Open access • Journal Article • DOI:10.1002/14651858.CD006267.PUB2

Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis — Source link

Usama Ahmed Ali, Frederik Keus, J.T. Heikens, Willem A. Bemelman ...+3 more authors

Institutions: Utrecht University, University Medical Center

Published on: 21 Jan 2009 - Cochrane Database of Systematic Reviews (John Wiley & Sons, Ltd)

Topics: Proctocolectomy, Cosmesis, Colorectal surgery, Randomized controlled trial and Cochrane Library

Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis (Review)

Ahmed Ali U, Keus F, Heikens JT, Bemelman WA, Berdah SV, Gooszen HG, van Laarhoven CJHM

This is a reprint of a Cochrane review, prepared and maintained by The Cochrane Collaboration and published in *The Cochrane Library* 2009, Issue 1

http://www.thecochranelibrary.com

TABLE OF CONTENTS

[Intervention Review]

Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Usama Ahmed Ali[1], Frederik Keus[2], Joost T Heikens[3], Willem A Bemelman[4], Stephane V Berdah[5], H G Gooszen[6], Cees JHM van Laarhoven[7]

[1]Department of Surgery, Dutch Pancreatitis Study Group, University Medical Center Utrecht, Utrecht, Netherlands. [2]Surgery, Diakonessenhuis, Utrecht, Netherlands. [3]Surgery, St Elisabeth Hospital, Tilburg, Netherlands. [4]Department of Surgery, Academic Medical Centre, Amsterdam, Amsterdam, Netherlands. [5]Department of Digestive Surgery, Höpital Nord - Marseille, Marseille, France. [6]Surgery, University Medical Center, Utrecht, Netherlands. [7]Department of Surgery 690, University Medical Centre Nijmegen, HB Nijmegen, Netherlands

Contact address: Usama Ahmed Ali, Department of Surgery, Dutch Pancreatitis Study Group, University Medical Center Utrecht, Heidelberglaan 100, P.O. Box 85500, Utrecht, Utrecht, 3508 GA, Netherlands. U.ahmedali@gmail.com. u.ahmedali@umcutrecht.nl.

Editorial group: Cochrane Colorectal Cancer Group.
Publication status and date: New, published in Issue 1, 2009.
Review content assessed as up-to-date: 3 November 2008.

Citation: Ahmed Ali U, Keus F, Heikens JT, Bemelman WA, Berdah SV, Gooszen HG, van Laarhoven CJHM. Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis. *Cochrane Database of Systematic Reviews* 2009, Issue 1. Art. No.: CD006267. DOI: 10.1002/14651858.CD006267.pub2.

ABSTRACT

Background

Restorative proctocolectomy with ileo pouch anal anastomosis (IPAA) is the main surgical treatment for patients with ulcerative colitis (UC) and familial adenomatous polyposis (FAP). With the advancements of minimal-invasive surgery this demanding operation is increasingly being performed laparoscopically. Therefore, the presumed benefits of the laparoscopic approach need to be systematically evaluated.

Objectives

To compare the beneficial and harmful effects of laparoscopic versus open IPAA for patients with UC and FAP.

Search methods

We searched The Cochrane IBD/FBD Group Specialized Trial Register (April 2007), The Cochrane Library (Issue 1, 2007), MEDLINE (1990 to April 2007), EMBASE (1990 to April 2007), ISI Web of Knowledge (1990 to April 2007) and the web casts of the American Society of Colon and Rectal Surgeons (ASCRS) (up to 2006) for all trials comparing open versus laparoscopic IPAA.

Selection criteria

All trials in patients with UC or FAP comparing any kind of laparoscopic IPAA versus open IPAA. No language limitations were applied.

Data collection and analysis

Two authors independently performed selection of trials and data extraction. The methodological quality of all included trials was evaluated to assess bias risk. Analysis of RCTs and non-RCTs was performed separately. Analyses were based on the intention-to-treat principle. Authors were requested additional information in case of missing data. Sensitivity and subgroup analyses were performed if appropriate.

Main results

Eleven trials included 607 patients of whom 253 (41%) in the laparoscopic IPAA group. Only one of the included trials was a randomised controlled trial. There were no significant differences in mortality or complications between the two groups. Reoperation and readmission rates were not significantly different. Operative time was significantly longer in the laparoscopic group both in the RCT and meta-analysis of non-RCTs (weighted mean difference (WMD) 91 minutes; 95% Confidence Interval (CI) 53 to 130). There were no significant differences between the two groups regarding postoperative recovery parameters. Total incision length was significantly shorter in the laparoscopic group, while two trials evaluating cosmesis found significantly higher cosmesis scores in the laparoscopic group. Other long-term outcomes were poorly reported.

Authors' conclusions

The laparoscopic IPAA is a feasible and safe procedure. Short-term advantages of the laparoscopic approach seem to be limited and their clinical significance is arguable. Large high-quality trials focusing on differences regarding specific postoperative complications, cosmesis, quality of life and costs are needed.

PLAIN LANGUAGE SUMMARY

Open versus laparoscopic approach to pouch surgery in patients with ulcerative colitis and familial adenomatous polyposis showed no significant differences in mortality and complications, but the laparoscopic approach resulted in better cosmesis.

Resection of the entire colon and creation of an ileal pouch by means of an ileo pouch anal anastomosis (IPAA) is a last resort for many patients with ulcerative colitis and familial adenomatous polyposis. In recent years this operation has increasingly being performed laparoscopically. In this review we compared the open versus laparoscopic IPAA. We found no significant differences in mortality and complications between the two techniques. The laparoscopic IPAA had a longer operative time of on average 90 minutes. No reliable conclusions could be made regarding the benefit of laparoscopic IPAA on the postoperative recovery. Findings suggest that the laparoscopic approach may improve the postoperative recovery, but the importance of these advantages seems limited. The laparoscopic IPAA did result in better cosmesis than the open IPAA, but more studies will be needed to confirm these findings.

The most important limitation of this review is that we only found one randomised controlled trial (RCT) on this subject, and we therefore needed to include non-randomised controlled trials. Another important limitation is that most studies did not report on important long-term outcomes, like quality of life and functional outcome.

BACKGROUND

Ulcerative colitis (UC) is an inflammatory disease of the large intestine of uncertain aetiology characterized by recurring episodes of inflammation primarily involving the mucosal layer and occasionally the submucosa of the colon. The estimated incidence of UC is 8.7/100.000 in Europe (Shivananda 1996). Whereas medical treatment is the mainstream for the management of UC, several evidence-based indications for surgical treatment have been identified, including acute pan colitis, intractability to medical treatment and the presence of dysplasia or neoplasia (Cohen 2005).

Familial adenomatous polyposis (FAP) is a rare autosomal dominant disease, characterized by the development of hundreds to thousands of adenomatous polyps in the colon and rectum of affected individuals leading to cancer at young age, if left untreated. The incidence is around 2 per million and the prevalence is around 40 per million (Bulow 2003; Jarvinen 1992). Because of the in-

evitable development of cancer in this disease, colectomy is warranted for all patients with FAP at a certain point of their disease.

Both UC and FAP are limited to the colon and rectum. Therefore, proctocolectomy provides relief of symptoms and eliminates the risk of developing colorectal cancer. Since its introduction in 1978 the restorative ileo pouch-anal anastomosis (IPAA) has gained wide acceptance in the surgical treatment of patients with UC and FAP (Parks 1978). The open IPAA has become the standard surgical approach for UC and FAP, due to its good functional results and high patient satisfaction (Cohen 1992; Fazio 1995; Hueting 2005; Marcello 1993).

Over the past decades laparoscopic techniques have evolved rapidly and large bowel resections were increasingly being performed laparoscopically. The first laparoscopic-assisted restorative proctocolectomy with IPAA (LA-IPAA) was described in 1992 (Peters 1992) and technical feasibility of this procedure has been shown repeatedly (Casillas 2005; Ky 2002; Santoro 1999; Wexner 1992). Reduced post-operative pain, quicker recovery and superior cosmetic results are presumed advantages of the LA-IPAA over the open IPAA. However, reports have shown inconsistent results. Early reports tend to be sceptical with respect to the benefits of the LA-IPAA (Reissman 1996; Sardinha 1998; Schmitt 1994), while recent studies tend to show more favourable results of the laparoscopic technique (Gill 2004; Larson 2005; Marcello 2000).

As patients with UC and FAP requiring surgery generally are young, active and highly motivated individuals, minimal-invasive surgery may especially be appealing in this group of patients (Ky 2002). Cosmesis and patients' satisfaction could therefore play important role in the choice between these two approaches. However, possible benefits regarding these items is of secondary importance compared to primary outcomes of surgery, like postoperative morbidity and mortality.

To be able to compare both techniques in a satisfactory manner, a systematic evaluation of the benefits and harms of open versus LA-IPAA is needed.

OBJECTIVES

To study whether laparoscopic and open IPAA for UC and FAP are different in terms of primary (mortality and complications) and secondary outcomes (operative time, hospital stay, convalescence, cosmesis, functional outcome and quality of life). If data were present, differences in other secondary outcomes were compared as well.

METHODS

Criteria for considering studies for this review

Types of studies

Due to the paucity of randomised clinical trials, non-randomised controlled clinical trials comparing open IPAA versus LA-IPAA were also included in this review. Trials were included if they performed a direct comparison of open IPAA versus LA-IPAA, irrespectively of randomisation, prospective data collection, number of patients or language of the article.

Types of participants

Studies including patients with UC or FAP who underwent an IPAA procedure were included. If studies sporadically included patients with other diseases, they were included as long as the main population consisted of UC or FAP patients. Studies including mainly patients with other diseases were excluded, unless they presented the data for the UC and FAP patients separately. When multiple studies have overlapping patient populations, only the most recent publication was included in the review.

Types of interventions

Studies comparing any type of open IPAA to any type of LA-IPAA were included. The following classification of the surgical procedures (based on intention-to-treat) was used:

- 'Laparoscopic IPAA' included those procedures started as a laparoscopic procedure, with creation of any kind of pneumoperitoneum (by Veress needle or open introduction) or mechanical abdominal wall lift, irrespective of the number of trocars used. 'Laparoscopic-assisted IPAA' included those procedures in which an additional small incision laparotomy was used (e.g. Pfannenstiel or subumbilical midline incision) to facilitate the laparoscopic IPAA procedure.

- In all other cases the surgical intervention was classified as 'open IPAA'.

Types of outcome measures

Primary outcome measures were mortality and complications (except minor complications). Secondary outcome measures were all other outcomes assessed in the comparison of the two operative techniques. These included minor complications, operative time, operative blood loss, time to bowel movement, time to regular diet, hospital stay, readmission rate, reoperation rate, incision length, cosmesis, functional outcome (faecal and sexual function) and costs.

Complications were classified into the following categories:

- Intraoperative complications: all complications occurring and detected intraoperatively, like small bowel perforation and severe intraoperative bleeding.

- Procedure specific complications: pouch failure, pelvic sepsis, pouch fistula, anastomotic leakage and strictures.
- Severe postoperative complications: e.g. intra-abdominal abscesses, bleeding, sepsis, burst abdomen (Platzbauch) and myocardial infarction.
- Mild postoperative complications: e.g. including prolonged ileus, wound infections, urinary tract infections, urinary retention, pleural effusion, late incisional hernia, and deep venous thrombosis. Other postoperative complications were categorized appropriately at first encounter.
- Total complications: the total number of all complications per study.

The following definitions were used for the procedure specific complications:

- Pouch failure: pouch excision or a non-functioning pouch at 12 months after IPAA procedure.
- Pelvic sepsis: pelvic abscess, anastomotic leakage or dehiscence or pelvic/perineal wound infection.
- Pouch fistula: any pouch related fistula.
- Stricture: anastomotic fibrosis necessitating dilatation.

Functional outcome was assessed using the following items:

- Defecation frequency: times of defecation per day, night or per 24 hours.
- Mild faecal incontinence: soiling or spotting in underwear.
- Severe faecal incontinence: regularly severe leakage or faecal loss or passive faecal incontinence.Urge faecal incontinence: inability to defer defecation more than 15 minutes after first urge.
- Sexual dysfunction: retrograde ejaculation, erection disorder or dyspareunia.

Search methods for identification of studies

We have searched the following databases:

- The Cochrane IBD/FBD Group Specialized Trial Register (Non MEDLINE Records)
- The Cochrane Library (including The Cochrane Database of Systematic Reviews, Database of Abstracts of Reviews of Effects (DARE), The Cochrane Central Register of Controlled Trials (CENTRAL), Health Technology Assessment (HTA) Database, NHS Economic Evaluation Database) (Issue 1, 2007)
- MEDLINE (1990 to April 2007)
- EMBASE (1990 to April 2007)
- ISI Web of Knowledge (Web of Science) (1990 to April 2007)
- Web casts of the annual meetings of the American Society of Colon and Rectal Surgeons (ASCRS)

For each database a specific search strategy was devised and adapted to the syntax requirements of the respective database. The used search strategies are listed in Table 1. Since the LA-IPAA was not described before 1992 the search was started from the year 1990. As a fall-safe strategy we pre-specified that if any eligible article published before 1992 was to be found, the search would have been expanded to start from 1985. During the search no eligible articles prior to 1992 were found, thus the search remained unchanged. References of included trials and relevant reviews encountered during the search were searched manually. Finally, all authors of included trials were requested for additional information on any published, unpublished or ongoing trials.

Data collection and analysis

The review was conducted according to the prespecified protocol (Ahmed Ali 2007) and the recommendations from the Cochrane Handbook for Systematic Reviews of Interventions (Higgins 2008).

Selection of studies

Titles of all retrieved articles were first screened by UAA or FK and all obviously irrelevant reports were excluded. Subsequently, abstracts of selected articles were reviewed by both UAA and FK independently and differences were resolved by discussion with CVL, if necessary. In case of any uncertainty, articles were always selected for the subsequent step. Finally, the full-text of all selected articles was reviewed by UAA and FK independently to determine the eligibility of the article for this review. All included trials are listed in the 'Characteristics of included studies' table. Excluded studies are listed in the 'Characteristics of excluded studies' table along with the reason for their exclusion.

Extraction of data

Two reviewers (UAA and FK or JH) independently extracted all relevant data. For each study patient characteristics, study characteristics, data needed for the methodological quality assessment of the study and the primary and secondary outcomes were extracted according to availability. Data regarding patient characteristics included number of patients in each group, age, gender, BMI and diagnoses of included patients. Data regarding study characteristics included study design, sample size information, inclusion and exclusion criteria of the study, follow-up period, loss to follow-up, surgical experience and information regarding surgical techniques. Individual authors were contacted if any essential data were missing.

Assessment of methodological quality of included studies

In this review both randomised controlled trials (RCTs) and non-randomised controlled trials (non-RCTs) were included. For both types a different assessment method was chosen.

Assessment of methodological quality of randomised clinical trials

Based on the available empirical evidence (Higgins 2008; Kjaergard 2001; Moher 1998; Schulz 1995) we assessed the methodological quality of RCTs using the following items.

Generation of the allocation sequence

Adequate, if the allocation sequence was generated by a computer or random number table. Drawing of lots, tossing of a coin, shuffling of cards, or throwing dice was considered as adequate if a person who was not otherwise involved in the recruitment of participants performed the procedure.
Unclear, if the trial was described as randomised, but the method used for generation of the allocation sequence was not described.
Inadequate, if a system involving dates, names, or admittance numbers was used for the allocation of patients.
Allocation concealment
Adequate, if the allocation of patients involved a central independent unit, on-site locked computer, or sealed envelopes.
Unclear, if the trial was described as randomised, but the method used to conceal the allocation was not described.
Inadequate, if the allocation sequence was known to the investigators who assigned participants or if the study was quasi-randomised.
Blinding
Adequate, if the trial was described (at least) as blind to participants or assessors and the method of blinding was described. We are well aware that it is very difficult to properly blind trials comparing surgical treatments, therefore one level of blinding was considered adequate.
Unclear, if the trial was described as (double) blind, but the method of blinding was not described.
Not performed, if the trial was not blinded.
Follow-up
Adequate, if the numbers and reasons for dropouts and withdrawals in all intervention groups were described or if it was specified that there were no dropouts or withdrawals.
Unclear, if the report gave the impression that there had been no dropouts or withdrawals, but this was not specifically stated.
Inadequate, if the number or reasons for dropouts and withdrawals were not described.

Assessment of methodological quality of non-randomised clinical trials

Quality assessment for non-randomised clinical trials is a complex topic and is generally considered to be an area of ongoing research (Higgins 2008, section 6.8). In an extensive review of this topic (Deeks 2003, chapter 4) investigators reviewed 193 tools for quality assessment in literature, and concluded that based on quality and design of these tools only 6 tools were suitable for use in systematic reviews. They also concluded that all 6 tools needed some type of modification before being fully suitable for that purpose.
In this review we used a modification of the Methodological Index for Non-Randomised Studies (MINORS) (Slim 2003). This tool is one of the few validated and tested methods specifically developed for the assessment of quality of non-randomised trials. To adhere to the guidelines of the Cochrane Handbook the following modifications were applied:

- Four of the 12 items of the MINORS were disregarded in the quality assessment, because these items related to the applicability, reporting quality, and precision of the results, rather than the validity of the assessed trials (Higgins 2008, section 6.7.2).
- Every item was used independently to distinguish between high and low quality trials, rather than using the sum score of this list. The draw-backs of using summary scores are the decreased transparency to readers of the review and the evidence showing that different scales could results in contradicting results when applied in the same review (Juni 1999).

The modified MINORS list is outlined in Table 2. Every study was assessed using this method by UAA and JH independently. Discrepancies were solved by consensus discussion with a third reviewer, CVL, if necessary.

