Surg Today (2015) 45:933–938
DOI 10.1007/s00595-014-1053-7

REVIEW ARTICLE

Laparoscopic surgery for ulcerative colitis: a review of the literature

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Received: 23 August 2014 / Accepted: 24 September 2014 / Published online: 28 October 2014

Abstract Despite the development of new therapies, including anti-TNF alpha antibodies and immunosuppressants, a substantial proportion of patients with ulcerative colitis (UC) still require surgery. Restorative proctocolectomy with ileal-pouch anal anastomosis is the standard surgical treatment of choice for UC. With the advent of laparoscopic techniques for colorectal surgery, ileal-pouch anal anastomosis has also been performed laparoscopically. This paper reviews the history and current trends in laparoscopic surgery for UC. The accumulation of experience and improvement of laparoscopic devices have shifted the paradigm of UC surgery towards laparoscopic surgery over the past decade. Although laparoscopic surgery requires a longer operation, it provides significantly better short and long-term outcomes. The short-term benefits of laparoscopic surgery over open surgery include shorter hospital stays and fasting times, as well as better cosmesis. The long-term benefits of laparoscopy include better fecundity in young females. Some surgeons favor laparoscopic surgery even for severe acute colitis. More efforts are being made to develop newer laparoscopic methods, such as reduced port surgery, including single incision laparoscopic surgery and robotic surgery.

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Keywords Laparoscopic surgery · Ulcerative colitis · Ileal-pouch anal anastomosis · Inflammatory bowel disease · Hand-assisted laparoscopic surgery · Single incision laparoscopic surgery · Robotic surgery

Introduction

A substantial proportion of patients with ulcerative colitis (UC) still require surgery despite the development of many novel therapies, including anti-TNF alpha antibodies and immunosuppressants [1, 2]. Parks et al. [3] first described restorative proctocolectomy and ileal-pouch anal anastomosis (IPAA) in 1978, which has since become the standard treatment of choice for most UC patients who require surgical resection [4, 5]. Although several reports showed a sufficient quality of life (QOL) after IPAA, this procedure is associated with relatively frequent complications and cosmetic issues, especially considering the fact that most of the treated patients were young [6, 7]. Moreover, the risk of infertility was reported to be about threefold higher than normal after IPAA, probably due to the development of adhesions to the fallopian tubes.

With the advent of laparoscopic surgery (LS), many surgeons have made efforts to apply LS for IPAA. Obviously, the length of the incision is significantly shorter if LS is completed without conversion to open surgery (OS) [8, 9]. However, due to the complexity, early reports from the 1990s were generally negative for the use of LS-IPAA for UC [10–12]. Over the past decade, the dramatic improvements made in laparoscopic devices and the accumulation of experience from colorectal cancer surgery have made it possible for surgeons to apply LS to IPAA. There are two major types of LS: hand-assisted laparoscopic surgery (HALS) and laparoscopy-assisted surgery (LAS) [13]. LAS

is also referred to as "straight laparoscopy" or "standard laparoscopy" in some papers [14, 15]. The emergence of the HALS technique facilitated more surgeons to combine this new technique with the traditional OS.

In this review, the history of LS-IPAA for UC and the current evidence regarding its indications and outcomes will be discussed. Total abdominal colectomy (TAC) for severe acute colitis will also be discussed.

The predawn period of laparoscopic surgery for UC

Laparoscopic colectomy for colorectal cancer has been acquiring popularity since 1991, when it was introduced by Jacobs et al. [16]. Following this report by Jacobs, Peters et al. reported two cases of UC which were successfully treated by LS in 1992 [17]; however, several reports had suggested that LS-IPAA did not confer much benefit over OS-IPAA for UC because of the complex and lengthy surgical procedure associated with LS-IPAA [10–12, 18].

Sardinha et al. collected published data regarding the laparoscopic treatment of inflammatory bowel disease from 1992 to 1997 [10]. They used five ports with a suprapubic incision (Pfannelstiel) for UC surgery. Twenty-three patients with UC who underwent LS-IPAA with a J pouch were compared with matched patients who underwent OS-IPAA. The length of the operation was significantly longer and the complication rate was significantly higher in the LS group. Therefore, they concluded that LS-IPAA could not be routinely justified as the standard surgical treatment for UC.

