitos K, Cohen CR. Mortality, morbidity and functional outcome after ileorectal anastomosis. *Br J Surg* 2003; 90: 59-65 [PMID: 12520576 DOI: 10.1016/j.bjs.4005]

Andersson P, Norblad R, Söderholm JD, Myrelid P. Ileorectal anastomosis in comparison with ileal pouch anal anastomosis in reconstructive surgery for ulcerative colitis--a single institution experience. *J Crohns Colitis* 2014; 8: 582-589 [PMID: 24315777 DOI: 10.1016/j.jcrohns.2013.11.014]

da Luz Moreira A, Lavery IC. Ileorectal anastomosis and proctocolectomy with end ileostomy for ulcerative colitis. *Clin Colorectal Surg* 2010; 3: 269-273 [PMID: 22131897 DOI: 10.1016/j.ccs.2010.08.007]

Turnbull RB. Surgical treatment of ulcerative colitis: early results after colectomy and low ileorectal anastomosis. *Dis Colon Rectum* 1959; 2: 260-263 [PMID: 13663743 DOI: 10.1007/BF02616889]

Lepistö A, Järvinen H. Fate of the rectum after colectomy with ileorectal anastomosis in ulcerative colitis. *Scand J Surg* 2005; 94: 40-42 [PMID: 15865115]

Oakley JR, Lavery IC, Fazio VW, Jagelman DG, Weakley FL, Easley K. The fate of the rectal stump after subtotal colectomy for ulcerative colitis. *Dis Colon Rectum* 1985; 28: 394-396 [PMID: 4006633 DOI: 10.1016/B978-0-12-282533-0.50029-1]

Morson BC, Pang LS. Rectal biopsy as an aid to cancer control in ulcerative colitis. *Gut* 1967; 8: 423-434 [PMID: 6057771 DOI: 10.1136/gut.8.5.423]

Johnson WR, McDermott FT, Pihl E, Hughes ES. Mucosal dysplasia. A major predictor of cancer following ileorectal anastomosis. *Dis Colon Rectum* 1983; 26: 697-700 [PMID: 6628140 DOI: 10.1016/B978-0-12-282545-9.50073-2]

Baker WN, Glass RE, Ritchie JK, Ayllett SO. Cancer of the rectum following colectomy and ileorectal anastomosis for ulcerative colitis. *Br J Surg* 1978; 65: 862-868 [PMID: 737423 DOI: 10.1002/bjs.1800652111]

Johnson WR, McDermott FT, Hughes ES, Pihl EA, Milne BJ, Price AB. The risk of rectal carcinoma following colectomy in ulcerative colitis. *Dis Colon Rectum* 1983; 26: 44-46 [PMID: 6822160 DOI: 10.1016/B978-0-12-282546-7.50074-9]

Kiran RP, Ali UA, Nisar PJ, Khoury W, Gu J, Shen B, Remzi FH, Hammel JP, Lavery IC, Fazio VW, Goldblum JR. Risk and location of cancer in patients with preoperative colitis-associated dysplasia undergoing proctocolectomy. *Ann Surg* 2014; 259: 302-309 [PMID: 23579580 DOI: 10.1097/SLA.0b013e318267417]

Lovegrove RE, Baker WN, Ritchie JK, Ayllett SO. The role of the rectum in the development of colorectal cancer. *Aliment Pharmacol Ther* 2001; 166: 120-128 [PMID: 11343542 DOI: 10.1002/bjs.80065211]

Lovegrove RE, Lovegrove RC, Baker WN, Ritchie JK, Ayllett SO. The role of the rectum in the development of colorectal cancer. *Br J Surg* 2001; 88: 120-128 [PMID: 11343542 DOI: 10.1002/bjs.80065211]

WJC | www.wjgnet.com
Duff SE, O’Dwyer ST, Hultén L, Willén R, Haboubi NY. Dysplasia in the ileoanal pouch. *Colorectal Dis* 2002; 4: 420-429 [PMID: 12790913 DOI: 10.1046/j.1463-1318.2002.00422.x]

Hurlstone DP, Shorthouse AJ, Cross SS, Brown S, Sanders DS, Lobo AJ. High-magnification chromoscopic pouchoscopy: a novel in vivo technique for surveillance of the anal transition zone and columnar cuff following ileal pouch-anal anastomosis. *Tech Coloproctol* 2004; 8: 173-178; discussion 178 [PMID: 15654525 DOI: 10.1007/s10151-004-0083-3]

P- Reviewer: Caviglia R, Herszenyi L, Lee CL
S- Editor: Ding Y
L- Editor: A
E- Editor: Wang CH