Statistical analysis

Data from RCTs and non-RCT were analysed separately. With adequate data available statistical analysis of binary data was conducted using relative risks (RR) as the summary statistic. Trials with zero events in both arms were excluded from meta-analyses. However, a sensitivity analysis using risk differences (RD) was performed with inclusion of these trials, and in case of inconsistency the results of this sensitivity analysis were reported.
For continuous outcomes weighted mean differences (WMD) were used as the summary statistic. Authors, however, often presented their results in medians with ranges due to suspicion of skewed data, while means with their standard deviations (SD) are needed for meta-analysis. Authors were contacted for additional data if necessary. Additionally, sensitivity analyses imputing data for missing means and standard deviations (calculated from available medians and ranges) were performed (Hozo 2005).
Heterogeneity was calculated using Higgins χ^2-test and quantified by measuring I^2 (Higgins 2002). A χ^2-test with a P-value of < 0.10 was considered to indicate the presence of heterogeneity, while an $I^2 > 50\%$ was considered to suggest a marked inconsistency in effect between studies. The fixed-effect model was only used if no heterogeneity was present. In all other cases the random-effects model was used. If excessive heterogeneity was present, data were re-checked first. If heterogeneity persisted, subgroup or sensitivity analyses were used to explore its causes. When adequate reasons were present extreme outliers were excluded in sensitivity analyses. In situations of excessive heterogeneity that could not be explained, we refrained from reporting a pooled estimate.

Bias detection

Funnel plots were used to provide a visual assessment of whether treatment estimates were associated with study size. This may help identify the presence of publication or other type of biases (Begg 1994; Egger 1997; Macaskill 2001).

Subgroup and sensitivity analyses

Subgroup analyses were performed according to the methodological quality of the included trials:

- For RCTs: adequate compared to unclear/inadequate regarding the four quality criteria used to assess the

methodological quality of RCTs.

- For non-RCTs: adequate compared to unclear/inadequate regarding each item of the modified MINORS list on which the studies differed.

Furthermore, causes of heterogeneity were explored by performing sensitivity analysis based on surgical technique and other factors that may explain heterogeneity.

Statistical analysis was conducted using the statistical package (RevMan Analyses v. 5.0.16) provided by The Cochrane Collaboration and was performed by UAA, FK and CVL.

RESULTS

Description of studies

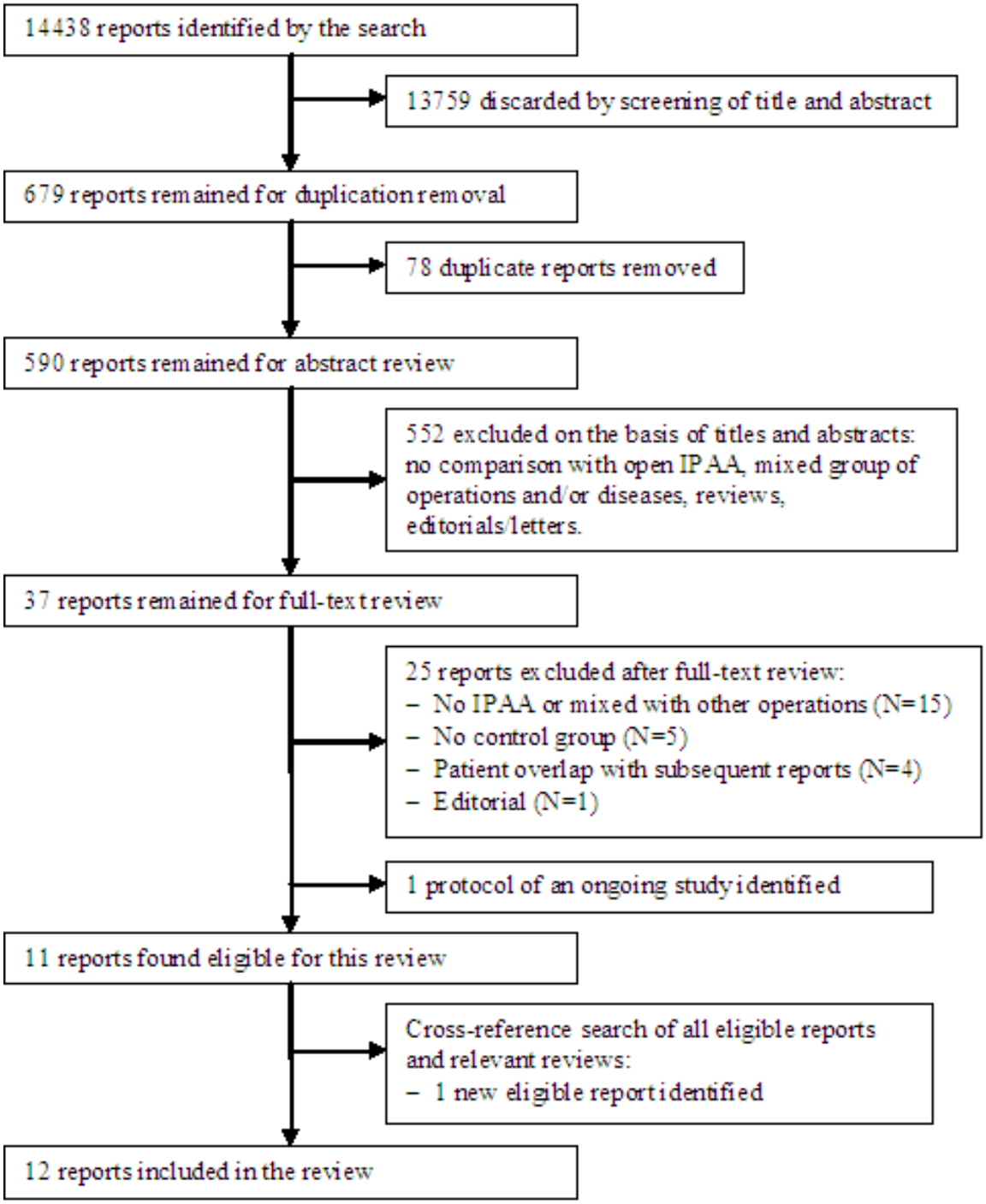
See: Characteristics of included studies; Characteristics of excluded studies; Characteristics of ongoing studies.

Search and trial identification

The systematic search was conducted in The Cochrane IBD/FBD Group Specialized Trial Register (Non MEDLINE Records) (931 records, 0 selected), The Cochrane Library, Issue 1, 2007 (649 hits, 5 selected), The National Library of Medicine (MEDLINE) via PubMed (4455 hits, 117 selected), Exerpta Medica via EMBASE (6830 hits, 503 selected), ISI Web of Knowledge (1573 hits, 54 selected), and web casts of the annual meetings of the American Society of Colon and Rectal Surgeons (ASCRS) (all published web cast until 2006, 2 selected). For detailed information about the search strategies and the numbers of hits we refer to additional Table 1.

Altogether, the search resulted in 14,438 hits. The first selection was performed based on the titles of publications and all clearly irrelevant publications were excluded. A total of 679 hits were considered possibly relevant based on their titles. After correction for duplicates, 590 publications remained. The abstracts of these 590 publications were reviewed independently by two reviewers (UAA and FK). Differences between UAA and FK were discussed with CVL. A total of 552 publications could be rejected based on their abstracts. Eventually, 37 publications were selected for further evaluation and these are listed in this review with reasons for in- and exclusion. Studies that described series of LA-IPAA operations, without comparison to an open IPAA group were excluded and are listed in the 'Characteristics of excluded studies' table as well. From the selected 37, a total of 25 publications were excluded (see 'Characteristics of excluded studies' table). Eleven publications were included (see 'Characteristics of included studies' table), and one protocol of an ongoing RCT was identified (see 'Characteristics of ongoing studies' table). A cross-reference search was performed of all included publications as well as five reviews considered relevant to our review (Ballantyne 2004; Bemelman 1998; Chung 2003; Schwenk 2005; Tan 2006). This resulted in the identification of one additional publication (Araki 2001). Consequently, 12 publications were finally included in this review. A flow-chart of the selection process is provided in Figure 1.

Figure 1. Flow-chart of the selection process



Of these 12 publications, two described the short- and long-term outcomes of a partially overlapping patient population (Larson 2005; Larson 2006). These publications were considered to be two distinct trials, but data of only one of these two publications was used in any single meta-analysis to prevent double reporting of patients. Two other publications (Maartense 2004a; Polle 2007) described the short- and long-term outcomes of the same trial. These two publications were considered one trial and data was handled accordingly. In summary, 12 publications, describing 11 trials were included in this review.

Finally, two publications (Berdah 2004; Otani 2001) were translated from French and Japanese, respectively (see acknowledgement). Additional information on methodology was obtained regarding seven out of 11 trials and additional data (i.e. individual patient data) was obtained from two trials (Berdah 2004; Maartense 2004a).

Patient characteristics

The 11 trials included 607 patients, of whom 253 (41%) in the laparoscopic and 354 (59%) in the open IPAA group. A total of 516 (85%) patients suffered from UC and 89 (14,7%) from FAP. Two studies exclusively included patients with UC (Araki 2001; Otani 2001), whereas all other studies included both UC and FAP patients. None of these studies presented the results of the UC and FAP patients separately.

Trial designs

Of the 11 included trials, only one was a randomised controlled trial (Maartense 2004a). Four of the 10 non-randomised trials collected their data prospectively. The other 6 had retrospectively data-collection or did not clearly specify this aspect. Ten trials had a mono-centre design, and one trial was conducted in two centres (Maartense 2004a). All trials, except one (Otani 2001), specified that they performed their analysis according to the intention-to-treat principle.

Surgical interventions

The types of performed surgical interventions varied between the included trials. Eight trials compared the laparoscopic-assisted IPAA (LA-IPAA) with the conventional open IPAA. The other three trials compared slightly different types of procedures: one trial (Brown 2001) compared the LA-IPAA with a mini-open IPAA, another trial (Maartense 2004a) compared the laparoscopic hand-assisted IPAA (HA-IPAA) with the conventional open IPAA, and yet another trial (Larson 2006) compared a combined group of LA-IPAA and HA-IPAA with the conventional open IPAA. We considered all trials comparing procedures using a laparoscopic technique versus open IPAA.

The HA-IPAA differs from the LA-IPAA in that the accessory incision is performed at the start of the operation and covered with an air sealed hand-port. Through this hand-port manual assistance could be provided during the different stages of the operation. In general, HA-IPAA and LA-IPAA were performed using a small Pfannenstiel incision, facilitating open rectum resection and open creation of a J-pouch by means of a double-stapling technique to construct the ileo pouch anal anastomosis. Details of the operative techniques used by the included trials are listed in the 'Characteristics of included studies' table.

Outcome measures

Primary outcome measures, mortality and complications, were well reported. Due to the brief follow-up period in most trials mainly short-term complications were reported. Long-term outcomes were reported by 4 trials only (Berdah 2004; Dunker 2001; Larson 2005; Maartense 2004a).

Secondary outcomes were reported variably . Based on availability of data, meta-analysis was performed for complications, operative time, blood loss, time to bowel movement, time to regular diet, hospital stay, re-operation rate and incision length. Cosmesis, functional outcome and costs were reviewed without meta-analysis.

Risk of bias in included studies

Since only one RCT was identified all trials, including the RCT, were assessed using the modified MINORS. Differences were identified regarding three items only:

- Prospective collection of data: five trials (45%) scored 'adequate' and six trials (55%) scored 'unclear / inadequate'.
- Contemporary groups of cases and controls: seven trials (64%) scored 'adequate' and four trials (36%) scored 'unclear / inadequate'.
- Baseline equivalence of groups: seven trials (64%) scored 'adequate' and the four trials (36%) scored 'inadequate'.

Only three trials, including the RCT, scored adequate for these three items. Detailed methodological assessment of trials is listed in Table 3.

Effects of interventions

Characteristics of the included trials are shown in Table 4. Baseline characteristics of included patients are shown in Table 5.

Meta-analysis of RCTs was not feasible, since only one RCT (Maartense 2004a) was identified. An overview of the results of this RCT are presented in Table 6. When adequate data was available, a meta-analysis of the non-randomised trials was performed. In this meta-analysis five comparisons were conducted. In three comparisons trials were subdivided into subgroups of high- and low-quality trials based on the three methodological quality criteria. In the fourth comparison trials meeting all three methodological criteria (highest-quality trials) were set against all other trials. The fifth comparison contained additional sensitivity anal-

yses.The findings of the RCTs as well as the results of the meta-analysis of non-RCTs are presented below.

No significant differences were observed regarding mortality, intraoperative complications, procedure specific complications, severe complications, minor complications, readmission and reoperation rate in any of the performed comparisons.

Mortality

Mortality was not reported in two trials (Hashimoto 2001; Otani 2001). In the nine trials reporting mortality a total of 232 patients and 323 patients were included in the laparoscopic and the open group, respectively. Eight trials reported zero mortality in both groups. With one death in the open group (Araki 2001), there was no statistically significant difference.

Intraoperative complications

Intraoperative complications were reported by 5 trials including 130 and 230 patients in the laparoscopic and open groups, respectively. The RCT by Maartense (Maartense 2004a) and the study by Larson (Larson 2006) reported one intraoperative complication in each group, while three trials reported zero intraoperative complications. No significant differences were observed between the two groups .

Procedure specific complications

Procedure specific complications were reported in 8 trials, with 2 trials reporting zero complications. The RCT reported 4/30 (13%) and 6/30 (20%) complications in the laparoscopic and open group, respectively (not statistically significant). Five non-RCTs were pooled showing 6/132 (4.5%) procedure specific complications in the laparoscopic group and 6/224 (2.7%) in the open group. Differences were not statistically significant (Relative risk (RR) 0.81; 95% confidence interval (CI) 0.32 to 2.02). Heterogeneity was not present.

Severe complications

Severe complications were reported in 9 trials, with 3 trials reporting zero complications.The RCT reported 0/30 (0%) and 2/30 (7%) severe complications in the laparoscopic and open group, respectively (not statistically significant). Five non-RCTs were pooled showing 8/157 (5.1%) severe complications in the laparoscopic group and 20/258 (7,8%) in the open group. Differences were not statistically significant (RR 0.65; 95% CI 0.29 to 1.48). Heterogeneity was not present.

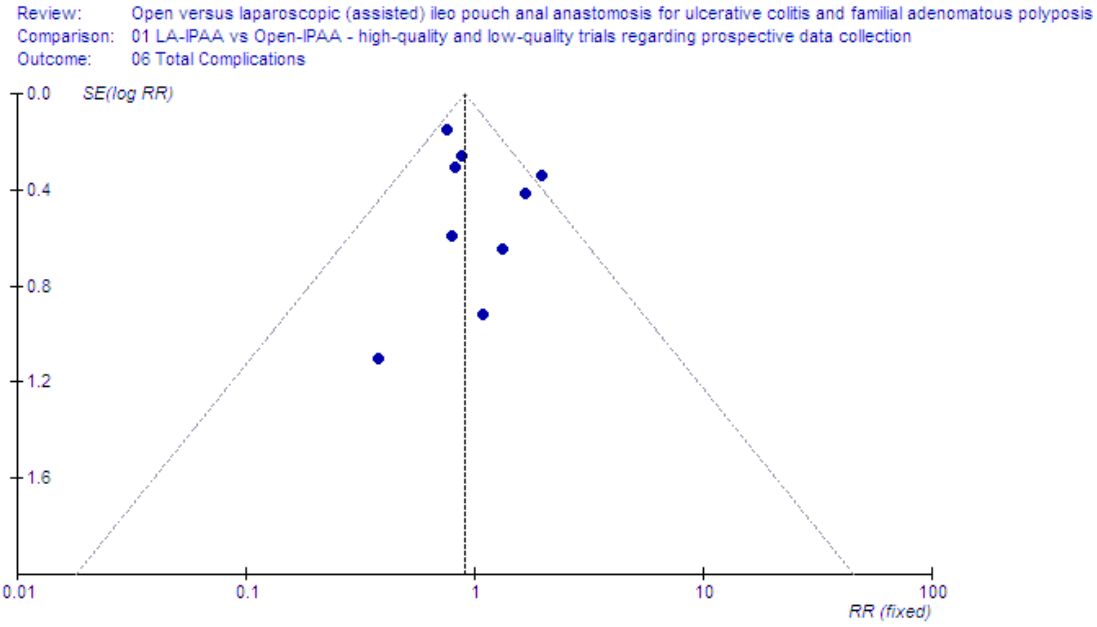
Minor complications

Minor complications were reported in 9 trials. The RCT reported 9/30 (30%) and 7/30 (23%) minor complications in the laparoscopic and open group, respectively (not statistically significant). Eight non-RCTs were pooled. There were 59/213 (27.7%) minor complications in the laparoscopic group and 83/306 (27.1%) in the open group. Differences were not statistically significant (RR 1.05; 95% CI 0.78 to 1.41). No significant heterogeneity was present.

Total complications

Total complications consisted of the sum of all complications in the aforementioned categories. The RCT showed 14/30 (47%) and 16/30 (53%) total complications in the laparoscopic and open group, respectively (not statistically significant). Eight non-RCTs with 213 patients in the laparoscopic group and 306 patients in the open group were pooled. A total of 80 (37.6%) complications in the laparoscopic group and 127 (41.5%) in the open group were observed. There were no significant differences between the two groups (RR 0.91; 95% CI 0.73 to 1.14). No heterogeneity was observed between the studies. In a funnel plot on total complications we did not find arguments for bias (Figure 2).

Figure 2. Funnel plot of trials reporting total complications, including 95% confidence interval lines. There are no indications for bias.



Operative time

Operative time was reported in 10 trials, but only five provided data in means with their standard-deviations. Both the RCT and the pooled non-RCTs showed a significantly longer operative time for the laparoscopic procedure. The RCT showed an increase in the median operative time from 133 (range 97 to 260) for the open IPAA to 214 (range 149 to 400) for the laparoscopic approach (p= <0.001). The meta-analysis of four non-RCTs included 58 patients in each group and showed a significantly longer operative time in the laparoscopic group (weighted mean difference (WMD) 92 minutes; 95% CI 53 to 130). The random-effects model was used, since substantial heterogeneity was present (χ^2=11.02 (p=0.01), I^2=73%).