Hand-assisted laparoscopic surgery

HALS is one form of LS, where one hand of the surgeon can be inserted into the abdominal cavity through a hand port. This technique shed light on the complex and lengthy LS-IPAA procedures. The benefit of HALS is that surgeons can touch the organs directly as in OS, so that they can feel the tension and easily apply appropriate countertraction. Nakajima et al. [15] compared HALS with the "standard" LAS. Their study retrospectively compared 12 HALS and 11 LAS procedures combining TAC and IPAA. Out of 23 patients examined, 17 had UC. The length of the operation was significantly shorter in the HALS group than in the LAS group (210 vs. 273 min, $p = 0.03$). Boushey et al. [14] compared HALS and LAS in terms of the time to bowel movement, hospital stay and re-admission rate; they reported that these factors were comparable between the two groups. A randomized controlled trial (RCT) by Maartense et al. [19] comparing HALS and OS showed that the QOL, morbidity and mortality were comparable between the two groups, although the operation was longer in the HALS group; they thus concluded that HALS was safe and feasible for UC. Moreover, the cost of HALS was reported to be comparable to that of LAS according to papers assessing the methods for colorectal cancer surgery [20].

Randomized controlled trials comparing laparoscopic vs. open surgery for ulcerative colitis

With the accumulation of experience and improvement of laparoscopic tools, such as energy devices and specific forceps, both LAS-IPAA and HALS-IPAA have become more feasible. The evidence for LS-based treatment of UC is not mature, although LS has been gaining popularity at many specialized institutions. There have been only two RCTs comparing LS with OS for UC surgery (Table 1).

In one study, Schiessling et al. [21, 22] reported a RCT comparing five-port LS with OS to assess the short-term

Table 1 Randomized controlled trial comparing laparoscopic vs open ileo-anal pouch anal anastomosis for ulcerative colitis

Author	Publication year	Reference	Total patients included	Accrual	Difference seen in LS		Conversion
Maartense et al.	2004	[19]	HALS 30 OS 30	2000–2003	Operation time	Longer	0 %
					Cosmesis	Better	
					Morbidity	NS	
					Hospital stay	NS	
					Mortality	NS	
					Cost	Higher	
Schiessling et al.	2013	[21]	LS 21 OS 21	2004–2008	Operation time	Longer	23.80 %
					Cosmesis	Better	
					Blood loss	NS	
					Hospital stay	NS	
					Bowel function	NS	
					QOL	NS	

HALS hand-assisted surgery, *LS* laparoscopic surgery, *OS* open surgery, *QOL* quality of life, *NS* not significant

complication rates. Although they were trying to accrue at least 65 patients to obtain sufficient power to show a statistically significant difference, the trial was stopped in the middle because of insufficient recruitment, resulting in a total accrual of 42 patients. They concluded that the blood loss between the LS and OS groups was not significantly different, and that LS was feasible for restorative proctocolectomy. However, this study was underpowered due to the insufficient recruitment. In addition, it should be noted that the conversion rate from LS to OS was high, at up to 23.8 %.

The other RCT published in 2004 by Maartense et al. [19] compared HALS and OS in 40 UC and 20 familial adenomatous polyposis (FAP) patients. They assessed the QOL using the SF-36 three months after surgery and the GIQLI scores during the first two weeks. Their results showed no significant differences between the two procedures. In addition, the morbidity and hospital stays were comparable between the two groups. This RCT also assessed the costs of the procedures. Although the cost of the operation was significantly higher in the LS group, the overall cost was reported to be comparable between the two groups. The same group published a follow-up study for this RCT that assessed the long-term body image and cosmesis [23]. At a median of 2.7 years after surgery, they collected questionnaires from 46 out of the 60 enrolled patients. The patients who underwent OS indicated that the surgery had a negative impact on their body image and cosmesis compared with those who had undergone LS.