Sensitivity analysis imputing data for missing values included 223 and 324 patients in the laparoscopic and open groups, respectively, and confirmed the findings of the primary meta-analysis (WMD 82 minutes; 95% CI 60 to 105). Heterogeneity remained significant (χ^2=36.30 (p<0.0001), I^2=75.2%). Further exploring of data in subgroup analyses did not identify clear causes for the observed heterogeneity.

Blood loss

Operative blood loss was reported by five trials. The RCT reported no difference between the two groups with a median blood loss of 263 mL (range 75 to 1200) in the laparoscopic and 300 mL (range 50 to 800) in the open group (p=0.98). Two non-RCTs provided data in means and SDs and were pooled. The meta-analysis included 31 and 29 patients in the laparoscopic and open groups, respectively. There was no significant difference in blood loss between the two techniques (WMD -99 mL; 95% CI -261 to 64). As heterogeneity was present, the random-effects model was applied (χ^2 =2.70 (p<0.10), I^2=63.0%).

A sensitivity analysis imputing data for two more trials included 62 patients in each group and did show a significant reduction in blood loss using the laparoscopic technique (WMD -138 mL; 95% CI -235 to -41). Adding these two extra trials reduced heterogeneity significantly (χ^2=4.57 (p<0.21), I^2=34.4%).

Time to bowel movement

Time to bowel movement was reported by three non-RCTs. All trials found a significant shorter time to bowel movement in the laparoscopic group. Data of only one trial was provided in means and standard-deviations (Araki 2001). Therefore, only pooled data from a sensitivity analyses imputing data for means and SD from the two other trials was available. This analysis included 141 and 231 patients in the laparoscopic and open group, respectively, and showed a significant shorter time to bowel movement in the laparoscopic group (WMD -1.96 days; 95% CI -3.45 to -0.46). The random-effects model was used, since heterogeneity was present (χ^2=6.74 (p=0.03), I^2=70%).

Time to regular diet

Time to regular diet was reported by six trials. The RCT showed a median of 6 days (range 4 to 19) in the laparoscopic and 7 days

(range 4-15) in the open group (p=0.6). Only two non-RCTs including 25 and 35 patients in the laparoscopic and open groups, respectively, provided data in means and standard-deviations. No significant difference between both groups was found when pooling these trials (WMD -2.72 days, 95% CI -8.33 to 2.88).

A sensitivity analysis with imputed data including three additional trials, with a total of 148 patients in the laparoscopic and 261 patients in the open group, did result in a significant difference in favour of the laparoscopic group (WMD -1.47 days; 95% CI -2.25 to -0.69). No significant heterogeneity was present.

Hospital stay

Hospital stay was reported by 9 trials. The RCT showed no significant difference between the two groups, with a median stay of 10 days (range 5 to 13) in the laparoscopic and 11 days (range 6-28) in the open group. Four non-RCTs, including 48 patients in the laparoscopic and 40 in the open group, presented data in means with SD. Pooling these trials showed a significantly shorter hospital stay for the laparoscopic procedure compared to the open technique (WMD -2.66 days; 95% CI -4.28, -1.04). No heterogeneity was present.

A sensitivity analysis using imputed data included five additional trials, with a total of 213 patients in the laparoscopic and 306 in the open group. This sensitivity analysis showed a significant shorter hospital stay for the laparoscopic group as well (WMD -2.12 days; 95% CI -3.12 to -1.12). The random-effects model was used, since heterogeneity was present (χ^2 =12.33 (p=0.09), I^2=43%).

Readmission rate

Readmission rate was reported by two trials. The RCT reported 5/23 (22%) and 3/23 (13%) readmissions in the laparoscopic and open group, respectively. Larson 2006 found 21/100 (21%) readmissions in the laparoscopic and 44/200 (22%) in the open group. Both studies showed no significant difference between the two groups.

Reoperation rate

Re-operation rate was reported by seven trials. The RCT reported 5/30 (17%) reoperations in both groups (not statistically significant). Six non-RCTs were pooled. There were 7/172 (4,0%) reoperations in the laparoscopic and 16/275 (5,8%) in the open group. Differences were not statistically significant (RR 0.74; 95% CI 0.32 to 1.71). No significant heterogeneity was present.

Incision length

Incision length was reported by two studies (Brown 2001, Dunker 2001). Both studies showed a significant smaller incision length for the laparoscopic group. Since only one trial provided means and SDs, no meta-analysis was performed. Sensitivity analysis with imputed data, including 27 patients in the laparoscopic and 30 patients in the open group, showed a significantly shorter incision in the laparoscopic group as well (WMD -7.79 cm; 95% CI -9.68 to -5.9). There was no heterogeneity present.

Cosmesis

Cosmesis scores were reported by two trials (Dunker 2001; Maartense 2004a). Both studies used the same cosmesis scale and both showed significantly higher cosmesis scores in the laparoscopic group. The RCT showed a significant increase from a mean of 14.7 points in the open group to 18.5 in the laparoscopic groups (SD not reported, p=0.01). The study by Dunker 2001 reported an increase from a mean of 16 (4.6) points in the open to 19.8 (4.6) in the laparoscopic group (p=0.03).

Functional outcome

Defecation frequency

Defecation frequency was reported by four trials. However, pooling data was not possible due to inconsistencies in reporting of results. All available data of these four trials are presented in Table 7. The defecation frequency was reported by three trials (1 RCT and 2 non-RCTs) per day and night separately, all with a follow-up period of at least 12 months. One trial (Otani 2001) reported the defecation frequency per 24 hours at discharge. No significant differences were reported between the two groups by any of the four trials. Two sensitivity analyses imputing missing data for non-RCTs reporting the defecation frequency per day and night separately, showed no significant differences as well.

Faecal incontinence

Four trials (Berdah 2004; Dunker 2001; Maartense 2004a) reported on this outcome. Every study used its own classification for faecal incontinence and pooling results was not possible. None of the four trials found any significant difference between the two groups regarding daytime continence, overnight continence, soiling, urge incontinence, or any of the used measure of faecal continence.

Sexual function

Sexual function was reported by three trials (Dunker 2001; Larson 2005; Maartense 2004a). All trials measured and reported sexual function differently. None of these trials identified a significant difference between the laparoscopic and open group regarding this outcome as well.

Costs

Only one trial (Maartense 2004a) reported on differences in costs between the laparoscopic and open IPAA (Table 7). Operative costs were significantly higher in the laparoscopic group. However, when the overall total costs (including costs for hospital stay, relaparotomies and readmission, etc) were analysed no significant difference was found.

DISCUSSION

This systematic review evaluating differences between laparoscopic and open IPAA procedures shows several important findings. First, only one randomised trial has been conducted so far on LA-IPAA versus open IPAA. Therefore, lower level evidence had to be included in this review with consequently an increased risk for introducing bias. Second, no significant differences were found in the primary outcome measures: mortality and complications. Also

readmission and reoperation rates were not significantly different. Third, laparoscopic IPAA is associated with a significantly longer operative time. Fourth, presumed short-term benefits of the LA-IPAA regarding convalescence could not be confirmed reliably. Fifth, follow-up periods of most studies were inappropriate for evaluation of long-term outcomes.

This review has encountered several methodological problems. First, by including non-randomised studies the risk for bias and its influence on false conclusions is considerable (Deeks 2003). Non-randomised trials have a higher risk of bias, due to lack of standardized protocols, unclear methodology, high risk of selection bias and inability to match for all confounders. Moreover, the methodological quality of most included trials was moderate or poor. For example, only 3 out of the 10 non-randomised trials collected their data prospectively and had a sufficient level of baseline equivalence between the two groups. However, these lower level evidence studies are the best we have so far. While future research is obviously needed, we hope that by reviewing this evidence systematically we can provide clinicians with a balanced understanding of the present evidence and its possible implications.

Methodological quality assessment of non-randomised trials has proved to be problematic as well. Contrary to RCTs, little evidence exists regarding important items in the methodological assessment of non-randomised trials. Moreover, few validated scales and lists exist for this purpose and there is no consensus regarding the tool of choice. The MINORS index, chosen for its validation and simplicity, proved to have its own shortcomings as well. It was liable to confuse the validity of trials with other items like quality of reporting and precision of results, and it used a summary score to indicate the overall quality of trials. Both properties have important drawback and their use is discouraged by the Cochrane guidelines (Higgins 2008, 6.7.2). The applied modifications did solve these problems, but they also may have undermined the validity of the scale. Empirical evidence regarding methodological criteria influencing reliability of the results of non-randomised trials is needed for better assessment of this type of trials.

Another problem that faced this review was the paucity of data regarding several outcomes. This was caused by the relatively small number of available trials, but also by the small numbers of patiens in every trial and the limited amount of data suitable for meta-analysis. Especially the latter point was of considerable importance. For several continuous outcomes less then half of the available trials could be included in the meta-analysis. This could undermine the reliability of results, as illustrated by the inconsistent results of the meta-analysis and the sensitivity analysis with imputed data, seen in several outcomes. Additionally, most trials had a short follow-up period, usually until discharge, which made it difficult to evaluate important long-term outcomes, like functional outcome and quality of life.

During the conduct of this review another meta-analysis comparing open versus laparoscopic IPAA was published (Tilney 2007). General conclusions of this meta-analysis were quite similar to ours, although there were some important differences. First, the search strategy performed was less extensive and limits were applied for the study type in PUBMED. This resulted in failure to identify two relevant trials (Berdah 2004; Otani 2001). Secondly, this meta-analysis included just over half the numbers of patients included in our meta-analysis (329 compared to 607), mainly due to a large trial (Larson 2006) which was published recently. Also, two trials were included in this meta-analysis that were excluded by us for having partial overlap in patients with other included trials (Wexner 1992; Young-Fadok 2001). The last important difference is that the authors imputed means and standard deviations using medians and ranges in their meta-analyses without specification in the methods section. Some of their findings were therefore partly based on imputed data and may very well be biased.

The absence in this review of differences between the open and laparoscopic IPAA considering the primary outcomes, mortality and complications, suggests that the LA-IPAA is a feasible and safe procedure. This is in accordance to the results of several relative large series of LA-IPAA published recently (Kienle 2005; Ky 2002). However we have to emphasize that the number of included patients is rather low to be able to detect all clinically relevant differences. Especially detailed evaluation of individual complications, like wound infections or late incisional hernia that may benefit from a minimal invasive approach, is not possible based on the available data.

Regarding postoperative recovery, this review could not reliable identify clinically significant benefits of the laparoscopic approach. Hospital stay was shorter for the laparoscopic approach in both the meta-analysis of non-RCTs (WMD -2.7 days) and the sensitivity analysis with imputed data (WMD -2.1 days). However, this was not supported by the result of the RCT. One explanation could be that the RCT used a hand-assisted approach for the laparoscopic IPAA, while most other trials used a laparoscopic-assisted approach (see Description of studies - Surgical interventions). Sensitivity analyses imputing missing data also suggested that the laparoscopic technique was associated with less blood loss, time to bowel movement and time to regular diet. As proved by these inconsistent findings, more data is needed before a final word could be said regarding this matter.

A point worth considering is that the clinical relevance of such relatively small benefits regarding the postoperative recovery remains questionable. With a complex operation like the IPAA a one or a two day reduction of hospital stay is not likely to be decisive in the choice of operative technique. Neither will be a slightly faster normalization of bowel function or return to normal diet. Especially with the increased implementation of 'fast-track' perioperative care programs, the differences between open and laparoscopic techniques could diminish even further. 'Fast-track' programmes

have already been applied in a wide variety of colonic operations and results seem to confirm there ability to accelerate recovery, reduce morbidity and shorten hospital stay (Wind 2006). In time, implementation of such programs even in complex procedures, like the IPAA, seems likely. Therefore, future studies comparing open and laparoscopic IPAA should probably focus on other clinically more relevant outcomes, like specific complications, costs and long-term outcomes.

One of the most relevant long-term outcomes is maybe the cosmetic result of surgery and its impact in this predominately young group of patients. In this review, two trials showed a significantly shorter incision in the laparoscopic IPAA. Also, two trials reported results of cosmesis and body image. Both trials observed significantly higher scores regarding cosmesis in the laparoscopic group. Additionally, in the long-term follow-up of the only RCT (Maartense 2004a) body image scores in female patients were found to be significantly higher in the laparoscopic group. These results suggest that the shorter incision of the laparoscopic approach is associated with long-lasting benefits in the perception of patients of their own body, which could be an interesting argument in favour of the laparoscopic technique. While these results need conformation from other trials, the social and psychological impact could be significant. With an ever increasing patient's awareness a smaller scar and improved cosmesis could be important factor in guiding the choice of operative technique in clinical practice.

Costs also play an important role when evaluating new operative techniques, since fear of increased costs could be a strong motive against their implementation. In this review only one trial (Maartense 2004a) reported on costs and found no significant differences when the overall costs, including admission, complications and readmission, were evaluated. The costs of the laparoscopic procedure was, however, significantly higher than the open technique. Trials comparing costs of other types of colonic surgery give contradicting results: some trials show no differences in costs between laparoscopic and open approaches (Pokala 2005), while others show results favouring the laparoscopic approach (Senagore 1993). It is therefore not possible to draw reliable conclusion from these studies and future research is required to resolve this issue as well.

In this context the ongoing LapCon-Pouch Trial (Antolovic 2006) is an important step in the right direction. This single-centre, patient blinded trial will randomise 160 patients into two groups: a totally laparoscopic IPAA group and a conventional open IPAA group. This trial will be the largest randomised clinical trial and will have the largest number of total laparoscopic IPAA patients included in any report so far. It will have the power to answer several interesting question and with a follow-up period of 12 month more light could be shed on important long-term outcomes. While the sample-size is not large enough to resolve all issues, it should be noted that for a relatively infrequent operation as the IPAA a sample of this size is substantial. It is therefore to be hoped that other high-volume centres will follow the example of this trial and that in the near future a meta-analysis based solely on RCTs would become feasible.

AUTHORS' CONCLUSIONS

Implications for practice

The laparoscopic IPAA is a safe procedure, that could be performed successfully in centres experienced in laparoscopic and restorative pouch surgery. The laparoscopic approach seems to be associated with some short-term advantages regarding postoperative recovery, but these advantages seem to be limited and their clinical significance is arguable. For a complex operation like the IPAA other outcomes, like specific complications, long-term functional outcome, cosmesis and costs are more likely to influence the choice of the operative technique. This review have shown that for cosmesis there are some data favouring the laparoscopic approach, but that the evidence is still inconclusive and more research is needed before a general recommendation can be made. There is also some evidence that costs, a crucial item in today's health care, may not become a decisive item in the decision between open and laparoscopic IPAA.

Implications for research

High volume colorectal surgical centres should include patients scheduled for laparoscopic IPAA in high-quality RCTs with sufficiently long follow-up to be able to reliable assess differences in relevant long-term outcomes. The focus of these trials should be specific postoperative complications, cosmesis, quality of life and costs.Trials should provide data suitable for meta-analysis in there published publications, or at least make it readily available upon request. There is need for empirical evidence to guide the process of methodological quality assessment of non-randomised controlled trials.

ACKNOWLEDGEMENTS

We thank the Cochrane Colorectal Cancer Group in Copenhagen for their support and guidance. All workers of the Library of the St. Elisabeth Hospital in Tilburg for assistance in the search for full text articles. Dr. Yoshitaka Hitomi (University Medical Centre Groningen) for his tremendous effort in translation from Japanese. We wish to thank all authors for their willingness to help in improving the review by responding to our request for additional information, especially professor Berdah, who was admirably generous and swift in provide us with all the needed information, and professor Bemelman, who open heartedly shared with us the results of years of continued work and research.

REFERENCES

References to studies included in this review

Araki 2001 *{published data only}*

Araki Y, Ishibashi N, Ogata Y, Shirouzo K, Isomoto H. The Usefulness of Restorative Laparoscopic-Assisted Total Colectomy for Ulcerative Colitis. *Kurume Medical Journal* 2001;**48**(2):99–103. [MEDLINE: 11501505]

Berdah 2004 *{published and unpublished data}*

Berdah SV, Barthet M, Emungania O, Orsoni P, Alliot P, Grimaud JC, Brunet C. Two stage videoassisted restorative proctocolectomy. Early experience of 12 cases [Coloproctectomie totale avec anastomose iléoanale en deux temps vidéoassistée. Expérience initiale de 12 cas]. *Annales de Chirurgie* 2004 Jul–Aug;**129**(6-7):332–6.

Brown 2001 *{published data only}*

Brown SR, Eu KW, Seow-Choen F. Consecutive series of laparoscopic-assisted vs. minilaparotomy restorative proctocolectomies. *Diseases of the Colon & Rectum* 2001 Mar;**44**(3):397–400.

Dunker 2001 *{published data only}*

Dunker MS, Bemelman WA, Slors JFM, van Duijvendijk P, Gouma DJ. Functional outcome, quality of life, body image, and cosmesis in patients after laparoscopic assisted and conventional restorative proctocolectomy - A comparative study. *Diseases of the Colon & Rectum* 2001;**44**(12):1800–07.

Hashimoto 2001 *{published data only}*

Hashimoto A, Funayama Y, Naito H, Fukushima K, Shibata C, Naitoh T, Shibuya K, Koyama K, Takahashi K, Ogawa H, Satoh S, Ueno T, Kitayama T, Matsuno S, Sasaki I. Laparascope-assisted versus conventional restorative proctocolectomy with rectal mucosectomy. *Surgery Today* 2001;**31**(3):210–4.

Larson 2005 *{published data only}*

Larson DW, Dozois EJ, Piotrowicz K, Cima RR, Wolff BG, Young-Fadok TM. Laparoscopic-assisted vs. open ileal pouch-anal anastomosis: Functional outcome in a casematched series. *Diseases of the Colon & Rectum* 2005;**48**(10):1845–50.

Larson 2006 *{published data only}*

Larson DW, Cima RR, Dozois EJ, Davies M, Piotrowicz K, Barnes SA, Wolff B, Pemberton J. Safety, feasibility, and short-term outcomes of laparoscopic illeal-pouch-anal anastomosis - A single institutional case-matched experience. *Annals of Surgery* 2006;**243**(5):667–72.

Maartense 2004a *{published and unpublished data}*

Maartense S, Dunker MS, Slors JF, Cuesta MA, Gouma DJ, van Deventer SJ, van Bodegraven AA, Bemelman WA. Hand-assisted laparoscopic versus open restorative proctocolectomy with ileal pouch anal anastomosis: a randomized trial. *Annals of Surgery* 2004 Dec;**240**(6):984–91.

Polle SW, Dunker MS, Slors JFM, Sprangers MA, Cuesta MA, Gouma DJ, Bemelman WA. Body image, cosmesis, quality of life, and functional outcome of hand-assisted laparoscopic versus open restorative proctocolectomy: long-term results of a randomized trial.. *Surgical Endoscopy and Other Interventional Techniques* 2007;**21**(8):1301–7.

Marcello 2000 *{published and unpublished data}*

Marcello PW, Milsom JW, Wong SK, Hammerhofer KA, Goormastic M, Church JM, Fazio VW. Laparoscopic restorative proctocolectomy: case-matched comparative study with open restorative proctocolectomy. *Diseases of the Colon & Rectum* 2000 May;**43**(5):604–8.

Otani 2001 *{published data only}*

Otani Y, Nakamura T, Kanazawa H, Aihara N, Kokuba Y, Ihara A, Kakita A. Article in Japanese [Laparoscoy–assisted ileal–pouch anal–canal anastomosis for ulcerative colitis]. *Japanese Journal of Gastroenterological Surgery* 2001;**34**(4):351–6.

Schmitt 1994 *{published data only}*

Schmitt SL, Cohen SM, Wexner SD, Nogueras JJ, Jagelman DG. Does laparoscopic-assisted ileal pouch anal anastomosis reduce the length of hospitalization?. *International Journal of Colorectal Disease* 1994 Aug;**9**(3):134–7.

References to studies excluded from this review

Araki 2000 *{published data only}*

Araki Y, Matsumoto A, Isomoto H. Total colectomy combined laparoscopy. *Minimally Invasive Therapy & Allied Technologies* 2000;**9**(1):3–6.

Araujo 2005 *{published data only}*

Araujo SE, Nahas SC, Seid VE, Marchini GS, Torricelli FC. Laparoscopy-assisted ileal pouch-anal anastomosis: surgical outcomes after 10 cases. *Surgical Laparoscopy, Endoscopy & Percutaneous Techniques* 2005;**15**(6):321–4.

Baccari 2000 *{published data only}*

Baccari P, Di Palo S, Redaelli A, Carlucci M, Staudacher C. Laparoscopic versus conventional surgery in the treatment of colorectal diseases [Chirurgia laparoscopica versus chirurgia tradizionale nel trattamento della patologia colo–rettale]. *Chirurgia Italiana* 2000;**52**(1):17–27. [MEDLINE: 10832523]

Delaney 2003 *{published data only}*

Delaney CP, Kiran RP, Senagore AJ, Brady K, Fazio VW. Case-matched comparison of clinical and financial outcome after laparoscopic or open colorectal surgery. *Annals of Surgery* 2003;**238**(1):67–72. [MEDLINE: 12832967]

Dunker 2000 *{published data only}*

Dunker MS, Bemelman WA, Slors JFM, Van Hogezand RA, Ringers J, Gouma DJ. Laparoscopic-assisted vs open colectomy for severe acute colitis in patients with inflammatory bowel disease (IBD): A retrospective study in 42 patients. *Surgical Endoscopy and Other Interventional Techniques* 2000;**14**(10):911–4.

Etienne 1993 *{published data only}*

Etienne J, Jehaes C, Kartheuser A, de Neve de Roden A. Laparoscopic surgery for benign colorectal disease: a multicentre prospective study. *The British Journal of Surgery* 1993;**80**(Supplement):S45.

Georgeson 2002 *{published data only}*

Georgeson KE. Laparoscopic-assisted total colectomy with pouch reconstruction. *Seminars in pediatric surgery* 2002; **11**:233–6. [MEDLINE: 12407505]

Gill 2004 *{published data only}*

Gill TS, Karantana A, Rees J, Pandey S, Dixon AR. Laparoscopic proctocolectomy with restorative ileal-anal pouch. *Colorectal Disease* 2004;**6**(6):458–61.

Hahnloser 2004 *{published data only}*

Hahnloser D, Young-Fadok TM. Laparoscopic proctocolectomy and ileal pouch-anal anastomosis (IPAA) offers benefits compared with open IPAA. *Surgical Endoscopy and Other Interventional Techniques* 2004;**18**(Suppl):163.

Hasegawa 2002 *{published data only}*

Hasegawa H, Watanabe M, Baba H, Nishibori H, Kitajima M. Laparoscopic restorative proctocolectomy for patients with ulcerative colitis. *Journal of Laparoendoscopic & Advanced Surgical Techniques-Part A* 2002;**12**(6):403–6.

Hildebrandt 1998 *{published data only}*

Hildebrandt U, Lindemann W, Kreissler-Haag D, Feifel G, Ecker KW. Laparoscopically-assisted proctocolectomy with ileoanal pouch in ulcerative colitis [Die laparoskopisch assistierte Proktokolektomie mit ileoanalem Pouch bei Colitis ulcerosa]. *Zentralblatt fur Chirurgie* 1998;**123**(4): 403–5. [MEDLINE: 9622901]

Hong 2002 *{published data only}*

Hong D, Lewis M, Tabet J, Anvari M. Prospective comparison of laparoscopic versus openresection for benign colorectal disease. *Surgical Laparoscopy Endoscopy & Percutaneous Techniques* 2002;**12**(4):238–42.

Ishida 2003 *{published data only}*

Ishida H, Hashimoto D, Inokuma S, Nakada H, Ohsawa T, Hoshino T. Gasless laparoscopic surgery for ulcerative colitis and familial adenomatous polyposis - Initial experience of 7 cases. *Surgical Endoscopy and Other Interventional Techniques* 2003;**17**(6):899–902.

Kessler 2001 *{published data only}*

Kessler H, Milsom JW, Marcello PW, Hohenberger W. Laparoscopic restorative proctocolectomy in ulcerative colitis and colonicpolyps [Laparoskopische restaurative Proktokolektomie bei Colitis ulcerosa und Polyposis coli]. *Kongressband / Deutsche Gesellschaft fur Chirurgie Kongress* 2001;**118**:109–13. [MEDLINE: 11824230]

Kienle 2003 *{published data only}*

Kienle P, Weitz J, Benner A, Herfarth C, Schmidt J. Laparoscopically assisted colectomy and ileoanal pouch procedure with and without protective ileostomy. *Surgical Endoscopy and Other Interventional Techniques* 2003;**17**(5): 716–20.

Kienle 2005 *{published data only}*

Kienle P, Z'graggen K, Schmidt J, Benner A, Weitz J, Buchler MW. Laparoscopic restorative proctocolectomy. *British Journal of Surgery* 2005;**92**(1):88–93.

Ky 2002 *{published data only}*

Ky AJ, Sonoda T, Milsom JW. One-stage laparoscopic restorative proctocolectomy: an alternative to the conventional approach?. *Diseases of the Colon & Rectum* 2002 Feb;**45**(2):207–10.

Larach 1993 *{published data only}*

Larach SW, Salomon MC, Williamson PR, Goldstein E. Laparoscopic assisted colectomy: experience during the learning curve [Laparoskopie–unterstutzte Kolektomie: Erfahrungen wahrend der Lernperiode]. *Coloproctology* 1993;**1**:38–41.

Lindemann 1995 *{published data only}*

Lindemann W, Hildebrandt U, Schuder G, Kreissler-Haag D, Pistorius G. Laparoscopic surgery of benign small and large intestinal diseases [Laparoskopische Chirurgie benigner Dunn– und Dickdarmerkrankungen]. *Anasthesiologie, Intensivmedizin, Notfallmedizin, Schmerztherapie* 1995;**30** (7):444–6.

Liu 1995 *{published data only}*

Liu CD, Rolandelli R, Ashley SW, Evans B, Shin M, Mcfadden DW. Laparoscopic Surgery For Inflammatory Bowel-Disease. *American Surgeon* 1995;**61**(12):1054–6.

Maartense 2004b *{published data only}*

Maartense S, Dunker MS, Slors JF, Gouma DJ, Bemelman WA. Restorative proctectomy after emergency laparoscopic colectomy for ulcerative colitis: a case-matched study. *Colorectal Disease* 2004;**6**(4):254–7. [MEDLINE: 15206968]

Marcello 2001 *{published data only}*

Marcello PW, Milsom JW, Wong SK, Brady K, Goormastic M, Fazio VW. Laparoscopic total colectomy for acute colitis: a case-control study. *Diseases of the Colon & Rectum* 2001; **44**(10):1441–45.

Nogueras 1992 *{published data only}*

Nogueras JJ, Wexner SD. Laparoscopic Colon Resection. *Perspectives in Colon and Rectal Surgery* 1992;**5**(1):79–97.

Ouaissi 2006 *{published data only}*

* Ouaissi M, Alves A, Bouhnik Y, Valleur P, Panis Y. Three-step ileal pouch-anal anastomosis under total laparoscopic approach for acute or severe colitis complicating inflammatory bowel disease. *Journal of the American College of Surgeons* 2006;**202**:637–42.

Pace 2002 *{published data only}*

Pace DE, Seshadri PA, Chiasson PM, Poulin EC, Schlachta CM, Mamazza J. Early experience with laparoscopic ileal pouch-anal anastomosis for ulcerative colitis. *Surgical Laparoscopy, Endoscopy & Percutaneous Techniques* 2002;**12** (5):337–41.

Panis 2005 *{published data only}*

Panis YH, Marceau C, Alves A, Bouhnik Y, Lavergne-Slove A, Valleur P. Laparoscopic vs conventional subtotal

colectomy for acute or severe colitis complicating inflammatory bowel disease: a case-control study in 82 patients. *Diseases of the Colon & Rectum* 2005;**48**(3):678–9.

Pfeifer 1995 *{published data only}*
Pfeifer J, Wexner SD, Reissman P, Bernstein M, Nogueras JJ, Singh S, Weiss E. Laparoscopic vs open colon surgery. Costs and outcome. *Surgical Endoscopy and Other Interventional Techniques* 1995;**9**:1322–6. [MEDLINE: 8629220]

Santoro 1999 *{published data only}*
Santoro E, Carlini M, Carboni F, Feroce A. Laparoscopic total proctocolectomy with ileal J pouch-anal anastomosis. *Hepatogastroenterology* 1999;**46**(26):894–9.

Senagore 1993 *{published data only}*
Senagore AJ, Luchtefeld MA, Mackeigan JM, Mazier WP. Open colectomy versus laparoscopic colectomy: are there differences?. *American Surgeon* 1993;**59**(8):549–53. [MEDLINE: 8338287]

Seow 1999 *{published data only}*
Seow-Choen F, Eu KW, Leong AFPK, Ho YH, Wexner SD. A consecutive series of open compared to laparoscopic restorative proctocolectomy with ileo-pouch anal anastomosis for familial adenomatous polyposis. *Techniques in Coloproctology* 1999;**3**(2):83–6.

Seshadri 2001 *{published data only}*
Seshadri PA, Poulin EC, Schlachta CM, Cadeddu MO, Mamazza J. Does a laparoscopic approach to total abdominal colectomy and proctocolectomy offer advantages?. *Surgical Endoscopy-Ultrasound and Interventional Techniques* 2001; **15**(8):837–42.

Stocchi 2000 *{published data only}*
Stocchi L, Nelson H, Young-Fadok TM, Larson DR, Ilstrup DM. Safety and advantages of laparoscopic vs. open colectomy in the elderly: matched-control study. *Diseaes of the Colon & Rectum* 2000;**43**:326–32.

Vignali 2004 *{published data only}*
Vignali A, Braga M, Zuliani W, Frasson M, Radaelli G, Di Carlo V. Laparoscopic colorectal surgery modifies risk factors for postoperative morbidity. *Diseases of the Colon & Rectum* 2004;**47**(10):1686–93.

Wexner 1992 *{published data only}*
Wexner SD, Johansen OB, Nogueras JJ, Jagelman DG. Laparoscopic total abdominal colectomy - a prospective trial. *Diseases of the Colon & Rectum* 1992;**35**(7):651–5.

Wexner 1996 *{published data only}*
Wexner SD, Reissman P, Pfeifer J, Bernstein M, Gron N. Laparoscopic colorectal surgery - Analysis of 140 cases. *Surgical Endoscopy-Ultrasound and Interventional Techniques* 1996;**10**(2):133–6.

Young-Fadok 2001 *{published data only}*
Young-Fadok TM, Dozois E, Sandborn WJ, Tremaine WJ. A case matched study of laparoscopic proctocolectomy and ileal pouch-anal anastomosis (PC-IPAA) versus open PC-IPAA for ulcerative colitis. *Gastroenterology* 2001;**Suppl**: 2302.

References to ongoing studies

Antolovic 2006 *{published data only}*
Antolovic D, Kienle P, Knaebel HP, Schmidt J, Gutt CN, Weitz J, Koch M, Buchler MW, Seiler CM. Totally laparoscopic versus conventional ileoanal pouch procedure--design of a single-centre, expertise based randomised controlled trial to compare the laparoscopic and conventional surgical approach in patients undergoing primary elective restorative proctocolectomy--LapConPouch-Trial. *BMC Surgery* 2006;**6**:13.

Additional references

Ahmed Ali 2007
Ahmed Ali U, Keus E, Heikens JT, Gooszen HG, van Laarhoven CJHM. Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis or familial adenomatous polyposis (Protocol). *Cochrane Database of Systematic Reviews* 2006, Issue 4. [Art. No.: CD006267. DOI: 10.1002/14651858.CD006267]

Ballantyne 2004
Ballantyne GH, Leahy PF. Hand-Assisted Laparoscopic Colectomy: Evolution to a Clinically Useful Technique. *Diseases of the Colon & Rectum* 2004;**47**(5):753–65.

Begg 1994
Begg CB, Mazumdar M. Operating characteristics of a rank correlation test for publication bias. *Biometrics* 1994;**50**(4): 1088–101.

Bemelman 1998
Bemelman WA, Hogezand van RA, Meijerink WJHJ, Griffioen G, Ringers J. Laparoscopic-assisted bowel resections in inflammatory bowel disease: state of the art. *Netherlands Journal of Medicine* 1998;**53**:S39-S46.

Bulow 2003
Bulow S. Results of national registration of familial adenomatous polyposis. *Gut* 2003;**52**(5):742–6.

Casillas 2005
Casillas S, Delaney CP. Laparoscopic surgery for inflammatory bowel disease. *Digestive Surgery* 2005;**22**(3): 135–42.

Chung 2003
Chung CC, Tsang WWC, Kwok SY, Li MKW. Laparoscopy and its current role in the management of colorectal disease. *Colorectal Disease* 2003;**5**:528-43.

Cohen 1992
Cohen Z, McLeod RS, Stephen W, Stern HS, O'Connor B, Reznick R. Continuing evolution of the pelvic pouch procedure. *Annals of Surgery* 1992;**216**(4):506–11.

Cohen 2005
Cohen JL, Strong SA, Hyman NH, Buie WD, Dunn GD, Ko CY, Fleshner PR, Stahl TJ, Kim DG, Bastawrous AL, Perry WB, Cataldo PA, Rafferty JF, Ellis CN, Rakinic J, Gregorcyk S, Shellito PC, Kilkenny JW 3rd, Ternent CA, Koltun W, Tjandra JJ, Orsay CP, Whiteford MH, Penzer JR. Standards Practice Task Force American Society of

Colon and Rectal Surgeons. Practice parameters for the surgical treatment of ulcerative colitis. *Diseases of the Colon & Rectum* 2005;**48**(11):1997–2009.

Deeks 2003
Deeks JJ, Dinnes J, D'Amico R, Sakarovitch C, Song F, Petticrew M, Altman DG, for the International Stroke Trial Collaborative Group. Evaluating non-randomised intervention studies. *Health Technology Assessment* 2003;**7** (27):iii-x, 1-173.

Egger 1997
Egger M, Davey Smith G, Schneider M, Minder C. Bias in meta-analysis detected by a simple graphical test. *BMJ* 1997;**315**(7109):629–34.

Fazio 1995
Fazio VW, Ziv Y, Church JM, Oakley JR, Lavery IC, Milsom JW, Schroeder TK. Ileal pouch-anal anastomoses complications and function in 1005 patients. *Annals of Surgery* 1995 Aug;**222**(2):120–7.

Higgins 2002
Higgins JPT, Thompson SG. Quantifying heterogeneity in a meta-analysis. *Statistics in Medicine* 2002;**21**:1539–58.

Higgins 2008
Higgins JPT, Green S, editors. Cochrane Handbook for Systematic Reviews of Interventions version 5.0.0 [updated February 2008].. The Cochrane Collaboration 2008 available from www.cochrane-handbook.org.

Hozo 2005
Hozo SP, Djulbegovic B, Hozo I. Estimating the mean and variance from the median, range, and the size of a sample. *BMC Medical Research Methodology* 2005;**5**(1):13.

Hueting 2005
Hueting WE, Buskens E, van der Tweel I, Gooszen HG, van Laarhoven CJ. Results and complications after ileal pouch anal anastomosis: a meta-analysis of 43 observational studies comprising 9,317 patients. *Digestive Surgery* 2005; **22**(1-2):69–79.

Jarvinen 1992
Jarvinen HJ. Epidemiology of familial adenomatous polyposis in Finland: impact of family screening on the colorectal cancer rate and survival. *Gut* 1992;**33**(3):357–60.

Juni 1999
Juni P, Witschi A, Block R, Egger M. The Hazards of Scoring the Quality of Clinical Trials for Meta-analysis. *JAMA* 1999;**282**(11):1054–60.