The evidence level is not high enough to support LS surgery based on these two RCTs, and additional studies are, therefore, needed.

Systemic reviews and meta-analyses

Several systemic review and meta-analysis studies, including a Cochran Review [24], comparing LS and OS-IPAA have been published (Table 2). Because a meta-analysis usually collects data from several RCTs, the results are commonly regarded as reliable, highest-evidence data. This particular set of meta-analysis studies, however, was based mostly on retrospective studies. Thus, the evidence level was relatively low. It should also be noted that publication biases could not be completely excluded. All meta-analysis studies published after 2006 favored LS over OS, as described below:

Tan et al. [25] published the first meta-analysis comparing LS and OS for UC surgery in 2006. They included 11 non-randomized studies in this analysis, consisting of 387 patients. They separated the analysis based on the surgical procedures (TAC or IPAA). Surprisingly, they concluded that the complication rate was significantly higher after OS for TAC (OS 67.6 % vs. LS 39.7 %, $P = 0.005$) than after LS group, but was comparable between the LS and OS groups for IPAA. In addition, the hospital stays were shorter in the LS group, with a weighted mean difference of 2.64 days ($P = 0.003$).

Table 2 Meta-analysis comparing laparoscopic vs open ileo-anal pouch anal anastomosis for ulcerative colitis

Author	Publication year	Reference	Included study	Included patient	Difference seen in LS	
Tan et al.	2006	[25]	11 (no RCT)	387	Bowel function recovery	Faster
					Hospital stay	Shorter
					Complication for TAC	Lower
					Complication for IPAA	NS
Ahmed et al. (Cochrane)	2009	[24]	12 (1 RCT)	607	Bowel function recovery	Shorter
					Hospital stay	Shorter
					Incision length	Shorter
					Cosmesis	Better
					Operative cost	Higher
					Total cost	NS
					Operative time	Longer
Wu et al.	2010	[26]	16 (1 RCT)	923	Total complication rate	Lower
					Bowel function recovery	Faster
					Operation time	Longer
					Hospital stay	Shorter
Bartels et al.	2013	[27]	9 (no RCT)	966	Wound infection	Lower
					Intra-abdominal abscess	Lower
					Hospital stay	Shorter

NS not significant, *RCT* randomized controlled trial, *TAC* total abdominal colectomy, *IPAA* ileal-pouch anal anastomosis

The Cochrane Review published a systematic review and meta-analysis comparing LS-IPAA for UC and FAP in 2009 [24]. In this review, HALS and LAS-IPAA were combined and analyzed together as LS-IPAA. The review concluded that LS-IPAA is safe and feasible in experienced centers, and showed limited short-term advantages, including improved cosmesis and postoperative recovery. Functional outcomes such as the defecation frequency, fecal incontinence and sexual function were not significantly different between LS and OS.

Wu et al. [26] performed a meta-analysis that reviewed 16 reports including one RCT published in 2010, and showed that the total complication rate was lower in the LS group than in the OS group. They also proved that LS offered shorter fasting times and reduced postoperative hospital stays than OS.

One meta-analysis by Bartels et al. [27] assessed the feasibility of LS-TAC for severe acute colitis in 2013. This will be discussed in the next section.

Laparoscopic surgery for severe acute colitis

For those with severe acute colitis, TAC with ileostomy and a mucous fistula is one of the initial surgical treatments of choice, followed by a second-stage surgery. Previously, LS was not applied for cases of severe acute colitis, because of the bowel friability. However, some now consider that even severe or urgent cases can be indicated for LS [28–34]. There have been several papers which have favored LS over OS even for severe acute colitis cases. Dunker et al. [28] retrospectively compared LS with OS in 42 consecutive patients with severe acute colitis, and showed comparable complication rates in the two groups. In that study, they performed total colectomy with a rectal mucous fistula and ileostomy. They concluded that LS was safe and feasible.

Watanabe et al. [35] reported the feasibility of HALS TAC with a mucous fistula and ileostomy. They compared 30 patients who received HALS total colectomy for severe UC with 30 patients who received OS total colectomy. Although the operation was longer in the LS group, the postoperative food prohibition and hospital stays were shorter in the LS group.