Kjaergard 2001
Kjaergard LL, Villumsen J, Gluud C. Reported methodological quality and discrepancies between large and small randomised trials in meta-analyses. *Annals of Internal Medicine* 2001;**135**(11):982–9.

Macaskill 2001
Macaskill P, Walter SD, Irwig L. A comparison of methods to detect publication bias in meta-analysis. *Statistics in Medicine* 2001;**20**:641–54.

Marcello 1993
Marcello PW, Roberts PL, Schoetz DJ Jr, Coller JA, Murray JJ, Veidenheimer MC. Long-term results of the ileoanal pouch procedure. *Archives of Surgery* 1993 May;**128**(5): 500–3.

Moher 1998
Moher D, Pham B, Jones A, Cook DJ, Jadad AR, Moher M, et al.Does quality of reports of randomised trials affect estimates of intervention efficacy reported in meta-analyses? . *Lancet* 1998;**352**(9128):609–13.

Parks 1978
Parks AG, Nicholls RJ. Proctocolectomy without ileostomy for ulcerative colitis. *British Medical Journal* 1978 Jul 8;**2** (6130):85–8.

Peters 1992
Peters WR. Laparoscopic total proctocolectomy with creation of ileostomy for ulcerative colitis: report of two cases. *Journal of Laparoendoscopic Surgery* 1992 Jun;**2**(3): 175–8.

Pokala 2005
Pokala N, Delaney CP, Senagore AJ, Brady KM, Fazio VW. Laparoscopic vs open total colectomy: a case-matched comparative study. *Surgical Endoscopy and Other Interventional Techniques* 2005;**19**(4):531–5.

Polle 2007
Polle SW, Dunker MS, Slors JFM, Sprangers MA, Cuesta MA, Gouma DJ, Bemelman WA. Body image, cosmesis, quality of life, and functional outcome of hand-assisted laparoscopic versus open restorative proctocolectomy: long-term results of a randomized trial.. *Surgical Endoscopy and Other Interventional Techniques* 2007;**21**(8):1301–7.

Reissman 1996
Reissman P, Salky BA, Pfeifer J, Edye M, Jagelman DG, Wexner SD. Laparoscopic surgery in the management of inflammatory bowel disease. *American Journal of Surgery* 1996;**171**(1):47–50.

Sardinha 1998
Sardinha TC, Wexner SD. Laparoscopy for inflammatory bowel disease: pros and cons. *World Journal of Surgery* 1998 Apr;**22**(4):370–4.

Schulz 1995
Schulz KF, Chalmers I, Hayer R, Altman D. Empirical evidence of bias. *JAMA* 1995;**273**(5):408–12.

Schwenk 2005
Schwenk W, Haase O, Neudecker J, Müller JM. Short term benefits for laparoscopic colorectal resection. *Cochrane Database of Systematic Reviews* 2005, Issue 2. [Art. No.: CD003145. DOI: 10.1002/14651858.CD003145.pub2]

Shivananda 1996
Shivananda S, Lennard-Jones J, Logan R, Fear N, Price A, Carpenter L, van Blankenstein M. Incidence of inflammatory bowel disease across Europe: is there a difference between north and south? Results of the European Collaborative Study on Inflammatory Bowel Disease (EC-IBD). *Gut* 1996;**39**(5):690–7.

Slim 2003
Slim K, Nini E, Forestier D, Kwiatkowski F, Panis Y, Chipponi J. Methodological index for non-randomized studies (minors): development and validation of a new instrument. *ANZ Journal of Surgery* 2003 Sep;**73**(9):712–6.

Tan 2006
Tan JJY, Tjandra JJ. Laparoscopic surgery for ulcerative colitis - a meta-analysis. *Colorectal Disease* 2006;**8**:626-36.

Tilney 2007
HS Tilney, RE Lovegrove, AG Heriot, S Purkayastha, V Constantinides, RJ Nicholls, PP Tekkis. Comparison of short-term outcomes of laparoscopic vs open approaches to ileal pouch surgery. *International Journal of Colorectal Disease* 2007;**22**:531–42.

Wind 2006
Wind J, Polle SW, Fung Kon Jin PH, Dejong CH, von Meyenfeldt MF, Ubbink DT, Gouma DJ, Bemelman WA, Laparoscopy and/or Fast Track Multimodal Management Versus Standard Care (LAFA) Study Group, Enhanced Recovery after Surgery (ERAS) Group. Systematic review of enhanced recovery programmes in colonic surgery. *British Journal of Surgery* 2006;**93**(7):800–9.

* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Araki 2001

Methods	- Mono-center trial - N = 32 (21 cases, 11 controls) - Collection of data: retrospective. - Matching: no (base-line equal) - Contemporary groups: no (controls from 1990 to 1994 and cases from 1994 to 1999) - Loss to follow-up: 0 - Intention to treat: yes - Sample size calculation: no
Participants	Diangosis: UC only In- and exclusion criteria: all patients undergoing IPAA procedures in the period of study
Interventions	LA-IPAA vs Open IPAA. - LA-IPAA: 7 cm incision along the lower abdomen, J-pouch, double-stapled, without diverting loop ileostomy. - Open IPAA: not specified. Surgical experience: not described.
Outcomes	Primary and secondary outcomes: not stated. Measured outcomes: mortality, postoprative complications, operative time, time to removal of nasogastric tube, to stool passage, to fluid diet and to stool solidification, and length of hospital stay Follow-up: till discharge.
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	D - Not used

Berdah 2004

Methods	- Mono-center trial - N = 24 (12 cases, 12 controls) - Collection of data: prospective - Matching: matched for age, gender, BMI and diagnosis. - Contemporary groups: yes - Loss to follow-up: 0 - Intention to treat: yes - Sample size calculation: no
Participants	Diagnosis: UC and FAP. In- and exclusion criteria: first 6 patients on basis of favorable morphology. After that all IPAA patients

Berdah 2004 (*Continued*)

Interventions	LA-IPAA vs Open IPAA. - LA-IPAA: through Pfannenstiel incision with unspecified length, J-pouch, double-stapled, with diverting loop ileostomy for all. - Open IPAA: midline incision from xephoid till symphesis, J-pouch, double-stabled, with diverting loop ileostomy for all Surgical experience: not described.
Outcomes	Primary and secondary outcomes: not stated. Measured outcomes: mortality, postoprative complications, conversion, operative time, length of incision, start of ileostomy function, commencement of diet, length of hospital stay Follow-up: > 3 years
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	D - Not used

Brown 2001

Methods	- Mono-center trial - N = 25 (cases 12, controls 13) - Collection of data: retrospective - Matching: not matched - Contemporary groups: no - Loss to follow-up: 0 - Intention to treat: yes - Sample size calculation: no
Participants	Diagnosis: UC, FAP and 1 rectal cancer (LA group) In- and exclusion criteria: all LA-IPAA and subsequently all mini-open IPAA
Interventions	LA-IPAA vs Mini-Open IPAA. - LA-IPAA: through short suprapubic incision of unspecified length, J-pouch, double-stapled anastomosis, with diverting loop ileostomy. - Mini-Open IPAA: suprapubic incision of variable length, using an illuminated St. Mark's retractor to facilitate the mobilization, J-pouch, double-stapled anastomosis, with diverting loop ileostomy Surgical experience: claim to have large experience in laparoscopic colonic surgery. No specific data is presented
Outcomes	Primary and secondary outcomes: not very well descriped. Measured outcomes: mortality, postoprative complications, conversion, operative time, length of incision, start of ileostomy function, commencement of diet, length of hospital stay Follow-up: till discharge

Brown 2001 (*Continued*)

Notes	- Performed a mini-open IPAA technique. - Included one patient with juvenile polyposis.

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	D - Not used

Dunker 2001

Methods	- Mono-center trial - N = 32 (cases 15, controls 17) - Collection of data: retrospective - Matching: matched for follow-up duration, type of disease and type of operation (1- or 2-stages). - Contemporary groups: yes - Loss to follow-up: 2/35 (5.7%) - Intention to treat: yes - Sample size calculation: no
Participants	Diagnosis: UC and FAP In- and exclusion criteria: all LAP-IPAA in periode of study, who agreed to participate and fill out the necessary forms
Interventions	LA-IPAA vs Open IPAA. - LA-IPAA: through Pfannenstiel incision with unspecified length, J-pouch, type of anastomosis not specified, no diverting loop ileostomy for all. Some patients had the operation in 2-stages (an emergency LA-total collectomy and ileostomy followed by a proctectomy with IPAA later on). - Open IPAA: midline incision from xephoid till symphesis, J-pouch, anastomosis type not specified, no diverting loop ileostomy for all. Some had a 2-stage operation. Surgical experience: not described.
Outcomes	Primary and secondary outcomes: not very well descriped. Measured outcomes: functional outcome: questenaire focusing on feacal function and sexual activity; quality of life using the SF-36 and GIQLI; Body image and cosmesis: body image questionnaire; Other outcomes: mortality, postoperative complications, conversion, length of operation, length of incision, time to intake > 1000 ml, time to regular diet, time to pouch drain > 100ml, length of hospital stay, relaparotomy Follow-up: variable, mean 16 month.
Notes	

Risk of bias

Item	Authors' judgement	Description

Dunker 2001 (*Continued*)

Allocation concealment?	Unclear	D - Not used

Hashimoto 2001

Methods	- Mono-center trial - N = 24 (cases 11, controls 13) - Collection of data: retrospective - Matching: not matched - Contemporary groups: no - Loss to follow-up: 0 - Intention to treat: yes - Sample size calculation: no
Participants	Diagnosis: UC and FAP In- and exclusion criteria: all LAP-IPAA in periode of study (indication for LAP-IPAA are well described)
Interventions	LA-IPAA vs Open IPAA. - LA-IPAA: through Pfannenstiel of 6 to 8 cm, J-pouch, with mucosectomy and hand-sewn, with diverting loop ileostomy for all. - Open IPAA: incision type and length not specified, J-pouch, mucosectomy and hand-sewn, with diverting loop ileostomy for all Surgical experience: not described.
Outcomes	Primary and secondary outcomes: not very well descriped. Measured outcomes: mortality, intra- and postoperative complications, conversion, operative time, intraoperative blood loss, time to solid intake, length of hospital stay, relaparotomy, frequency of use of analgesic drugs Follow-up: till discharge.
Notes	

Risk of bias

Item	**Authors' judgement**	**Description**
Allocation concealment?	Unclear	D - Not used

Larson 2005

Methods	- Mono-center trial - N = 66 (cases 33, controls 33) - Collection of data: prospective - Matching: matched for age, gender, date of surgery, BMI and indication. - Contemporary groups: yes - Loss to follow-up: 0 (4 of eligible 37 didn't return the standard annual survey, therefore not included in study) - Intention to treat: yes - Sample size calculation: no
Participants	Diagnosis: UC and FAP In- and exclusion criteria: all LAP-IPAA in periode of study, with a follow-up > 12 months
Interventions	LA-IPAA vs open IPAA. - LA-IPAA: through periumbilical of 4 to 5 cm, J-pouch, either mucosectomy and handsewn or double-stapled, with diverting loop ileostomy in majority (30/33) - Open IPAA: type en length of incision: not mentioned, J-pouch, either mucosectomy and handsewn or double-stapled, with diverting loop ileostomy in all Surgical experience: not specified.
Outcomes	Primary and secondary outcomes: not well described. Measured outcomes: mortality, posoperative complications, reoperation, rate of use of diverting ileostomy, faecal function and sexual activity Follow-up: > 12 months.
Notes	- Focus on longterm outcomes (shortterm outcomes published separately)

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	D - Not used

Larson 2006

Methods	- Mono-center trial - N = 300 (cases 100, controls 200) - Collection of data: cases prospective, controls retrospective - Matching: matched for age, gender, date of surgery, BMI and procedure. - Contemporary groups: yes - Loss to follow-up: 0 - Intention to treat: yes - Sample size calculation: no
Participants	Diagnosis: UC and FAP In- and exclusion criteria: all LAP-IPAA in periode of study

Larson 2006 (*Continued*)

Interventions	LA-IPAA and HA-IPAA vs open IPAA. - LA-IPAA: through periumbilical, low midline or Pfannenstiel incision of 4 to 5 cm, J-pouch, either handsewn or double-stapled, with diverting loop ileostomy. - HA-IPAA: through lower midline or Pfannenstiel incision of 6 to 8 cm, J-Pouch, either handsewn mucosectomy or double-Stapled, with diverting loop ileostomy . - Open IPAA: type en length of incision: not mentioned, J-pouch, either mucosectomy or double-stapled, with diverting loop ileostomy Surgical experience: LAP-IPAA: large experience in laparoscopic surgery, but most surgeons are new to LAP-IPAA. Open-IPAA: collective large experience in open IPAA
Outcomes	Primary and secondary outcomes: not stated. Measured outcomes: intraoperative complications, postoperative complications (bowel obstruction, wound infection, intra-abdominal abscesses, pulmonary infections, ileus, UTI, urinary retention, anastomotic leak, readmission and cause of readmission, surgical reintervention), mortality, duration of operation, conversion rate to open, time to bowel movement, time to regular diet, postoperative use of analgesic, length of hospital stay. Follow-up: 90 days
Notes	- Both LA-IPAA and HA-IPAA.

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	D - Not used

Maartense 2004a

Methods	- Two-centre trial. - N = 60 (30 cases, 30 controls) - Generation of allocation: unclear - Allocation concealment: adequate (sealed envelope). - Blinding: not performed. - Follow-up: adequate. - Loss to follow up: -- Maartense 2004: 2 in HA-IPAA, 3 in open group. -- Polle 2007: 7 in HA-IPAA, 7 in open group. - Intention-to-treat: yes - Sample size calculations: yes
Participants	Diagnosis: UC and FAP In- and exclusion criteria: well described.
Interventions	HA-IPAA vs open IPAA. - HA-IPAA: through Pfannenstiel incision of 8 cm, J-Pouch, double-Stapled, with diverting loop ileostomy on surgeon's discretion. - Open IPAA: median incision of unspecified length, J-pouch, double-stapled, with diverting loop ileostomy on surgeon's discretion

Maartense 2004a (*Continued*)

	Surgical experience: good experience in both laparoscopic colorectal surgery and open IPAA
Outcomes	Primary and secondary outcomes: well described. Measured outcomes: postoperative recovery, operating time, blood loss, conversion rate, morphine requirement, mortality, early complications, early readmissions and reoperations, costs and short-term quality of life (SF-36 & GIQLI) Follow-up: - Maartense 2004: 3 months. - Polle 2007: 2.7 years.
Notes	- Long-term outcomes published separately (Polle 2007)

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Yes	A - Adequate

Marcello 2000

Methods	- Mono-center trial - N = 40 (20 cases, 20 control) - Collection of data: prospective - Matching: matched for age, gender, diagnosis, BMI and severity of MUC (albumine, Hb, WCC, steroid requirements and indication for surgery) - Contemporary groups: yes - Loss to follow-up: 0 - Intention to treat: yes - Sample size calculations: no
Participants	Diagnosis: UC and FAP In- and exclusion criteria: all LAP-IPAA in periode of study
Interventions	LA-IPAA vs Open IPAA. - LA-IPAA: through Pfannenstiel incision of 6 to 8 cm, pouch-configuration: not mentioned, double-stapled, with diverting loop ileostomy for all but one patient with MUC and without ileostomy for all FAP. - Open IPAA: type and length of incision and pouch-configuration not mentioned, double-stapled anastomosis, with diverting loop ileostomy for all MUC and without for all FAP Surgical experience: good experience in laparoscopic colorectal surgery (>700 cases), including total abdominal colectomies (>100). However, new in LAP-IPAA
Outcomes	Primary and secondary outcomes: not stated. Measured outcomes: intraoperative complications, postoperative complications, conversion rate, estimated blood loss, operative time, time to bowel function, length of hospital stay, rate of use of diverting ileostomy Follow-up: till discharge.
Notes	

Marcello 2000 (*Continued*)

Risk of bias		
Item	**Authors' judgement**	**Description**
Allocation concealment?	Unclear	D - Not used

Otani 2001

Methods	- Mono-center trial - N = 28 (10 cases, 18 control) - Collection of data: not specified - Matching: not matched - Contemporary groups: yes - Loss to follow-up: 0 - Intention to treat: ns - Sample size calculations: no
Participants	Diagnosis: UC only In- and exclusion criteria: all LAP-IPAA and Open IPAA performed till that time
Interventions	LA-IPAA vs Open IPAA. - LA-IPAA: through midline incision of 6 to 7 cm, J-pouch, double-stapled, without a diverting loop ileostomy. - Open IPAA: type and length of incision, pouch-configuration and type of anastomosis not specified. A diverting ileostomy is used when the patient uses > 30 mg/day corticosteroids Surgical experience: new in LAP-IPAA.
Outcomes	Primary and secondary outcomes: not stated. Measured outcomes: estimated blood loss, time to oral feeding, operative time, length of hospital stay, frequency of defecation at discharge Follow-up: till discharge.
Notes	

Risk of bias		
Item	**Authors' judgement**	**Description**
Allocation concealment?	Unclear	D - Not used

Schmitt 1994

Methods	- Mono-center trial - N = 42 (22 cases, 20 control) - Collection of data: prospective - Matching: matched for age, gender and diagnosis - Contemporary groups: yes - Loss to follow-up: 0 - Intention to treat: yes - Sample size calculations: no
Participants	Diagnosis: UC, FAP and 1 juvenile polyposis (LA-group) In- and exclusion criteria: all LAP-IPAA in periode of study
Interventions	LA-IPAA vs Open IPAA. - LA-IPAA: through Pfannenstiel incision of unspecified length, J-Pouch, double-stapled anastomosis, with diverting loop ileostomy . - Open IPAA: type and length of incision not mentioned, J-pouch, double-stapled anastomosis, with diverting loop ileostomy Surgical experience: not specified.
Outcomes	Primary and secondary outcomes: not stated. Measured outcomes: mortality, postoperative complications, operative time, blood transfusion requirement, time clearance of ileus, time to first oral intake, length of hospital stay, reoperation rate Follow-up: till discharge.
Notes	- Included one patient with juvenile polyposis.

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	D - Not used

IPAA=restorative proctocolectomy with ileal-pouch anal anastomosis. LA-IPAA= laparoscopic-assisted IPAA. HA-IPAA= hand-assisted IPAA. N=number of patients.

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Araki 2000	Descriptive series, with no control group.
Araujo 2005	Descriptive series, with no control group.

(*Continued*)

Baccari 2000	Abstract did not specify type of operations performed. Reviewing the full article revealed that no IPAAs were performed
Delaney 2003	Abstract did not specify type of operations performed. Reviewing the full article revealed that no IPAAs were performed
Dunker 2000	Abstract did not specify type of operations performed. Reviewing the full article revealed that no IPAAs were performed
Etienne 1993	No abstract was found in the electronic databases, therefore the full publications was obtained. This showed that no IPAA were performed
Georgeson 2002	The full article showed that this was mainly a theoretical review, with a brief description of clinical experience without presentation of outcomes
Gill 2004	Descriptive series, with no control group.
Hahnloser 2004	This study had an overlapping patient population with a subsequent study from the same institution (Larson 2006)
Hasegawa 2002	Descriptive series, with no control group.
Hildebrandt 1998	Abstract did not specify wether the laparoscopic group was compared to an open group . Reviewing the full article revealed that there was no control group in this study
Hong 2002	Abstract did not specify type of operations performed. Reviewing the full article revealed that only 2 out of the 279 patients included in this study had an IPAA
Ishida 2003	Abstract did not specify type of operations performed. Reviewing the full article revealed that 4 of the 7 patients in this study did not underwent an IPAA procedure
Kessler 2001	Abstract did not specify wether the laparoscopic group was compared to an open group . Reviewing the full article revealed that there was no control group in this study
Kienle 2003	Descriptive series, with no control group.
Kienle 2005	Descriptive series, with no control group.
Ky 2002	Descriptive series, with no control group.
Larach 1993	No abstract was found in the electronic databases, therefore the full article has been retrieved. This showed that there were no IPAA's performed
Lindemann 1995	Abstract did not specify wether the laparoscopic group was compared to an open group . Reviewing the full article revealed that there was no control group in this study
Liu 1995	Descriptive series, with no control group.

(*Continued*)

Maartense 2004b	While the emergency colectomy was performed laparoscopically, the IPAA that has been done after a multiple month recovery periode was performed open in both groups
Marcello 2001	Abstract did not specify types of operations performed. Reviewing the full article revealed that no IPAAs were performed
Nogueras 1992	No abstract was available. Reviewing the full article revealed that there was no control group in this study
Ouaissi 2006	Abstract did not specify wether the laparoscopic group was compared to an open group . Reviewing the full article revealed that there was no control group in this study
Pace 2002	Descriptive series, with no control group.
Panis 2005	Abstract did not specify type of operations performed. Reviewing the full article revealed that no IPAAs were performed
Pfeifer 1995	Abstract did not specify type of operations performed. Reviewing the full article revealed that out of the 106 patients included in this study, only 2 had undergone a laparoscopic-assisted IPAA
Santoro 1999	Descriptive series, with no control group.
Senagore 1993	Abstract did not specify type of operations performed. Reviewing the full article didn't reveal any explicit mention of IPAA. Furthermore this study included patients with a large variety of diseases and the final analyses was made for all patients together
Seow 1999	This study had an overlapping patient population with a subsequent study from the same institution (Brown 2001)
Seshadri 2001	Abstract did not specify type of operations performed. Reviewing the full article revealed that no IPAAs were performed
Stocchi 2000	Abstract did not specify type of operations performed. Reviewing the full article revealed that no IPAAs were performed
Vignali 2004	Abstract did not specify type of operations performed. Reviewing the full article revealed that no IPAAs were performed
Wexner 1992	A preliminary study with partially overlapping patients with a subsequent trial of the same institution (Schmitt 1994)
Wexner 1996	Descriptive series, with no control group.
Young-Fadok 2001	This study had an overlapping patient population with a subsequent study from the same institution (Larson 2006)

Characteristics of ongoing studies *[ordered by study ID]*

Antolovic 2006

Trial name or title	LapConPouch-Trial: Totally Lparoscopic versus Conventional Ileoanal Pouch Procedure
Methods	
Participants	160 patients (80 per intervention arm) with ulcerative colitis or familial adenomatous polyposis, requiring restorative proctocolectomy
Interventions	Totally laparoscopic versus conventional open restorative proctocolectomy.
Outcomes	Blood loss, operative time, early and late onset complications, postoperative pain and analgesic drug use, length of hospital stay, lung function, quality of life (SF-36), body image and cosmesis
Starting date	September 2004,with a duration of 4 years.
Contact information	Corresponding author: Seiler - christoph_seiler@med.uni-heidelberg.de. Department of Surgery, University of Heidelberg, Heidelberg, Germany. Christoph M
Notes	

DATA AND ANALYSES

Comparison 1. LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding prospective data collection

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Procedure specific complications	5	420	Risk Ratio (M-H, Fixed, 95% CI)	0.81 [0.32, 2.02]
1.1 High-quality trials	2	64	Risk Ratio (M-H, Fixed, 95% CI)	0.6 [0.08, 4.30]
1.2 Low-quality trials	3	356	Risk Ratio (M-H, Fixed, 95% CI)	0.89 [0.32, 2.51]
2 Severe postoperative complications	5	415	Risk Ratio (M-H, Fixed, 95% CI)	0.65 [0.29, 1.48]
2.1 High-quality trials	2	66	Risk Ratio (M-H, Fixed, 95% CI)	2.85 [0.46, 17.50]
2.2 Low-quality trials	3	349	Risk Ratio (M-H, Fixed, 95% CI)	0.41 [0.15, 1.13]
3 Minor complications	8	519	Risk Ratio (M-H, Fixed, 95% CI)	1.05 [0.78, 1.41]
3.1 High-quality trials	3	106	Risk Ratio (M-H, Fixed, 95% CI)	2.14 [1.01, 4.54]
3.2 Low-quality trials	5	413	Risk Ratio (M-H, Fixed, 95% CI)	0.89 [0.64, 1.23]
4 Total Complications	8	519	Risk Ratio (M-H, Fixed, 95% CI)	0.91 [0.73, 1.14]
4.1 High-quality trials	3	106	Risk Ratio (M-H, Fixed, 95% CI)	1.45 [0.87, 2.44]
4.2 Low-quality trials	5	413	Risk Ratio (M-H, Fixed, 95% CI)	0.81 [0.63, 1.04]
5 Operative time (minutes)	4	116	Mean Difference (IV, Random, 95% CI)	91.52 [53.36, 129.68]
5.1 High-quality trials	1	24	Mean Difference (IV, Random, 95% CI)	97.5 [66.17, 128.83]
5.2 Low-quality trials	3	92	Mean Difference (IV, Random, 95% CI)	83.03 [21.45, 144.61]
6 Blood loss (mL)	2	60	Mean Difference (IV, Random, 95% CI)	-98.59 [-261.04, 63.86]
6.1 Low-quality trials	2	60	Mean Difference (IV, Random, 95% CI)	-98.59 [-261.04, 63.86]
7 Time to regular diet (days)	2	60	Mean Difference (IV, Fixed, 95% CI)	-1.48 [-2.71, -0.25]
7.1 Low-quality trials	2	60	Mean Difference (IV, Fixed, 95% CI)	-1.48 [-2.71, -0.25]
8 Hospital stay (days)	3	88	Mean Difference (IV, Fixed, 95% CI)	-2.66 [-4.28, -1.04]
8.1 High-quality trial	1	24	Mean Difference (IV, Fixed, 95% CI)	-2.98 [-7.11, 1.15]
8.2 Low-quality trial	2	64	Mean Difference (IV, Fixed, 95% CI)	-2.60 [-4.37, -0.84]
9 Reoperation	6	447	Risk Ratio (M-H, Fixed, 95% CI)	0.74 [0.32, 1.71]
9.1 High-quality trials	2	66	Risk Ratio (M-H, Fixed, 95% CI)	0.96 [0.14, 6.62]
9.2 Low-quality trials	4	381	Risk Ratio (M-H, Fixed, 95% CI)	0.70 [0.28, 1.78]

Comparison 2. LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding contemporary groups

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Procedure specific complications	5	420	Risk Ratio (M-H, Fixed, 95% CI)	0.81 [0.32, 2.02]
1.1 High-quality trials	3	364	Risk Ratio (M-H, Fixed, 95% CI)	0.63 [0.14, 2.77]
1.2 Low-quality trials	2	56	Risk Ratio (M-H, Fixed, 95% CI)	0.99 [0.31, 3.16]

2 Severe postoperative complications	5	415	Risk Ratio (M-H, Fixed, 95% CI)	0.65 [0.29, 1.48]
2.1 High-quality trials	3	366	Risk Ratio (M-H, Fixed, 95% CI)	0.65 [0.26, 1.60]
2.2 Low-quality trials	2	49	Risk Ratio (M-H, Fixed, 95% CI)	0.67 [0.09, 4.79]
3 Minor complications	8	519	Risk Ratio (M-H, Fixed, 95% CI)	1.05 [0.78, 1.41]
3.1 High-quality trials	5	438	Risk Ratio (M-H, Fixed, 95% CI)	0.99 [0.71, 1.38]
3.2 Low-quality trials	3	81	Risk Ratio (M-H, Fixed, 95% CI)	1.37 [0.70, 2.68]
4 Total Complications	8	519	Risk Ratio (M-H, Fixed, 95% CI)	0.91 [0.73, 1.14]
4.1 High-quality trials	5	438	Risk Ratio (M-H, Fixed, 95% CI)	0.88 [0.68, 1.13]
4.2 Low-quality trials	3	81	Risk Ratio (M-H, Fixed, 95% CI)	1.10 [0.68, 1.77]
5 Operative time (minutes)	4	116	Mean Difference (IV, Random, 95% CI)	91.52 [53.36, 129.68]
5.1 High-quality trials	2	56	Mean Difference (IV, Random, 95% CI)	116.12 [82.00, 150.25]
5.2 Low-quality trials	2	60	Mean Difference (IV, Random, 95% CI)	58.57 [17.76, 99.38]
6 Blood loss (mL)	2	60	Mean Difference (IV, Random, 95% CI)	-98.59 [-261.04, 63.86]
6.1 Low-quality trials	2	60	Mean Difference (IV, Random, 95% CI)	-98.59 [-261.04, 63.86]
7 Time to regular diet (days)	2	60	Mean Difference (IV, Fixed, 95% CI)	-1.48 [-2.71, -0.25]
7.1 High-quality trials	1	32	Mean Difference (IV, Fixed, 95% CI)	-1.40 [-2.64, -0.16]
7.2 Low-quality trials	1	28	Mean Difference (IV, Fixed, 95% CI)	-8.90 [-20.79, 2.99]
8 Hospital stay (days)	3	88	Mean Difference (IV, Fixed, 95% CI)	-2.66 [-4.28, -1.04]
8.1 High-quality trial	2	56	Mean Difference (IV, Fixed, 95% CI)	-2.66 [-4.28, -1.03]
8.2 Low-quality trial	1	32	Mean Difference (IV, Fixed, 95% CI)	-3.20 [-24.65, 18.25]
9 Reoperation	6	447	Risk Ratio (M-H, Fixed, 95% CI)	0.74 [0.32, 1.71]
9.1 High-quality trials	4	398	Risk Ratio (M-H, Fixed, 95% CI)	0.60 [0.23, 1.57]
9.2 Low-quality trials	2	49	Risk Ratio (M-H, Fixed, 95% CI)	1.87 [0.27, 13.04]

Comparison 3. LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding baseline equivalence

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Procedure specific complications	5	420	Risk Ratio (M-H, Fixed, 95% CI)	0.81 [0.32, 2.02]
1.1 High-quality trials	4	396	Risk Ratio (M-H, Fixed, 95% CI)	0.66 [0.24, 1.79]
1.2 Low-quality trials	1	24	Risk Ratio (M-H, Fixed, 95% CI)	3.5 [0.16, 78.19]
2 Severe postoperative complications	5	415	Risk Ratio (M-H, Fixed, 95% CI)	0.65 [0.29, 1.48]
2.1 High-quality trials	3	349	Risk Ratio (M-H, Fixed, 95% CI)	0.45 [0.17, 1.23]
2.2 Low-quality trials	2	66	Risk Ratio (M-H, Fixed, 95% CI)	2.03 [0.36, 11.37]
3 Minor complications	8	519	Risk Ratio (M-H, Fixed, 95% CI)	1.05 [0.78, 1.41]
3.1 High-quality trials	5	421	Risk Ratio (M-H, Fixed, 95% CI)	0.88 [0.63, 1.24]
3.2 Low-quality trials	3	98	Risk Ratio (M-H, Fixed, 95% CI)	1.97 [1.01, 3.84]
4 Total Complications	8	519	Risk Ratio (M-H, Fixed, 95% CI)	0.91 [0.73, 1.14]
4.1 High-quality trials	5	421	Risk Ratio (M-H, Fixed, 95% CI)	0.80 [0.62, 1.03]
4.2 Low-quality trials	3	98	Risk Ratio (M-H, Fixed, 95% CI)	1.56 [0.95, 2.56]

5 Operative time (minutes)	4	116	Mean Difference (IV, Random, 95% CI)	91.52 [53.36, 129.68]
5.1 High-quality trials	2	56	Mean Difference (IV, Random, 95% CI)	68.63 [-7.05, 144.30]
5.2 Low-quality trials	2	60	Mean Difference (IV, Random, 95% CI)	103.02 [41.06, 164.99]
6 Blood loss (mL)	2	60	Mean Difference (IV, Random, 95% CI)	-98.59 [-261.04, 63.86]
6.1 High-quality trials	1	32	Mean Difference (IV, Random, 95% CI)	-18.00 [-149.51, 109.51]
6.2 Low-quality trials	1	28	Mean Difference (IV, Random, 95% CI)	-186.0 [-335.65, -36.35]
7 Time to regular diet (days)	2	60	Mean Difference (IV, Fixed, 95% CI)	-1.48 [-2.71, -0.25]
7.1 Low-quality trials	2	60	Mean Difference (IV, Fixed, 95% CI)	-1.48 [-2.71, -0.25]
8 Hospital stay (days)	3	88	Mean Difference (IV, Fixed, 95% CI)	-2.66 [-4.28, -1.04]
8.1 High-quality trial	2	56	Mean Difference (IV, Fixed, 95% CI)	-2.99 [-7.04, 1.07]
8.2 Low-quality trial	1	32	Mean Difference (IV, Fixed, 95% CI)	-2.60 [-4.37, -0.83]
9 Reoperation	6	447	Risk Ratio (M-H, Fixed, 95% CI)	0.74 [0.32, 1.71]
9.1 High-quality trials	3	349	Risk Ratio (M-H, Fixed, 95% CI)	0.50 [0.18, 1.41]
9.2 Low-quality trials	3	98	Risk Ratio (M-H, Fixed, 95% CI)	2.14 [0.41, 11.25]

Comparison 4. LA-IPAA vs Open-IPAA - highest-quality trials versus other trials

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Procedure specific complications	5	420	Risk Ratio (M-H, Fixed, 95% CI)	0.81 [0.32, 2.02]
1.1 High-quality trials	2	64	Risk Ratio (M-H, Fixed, 95% CI)	0.6 [0.08, 4.30]
1.2 Low-quality trials	3	356	Risk Ratio (M-H, Fixed, 95% CI)	0.89 [0.32, 2.51]
2 Severe postoperative complications	5	415	Risk Ratio (M-H, Fixed, 95% CI)	0.65 [0.29, 1.48]
2.1 High-quality trials	1	24	Risk Ratio (M-H, Fixed, 95% CI)	1.0 [0.07, 14.21]
2.2 Low-quality trials	4	391	Risk Ratio (M-H, Fixed, 95% CI)	0.63 [0.26, 1.49]
3 Minor complications	8	519	Risk Ratio (M-H, Fixed, 95% CI)	1.05 [0.78, 1.41]
3.1 High-quality trials	2	64	Risk Ratio (M-H, Fixed, 95% CI)	1.2 [0.40, 3.57]
3.2 Low-quality trials	6	455	Risk Ratio (M-H, Fixed, 95% CI)	1.03 [0.76, 1.41]
4 Total Complications	8	519	Risk Ratio (M-H, Fixed, 95% CI)	0.91 [0.73, 1.14]
4.1 High-quality trials	2	64	Risk Ratio (M-H, Fixed, 95% CI)	1.0 [0.43, 2.34]
4.2 Low-quality trials	6	455	Risk Ratio (M-H, Fixed, 95% CI)	0.90 [0.72, 1.14]
5 Operative time (minutes)	4	116	Mean Difference (IV, Random, 95% CI)	91.52 [53.36, 129.68]
5.1 High-quality trials	1	24	Mean Difference (IV, Random, 95% CI)	97.5 [66.17, 128.83]
5.2 Low-quality trials	3	92	Mean Difference (IV, Random, 95% CI)	83.03 [21.45, 144.61]
6 Blood loss (mL)	2	60	Mean Difference (IV, Random, 95% CI)	-98.59 [-261.04, 63.86]
6.1 Low-quality trials	2	60	Mean Difference (IV, Random, 95% CI)	-98.59 [-261.04, 63.86]
7 Time to regular diet (days)	2	60	Mean Difference (IV, Fixed, 95% CI)	-1.48 [-2.71, -0.25]

7.1 Low-quality trials	2	60	Mean Difference (IV, Fixed, 95% CI)	-1.48 [-2.71, -0.25]
8 Hospital stay (days)	3	88	Mean Difference (IV, Fixed, 95% CI)	-2.66 [-4.28, -1.04]
8.1 High-quality trial	1	24	Mean Difference (IV, Fixed, 95% CI)	-2.98 [-7.11, 1.15]
8.2 Low-quality trial	2	64	Mean Difference (IV, Fixed, 95% CI)	-2.60 [-4.37, -0.84]
9 Reoperation	6	447	Risk Ratio (M-H, Fixed, 95% CI)	0.74 [0.32, 1.71]
9.1 High-quality trials	1	24	Risk Ratio (M-H, Fixed, 95% CI)	0.33 [0.01, 7.45]
9.2 Low-quality trials	5	423	Risk Ratio (M-H, Fixed, 95% CI)	0.79 [0.33, 1.91]

Comparison 5. LA-IPAA vs Open-IPAA - sensitivity analsyses

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Sensitivity analysis 1: Imputing means and standard deviations in operative time (minutes)	9	547	Mean Difference (IV, Random, 95% CI)	82.66 [59.99, 105.33]
2 Sensitivity analysis 2: Imputing means and standard deviations in blood loss (mL)	4	124	Mean Difference (IV, Random, 95% CI)	-137.75 [-234.64, -40.86]
3 Sensitivity analysis 3: Imputing means and standard deviations in time to bowel movement (days)	3	372	Mean Difference (IV, Random, 95% CI)	-1.96 [-3.45, -0.46]
4 Sensitivity analysis 4: Imputing means and standard deviations in time to regular diet (days)	5	409	Mean Difference (IV, Random, 95% CI)	-1.47 [-2.25, -0.69]
5 Sensitivity analysis 5: Imputing means and standard deviations in hospital stay (days)	8	519	Mean Difference (IV, Random, 95% CI)	-2.12 [-3.12, -1.12]
6 Sensitivity analysis 6: Imputing means and standard deviations in incision length (cm)	2	57	Mean Difference (IV, Fixed, 95% CI)	-7.79 [-9.68, -5.90]
7 Sensitivity analysis 8: Imputing means and standard deviations in defecation frequency day (times/day)	2	98	Mean Difference (IV, Random, 95% CI)	0.19 [-1.38, 1.76]
8 Sensitivity analysis 9: Imputing means and standard deviations in defecation frequency night (times/night)	2	98	Mean Difference (IV, Random, 95% CI)	-0.66 [-1.35, 0.03]

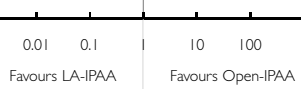
Analysis 1.1. Comparison 1 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding prospective data collection, Outcome 1 Procedure specific complications.