Gu et al. recently reviewed 412 patients with UC or indeterminate colitis who underwent TAC between 2006 and 2010. Out of these 412 patients, LS-TAC was performed in 197 patients. Although LS-TAC required a longer operation, it was associated with less blood loss, less overall morbidity, a faster return to bowel function and a shorter hospital stay.

Bartels et al. [27] published a systematic review and meta-analysis in the setting of acute colitis, excluding emergency cases. They pooled nine non-RCTs consisting of 966 patients. In that report, the rates of wound infection and intra-abdominal abscess significantly favored LS. The LS group also showed significantly shorter hospital stays. The pooled conversion rate from LS to OS was reported to be 5.5 percent.

Most studies included patients with severe colitis according to the criteria proposed by Truelove and Witts [36], who were refractory to medical therapy, but excluded those with toxic megacolon, perforation and major hemorrhage cases [31–35]. Therefore, for cases with toxic megacolon, perforation and/or major hemorrhage, there has been insufficient evidence to facilitate LS, and so far, OS is considered the standard treatment of choice for these patients.

Other possible points of superiority for laparoscopic surgery

The superiority of LS, especially in terms of both the short- and long-term outcome, has been emphasized. As already mentioned in the previous sections, there have been several reports that have investigated the superiority of LS for UC. [24–27] Not surprisingly, LS has an advantage in cosmesis, although it requires a longer operation than OS [37, 38]. The meta-analysis studies comparing LS with OS showed that LS was superior, with lower rates of wound infection and intra-abdominal abscess formation, better bowel function and shorter hospital stays [24–27].

On top of these advantages of LS, fecundity might be another possible advantage for LS-IPAA. Infertility is one of the problems that develops after IPAA in young females. Several meta-analysis studies showed that the risk of infertility was increased about threefold after IPAA. [39, 40]. Tubal adhesion is postulated as an underlying cause, which could be reduced by performing LS with small incisions [13]. A cross-sectional study from the Netherlands and Belgium corroborated this idea, and showed that the spontaneous pregnancy rate was significantly higher in the LS group than in the OS group ($p = 0.033$) [41]. However, that study only included 50 eligible patients. Therefore, a definitive conclusion cannot be made from the study, and future studies of larger population will be necessary.

Future perspectives: towards less invasive surgery and robotic surgery

While the LS-IPAA technique mentioned in most papers included a Pfannenstiel incision, Sahakitrungruang et al. [42] developed LS-IPAA with the McBurney incision. To further minimize the invasiveness and improve the cosmetic outcomes, Watanabe et al. [43] reported a single case of one-stage completely laparoscopic total proctocolectomy

without abdominal incisions where only port incisions were made. Recently, more efforts have been made to reduce the number of ports [44–46], and Gash et al. [47] applied a single incision laparoscopic (SILS) approach to total proctocolectomy for 10 cases of UC. Although they reported that the SILS approach was safe for total proctocolectomy for experienced laparoscopic surgeons, this approach is not yet generally accepted as a standard procedure. McLemore et al. applied robotic surgery for IPAA in three toxic UC patients, and the procedures were performed safely with minimal complications in all patients. However, the cost for the robotic surgery is currently higher than that of conventional LS surgery [48]. Several other issues remain to be clarified, such as the indications for LS in patients with colitis-associated colorectal cancer, pediatric and elderly patients and the possibility of omitting covering ileostomy with LS-IPAA [49, 50].

Conclusion

More than 30 years have passed since Parks et al. [3] first developed restorative proctocolectomy and IPAA for UC. IPAA has long been the standard treatment of choice for many patients with UC when surgery is indicated. Significant improvements in the laparoscopic techniques and tools have made it possible to apply LS to IPAA. The evidence from several meta-analysis studies, though the evidence levels are relatively low, favors LS-IPAA over OS-IPAA. LS may provide better short- and long-term outcomes, including improved cosmesis, hospital stays and fecundity in the hands of experienced surgeons in specialized centers.

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