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 1 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding prospective data collection

Outcome: 1 Procedure specific complications

Study or subgroup	LA-IPAA n/N	Open-IPAA n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 High-quality trials					
Berdah 2004	0/12	1/12		16.9 %	0.33 [0.01, 7.45]
Marcello 2000	1/20	1/20		11.2 %	1.00 [0.07, 14.90]
Subtotal (95% CI)	**32**	**32**		**28.1 %**	**0.60 [0.08, 4.30]**
Total events: 1 (LA-IPAA), 2 (Open-IPAA)					
Heterogeneity: Chi^2 = 0.27, df = 1 (P = 0.60); I^2 =0.0%					
Test for overall effect: Z = 0.51 (P = 0.61)					
2 Low-quality trials					
Araki 2001	4/21	3/11		44.2 %	0.70 [0.19, 2.58]
Hashimoto 2001	1/11	0/13		5.2 %	3.50 [0.16, 78.19]
Larson 2006	1/100	3/200		22.5 %	0.67 [0.07, 6.33]
Subtotal (95% CI)	**132**	**224**		**71.9 %**	**0.89 [0.32, 2.51]**
Total events: 6 (LA-IPAA), 6 (Open-IPAA)					
Heterogeneity: Chi^2 = 0.94, df = 2 (P = 0.62); I^2 =0.0%					
Test for overall effect: Z = 0.22 (P = 0.83)					
Total (95% CI)	**164**	**256**		**100.0 %**	**0.81 [0.32, 2.02]**
Total events: 7 (LA-IPAA), 8 (Open-IPAA)					
Heterogeneity: Chi^2 = 1.27, df = 4 (P = 0.87); I^2 =0.0%					
Test for overall effect: Z = 0.45 (P = 0.65)					

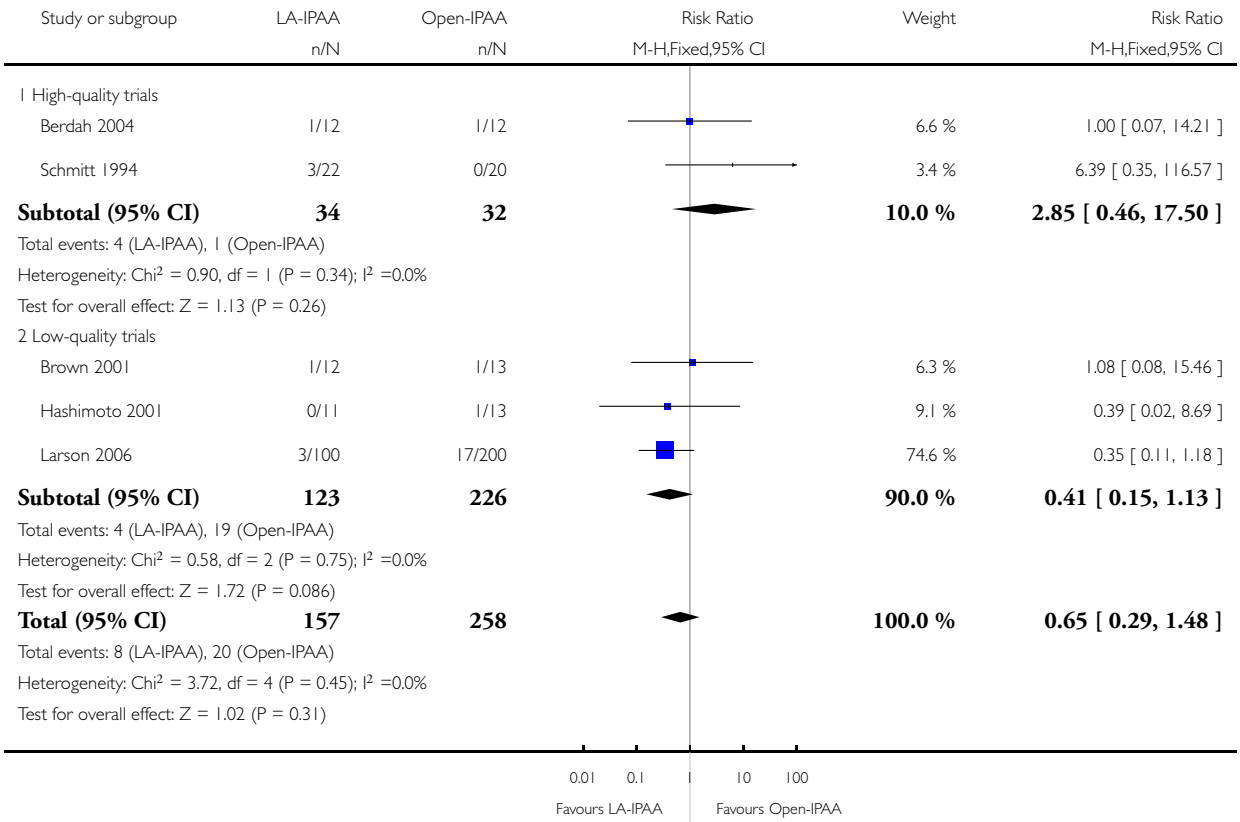


Analysis 1.2. Comparison 1 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding prospective data collection, Outcome 2 Severe postoperative complications.

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 1 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding prospective data collection

Outcome: 2 Severe postoperative complications



Analysis 1.3. Comparison 1 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding prospective data collection, Outcome 3 Minor complications.

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 1 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding prospective data collection

Outcome: 3 Minor complications

Study or subgroup	LA-IPAA n/N	Open-IPAA n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 High-quality trials					
Berdah 2004	3/12	1/12		1.6 %	3.00 [0.36, 24.92]
Marcello 2000	3/20	4/20		6.3 %	0.75 [0.19, 2.93]
Schmitt 1994	12/22	3/20		5.0 %	3.64 [1.20, 11.04]
Subtotal (95% CI)	**54**	**52**		**12.9 %**	**2.14 [1.01, 4.54]**
Total events: 18 (LA-IPAA), 8 (Open-IPAA)					
Heterogeneity: Chi² = 3.25, df = 2 (P = 0.20); I² =38%					
Test for overall effect: Z = 1.99 (P = 0.047)					
2 Low-quality trials					
Araki 2001	7/21	4/11		8.3 %	0.92 [0.34, 2.46]
Brown 2001	1/12	0/13		0.8 %	3.23 [0.14, 72.46]
Dunker 2001	1/15	3/17		4.5 %	0.38 [0.04, 3.26]
Hashimoto 2001	6/11	4/13		5.8 %	1.77 [0.67, 4.71]
Larson 2006	26/100	64/200		67.7 %	0.81 [0.55, 1.20]
Subtotal (95% CI)	**159**	**254**		**87.1 %**	**0.89 [0.64, 1.23]**
Total events: 41 (LA-IPAA), 75 (Open-IPAA)					
Heterogeneity: Chi² = 3.40, df = 4 (P = 0.49); I² =0.0%					
Test for overall effect: Z = 0.72 (P = 0.47)					
Total (95% CI)	**213**	**306**		**100.0 %**	**1.05 [0.78, 1.41]**
Total events: 59 (LA-IPAA), 83 (Open-IPAA)					
Heterogeneity: Chi² = 10.20, df = 7 (P = 0.18); I² =31%					
Test for overall effect: Z = 0.31 (P = 0.76)					

Analysis 1.4. Comparison 1 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding prospective data collection, Outcome 4 Total Complications.

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 1 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding prospective data collection

Outcome: 4 Total Complications

Study or subgroup	LA-IPAA n/N	Open-IPAA n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 High-quality trials					
Berdah 2004	4/12	3/12		3.1 %	1.33 [0.38, 4.72]
Marcello 2000	4/20	5/20		5.1 %	0.80 [0.25, 2.55]
Schmitt 1994	15/22	7/20		7.5 %	1.95 [1.00, 3.78]
Subtotal (95% CI)	**54**	**52**		**15.8 %**	**1.45 [0.87, 2.44]**
Total events: 23 (LA-IPAA), 15 (Open-IPAA)					
Heterogeneity: Chi^2 = 1.79, df = 2 (P = 0.41); I^2 =0.0%					
Test for overall effect: Z = 1.41 (P = 0.16)					
2 Low-quality trials					
Araki 2001	11/21	7/11		9.5 %	0.82 [0.45, 1.51]
Brown 2001	2/12	2/13		2.0 %	1.08 [0.18, 6.53]
Dunker 2001	1/15	3/17		2.9 %	0.38 [0.04, 3.26]
Hashimoto 2001	7/11	5/13		4.7 %	1.65 [0.73, 3.76]
Larson 2006	36/100	95/200		65.2 %	0.76 [0.56, 1.02]
Subtotal (95% CI)	**159**	**254**		**84.2 %**	**0.81 [0.63, 1.04]**
Total events: 57 (LA-IPAA), 112 (Open-IPAA)					
Heterogeneity: Chi^2 = 3.69, df = 4 (P = 0.45); I^2 =0.0%					
Test for overall effect: Z = 1.63 (P = 0.10)					
Total (95% CI)	**213**	**306**		**100.0 %**	**0.91 [0.73, 1.14]**
Total events: 80 (LA-IPAA), 127 (Open-IPAA)					
Heterogeneity: Chi^2 = 9.73, df = 7 (P = 0.20); I^2 =28%					
Test for overall effect: Z = 0.80 (P = 0.42)					

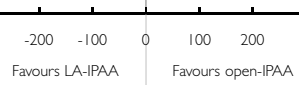
Analysis 1.5. Comparison 1 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding prospective data collection, Outcome 5 Operative time (minutes).

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 1 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding prospective data collection

Outcome: 5 Operative time (minutes)

Study or subgroup	LA-IPAA N	Mean(SD)	Open-IPAA N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
1 High-quality trials							
Berdah 2004	12	402.5 (35.96)	12	305 (42.1)		30.0 %	97.50 [66.17, 128.83]
Subtotal (95% CI)	**12**		**12**			**30.0 %**	**97.50 [66.17, 128.83]**
Heterogeneity: not applicable							
Test for overall effect: Z = 6.10 (P < 0.00001)							
2 Low-quality trials							
Araki 2001	21	215 (141)	11	198 (112)		12.2 %	17.00 [-72.54, 106.54]
Dunker 2001	15	292.3 (39)	17	159.9 (35)		32.1 %	132.40 [106.59, 158.21]
Otani 2001	10	377 (58.8)	18	308 (46.9)		25.7 %	69.00 [26.60, 111.40]
Subtotal (95% CI)	**46**		**46**			**70.0 %**	**83.03 [21.45, 144.61]**
Heterogeneity: Tau^2 = 2244.88; Chi^2 = 10.63, df = 2 (P = 0.005); I^2 =81%							
Test for overall effect: Z = 2.64 (P = 0.0082)							
Total (95% CI)	**58**		**58**			**100.0 %**	**91.52 [53.36, 129.68]**
Heterogeneity: Tau^2 = 1008.13; Chi^2 = 11.02, df = 3 (P = 0.01); I^2 =73%							
Test for overall effect: Z = 4.70 (P < 0.00001)							

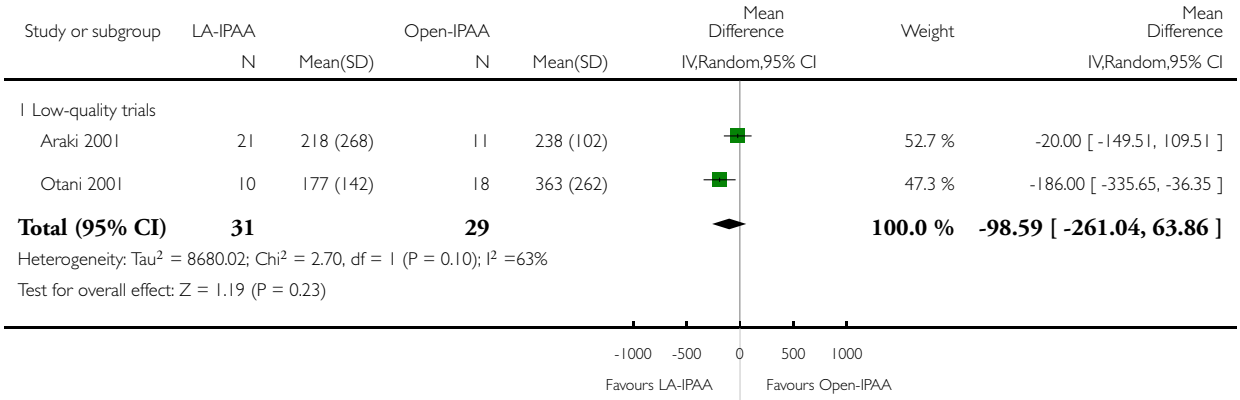


Analysis 1.6. Comparison 1 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding prospective data collection, Outcome 6 Blood loss (mL).

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 1 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding prospective data collection

Outcome: 6 Blood loss (mL)

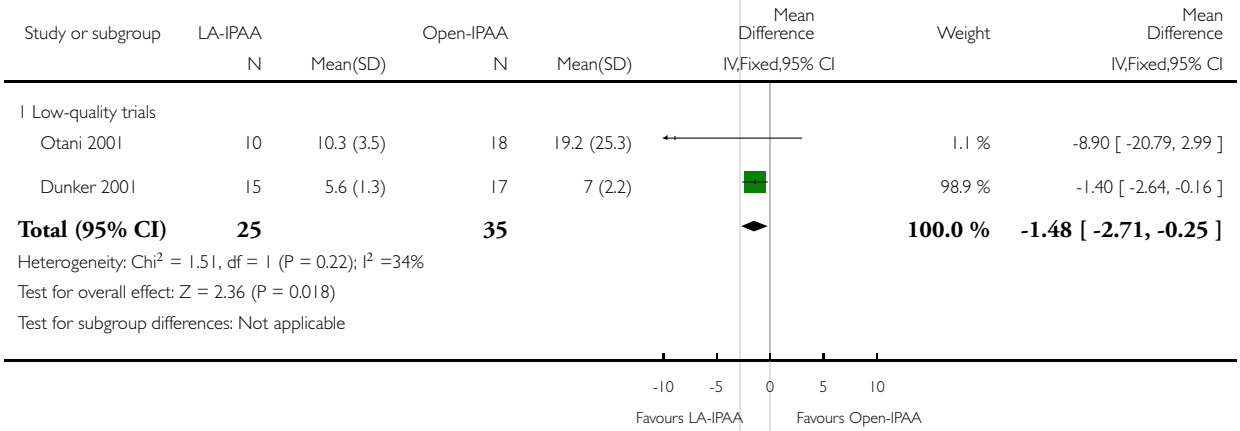


Analysis 1.7. Comparison 1 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding prospective data collection, Outcome 7 Time to regular diet (days).

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 1 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding prospective data collection

Outcome: 7 Time to regular diet (days)



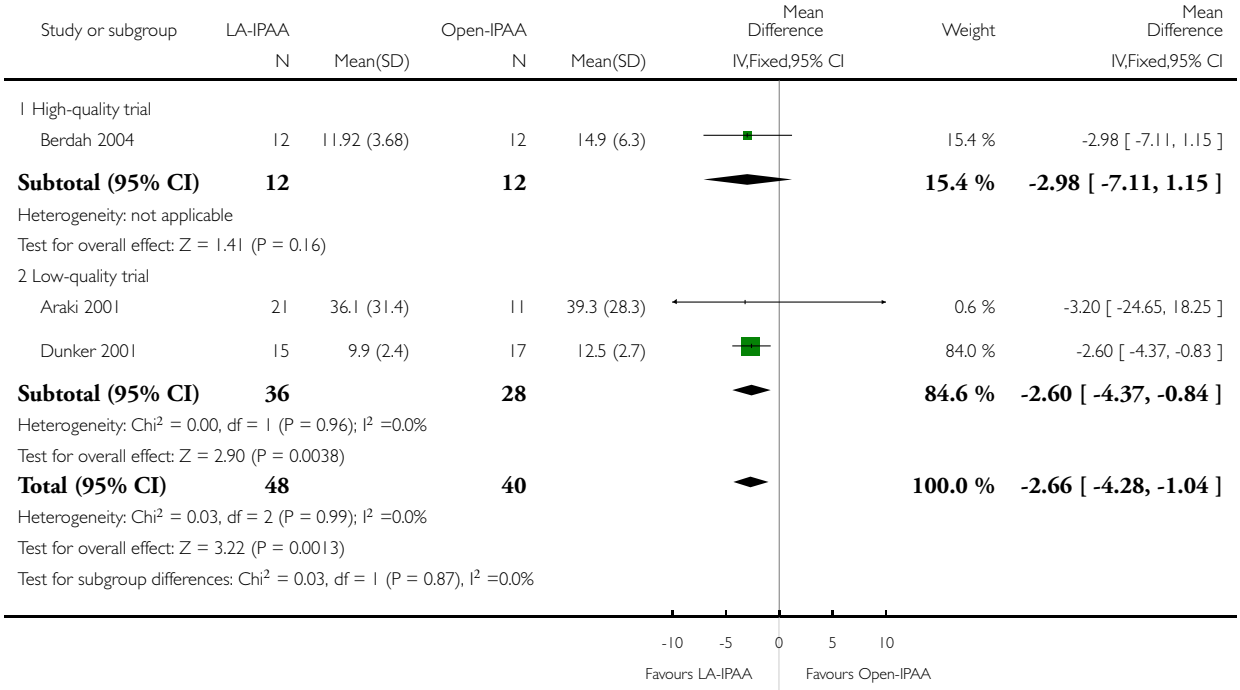
Analysis 1.8. Comparison 1 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding prospective data collection, Outcome 8 Hospital stay (days).

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 1 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding prospective data collection

Outcome: 8 Hospital stay (days)

Study or subgroup	LA-IPAA N	Mean(SD)	Open-IPAA N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 High-quality trial							
Berdah 2004	12	11.92 (3.68)	12	14.9 (6.3)		15.4 %	-2.98 [-7.11, 1.15]
Subtotal (95% CI)	**12**		**12**			**15.4 %**	**-2.98 [-7.11, 1.15]**
Heterogeneity: not applicable							
Test for overall effect: Z = 1.41 (P = 0.16)							
2 Low-quality trial							
Araki 2001	21	36.1 (31.4)	11	39.3 (28.3)		0.6 %	-3.20 [-24.65, 18.25]
Dunker 2001	15	9.9 (2.4)	17	12.5 (2.7)		84.0 %	-2.60 [-4.37, -0.83]
Subtotal (95% CI)	**36**		**28**			**84.6 %**	**-2.60 [-4.37, -0.84]**
Heterogeneity: Chi^2 = 0.00, df = 1 (P = 0.96); I^2 =0.0%							
Test for overall effect: Z = 2.90 (P = 0.0038)							
Total (95% CI)	**48**		**40**			**100.0 %**	**-2.66 [-4.28, -1.04]**
Heterogeneity: Chi^2 = 0.03, df = 2 (P = 0.99); I^2 =0.0%							
Test for overall effect: Z = 3.22 (P = 0.0013)							
Test for subgroup differences: Chi^2 = 0.03, df = 1 (P = 0.87), I^2 =0.0%							

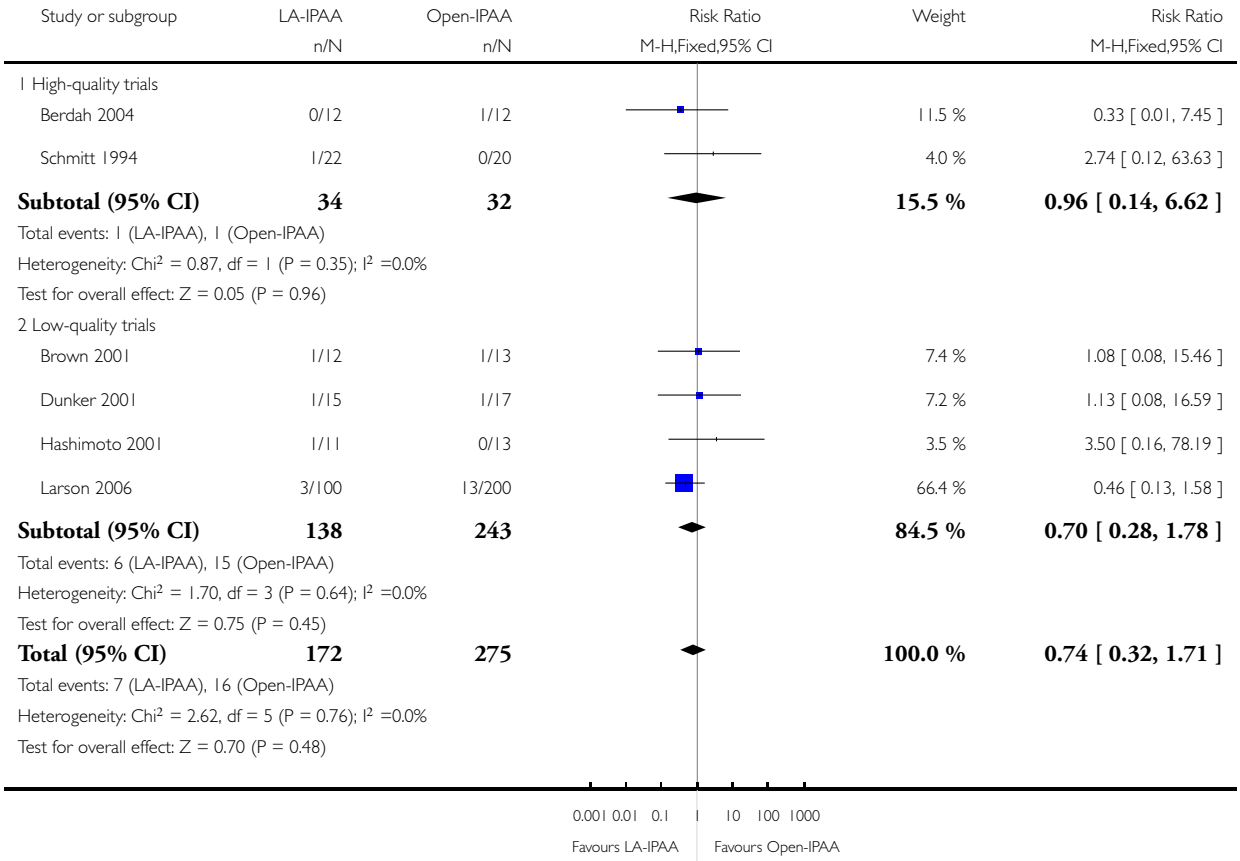


Analysis 1.9. Comparison 1 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding prospective data collection, Outcome 9 Reoperation.

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 1 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding prospective data collection

Outcome: 9 Reoperation



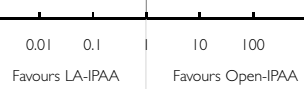
Analysis 2.1. Comparison 2 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding contemporary groups, Outcome 1 Procedure specific complications.

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 2 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding contemporary groups

Outcome: 1 Procedure specific complications

Study or subgroup	LA-IPAA n/N	Open-IPAA n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 High-quality trials					
Berdah 2004	0/12	1/12		16.9 %	0.33 [0.01, 7.45]
Larson 2006	1/100	3/200		22.5 %	0.67 [0.07, 6.33]
Marcello 2000	1/20	1/20		11.2 %	1.00 [0.07, 14.90]
Subtotal (95% CI)	**132**	**232**		**50.6 %**	**0.63 [0.14, 2.77]**
Total events: 2 (LA-IPAA), 5 (Open-IPAA)					
Heterogeneity: Chi² = 0.28, df = 2 (P = 0.87); I² =0.0%					
Test for overall effect: Z = 0.61 (P = 0.54)					
2 Low-quality trials					
Araki 2001	4/21	3/11		44.2 %	0.70 [0.19, 2.58]
Hashimoto 2001	1/11	0/13		5.2 %	3.50 [0.16, 78.19]
Subtotal (95% CI)	**32**	**24**		**49.4 %**	**0.99 [0.31, 3.16]**
Total events: 5 (LA-IPAA), 3 (Open-IPAA)					
Heterogeneity: Chi² = 0.91, df = 1 (P = 0.34); I² =0.0%					
Test for overall effect: Z = 0.01 (P = 0.99)					
Total (95% CI)	**164**	**256**		**100.0 %**	**0.81 [0.32, 2.02]**
Total events: 7 (LA-IPAA), 8 (Open-IPAA)					
Heterogeneity: Chi² = 1.27, df = 4 (P = 0.87); I² =0.0%					
Test for overall effect: Z = 0.45 (P = 0.65)					

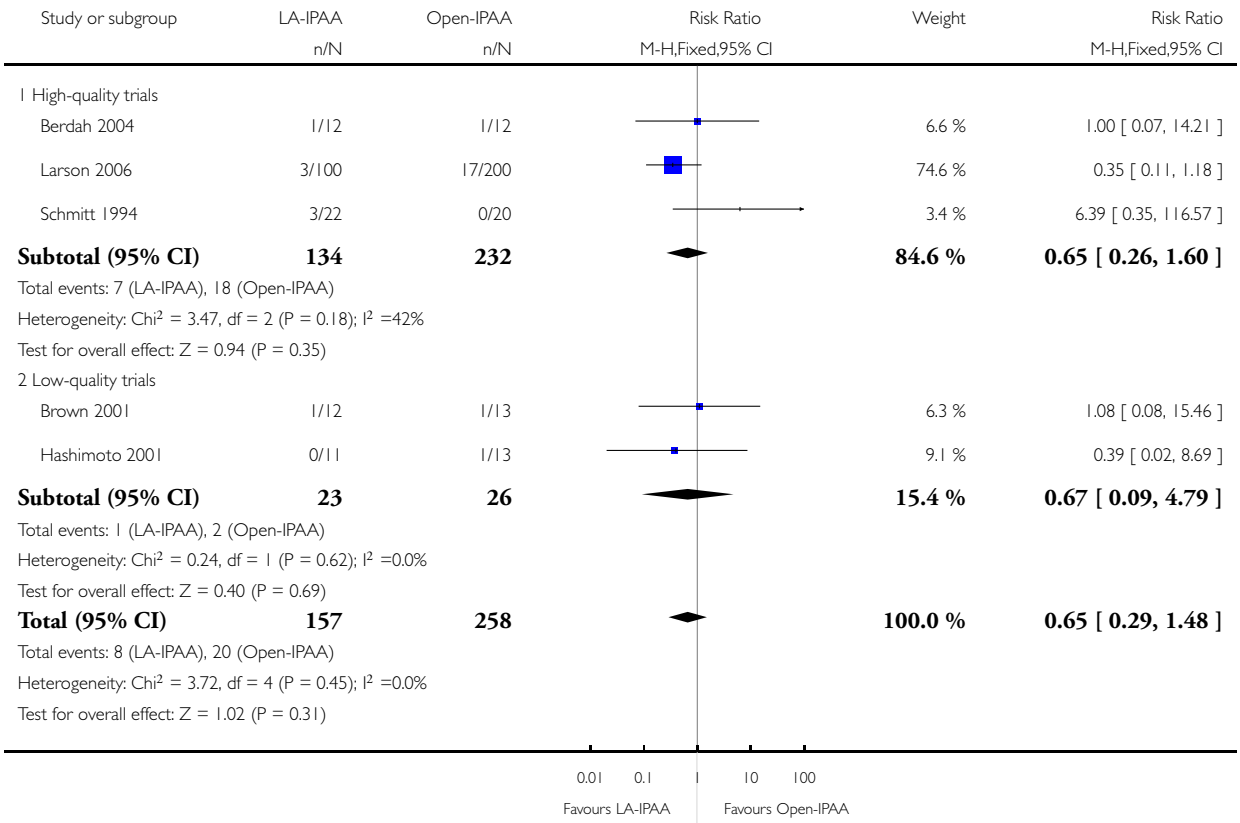


Analysis 2.2. Comparison 2 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding contemporary groups, Outcome 2 Severe postoperative complications.

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 2 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding contemporary groups

Outcome: 2 Severe postoperative complications



Analysis 2.3. Comparison 2 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding contemporary groups, Outcome 3 Minor complications.

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 2 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding contemporary groups

Outcome: 3 Minor complications

Study or subgroup	LA-IPAA n/N	Open-IPAA n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 High-quality trials					
Berdah 2004	3/12	1/12		1.6 %	3.00 [0.36, 24.92]
Dunker 2001	1/15	3/17		4.5 %	0.38 [0.04, 3.26]
Larson 2006	26/100	64/200		67.7 %	0.81 [0.55, 1.20]
Marcello 2000	3/20	4/20		6.3 %	0.75 [0.19, 2.93]
Schmitt 1994	12/22	3/20		5.0 %	3.64 [1.20, 11.04]
Subtotal (95% CI)	**169**	**269**		**85.1 %**	**0.99 [0.71, 1.38]**
Total events: 45 (LA-IPAA), 75 (Open-IPAA)					
Heterogeneity: Chi^2 = 8.25, df = 4 (P = 0.08); I^2 =52%					
Test for overall effect: Z = 0.05 (P = 0.96)					
2 Low-quality trials					
Araki 2001	7/21	4/11		8.3 %	0.92 [0.34, 2.46]
Brown 2001	1/12	0/13		0.8 %	3.23 [0.14, 72.46]
Hashimoto 2001	6/11	4/13		5.8 %	1.77 [0.67, 4.71]
Subtotal (95% CI)	**44**	**37**		**14.9 %**	**1.37 [0.70, 2.68]**
Total events: 14 (LA-IPAA), 8 (Open-IPAA)					
Heterogeneity: Chi^2 = 1.19, df = 2 (P = 0.55); I^2 =0.0%					
Test for overall effect: Z = 0.92 (P = 0.36)					
Total (95% CI)	**213**	**306**		**100.0 %**	**1.05 [0.78, 1.41]**
Total events: 59 (LA-IPAA), 83 (Open-IPAA)					
Heterogeneity: Chi^2 = 10.20, df = 7 (P = 0.18); I^2 =31%					
Test for overall effect: Z = 0.31 (P = 0.76)					

Analysis 2.4. Comparison 2 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding contemporary groups, Outcome 4 Total Complications.

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 2 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding contemporary groups

Outcome: 4 Total Complications

Study or subgroup	LA-IPAA n/N	Open-IPAA n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 High-quality trials					
Berdah 2004	4/12	3/12		3.1 %	1.33 [0.38, 4.72]
Dunker 2001	1/15	3/17		2.9 %	0.38 [0.04, 3.26]
Larson 2006	36/100	95/200		65.2 %	0.76 [0.56, 1.02]
Marcello 2000	4/20	5/20		5.1 %	0.80 [0.25, 2.55]
Schmitt 1994	15/22	7/20		7.5 %	1.95 [1.00, 3.78]
Subtotal (95% CI)	**169**	**269**		**83.9 %**	**0.88 [0.68, 1.13]**
Total events: 60 (LA-IPAA), 113 (Open-IPAA)					
Heterogeneity: Chi^2 = 7.53, df = 4 (P = 0.11); I^2 =47%					
Test for overall effect: Z = 1.02 (P = 0.31)					
2 Low-quality trials					
Araki 2001	11/21	7/11		9.5 %	0.82 [0.45, 1.51]
Brown 2001	2/12	2/13		2.0 %	1.08 [0.18, 6.53]
Hashimoto 2001	7/11	5/13		4.7 %	1.65 [0.73, 3.76]
Subtotal (95% CI)	**44**	**37**		**16.1 %**	**1.10 [0.68, 1.77]**
Total events: 20 (LA-IPAA), 14 (Open-IPAA)					
Heterogeneity: Chi^2 = 1.83, df = 2 (P = 0.40); I^2 =0.0%					
Test for overall effect: Z = 0.38 (P = 0.70)					
Total (95% CI)	**213**	**306**		**100.0 %**	**0.91 [0.73, 1.14]**
Total events: 80 (LA-IPAA), 127 (Open-IPAA)					
Heterogeneity: Chi^2 = 9.73, df = 7 (P = 0.20); I^2 =28%					
Test for overall effect: Z = 0.80 (P = 0.42)					

Analysis 2.5. Comparison 2 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding contemporary groups, Outcome 5 Operative time (minutes).

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 2 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding contemporary groups

Outcome: 5 Operative time (minutes)

Study or subgroup	LA-IPAA N	LA-IPAA Mean(SD)	Open-IPAA N	Open-IPAA Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
1 High-quality trials							
Berdah 2004	12	402.5 (35.96)	12	305 (42.1)		30.0 %	97.50 [66.17, 128.83]
Dunker 2001	15	292.3 (39)	17	159.9 (35)		32.1 %	132.40 [106.59, 158.21]
Subtotal (95% CI)	**27**		**29**			**62.1 %**	**116.12 [82.00, 150.25]**
Heterogeneity: Tau^2 = 394.55; Chi^2 = 2.84, df = 1 (P = 0.09); I^2 =65%							
Test for overall effect: Z = 6.67 (P < 0.00001)							
2 Low-quality trials							
Araki 2001	21	215 (141)	11	198 (112)		12.2 %	17.00 [-72.54, 106.54]
Otani 2001	10	377 (58.8)	18	308 (46.9)		25.7 %	69.00 [26.60, 111.40]
Subtotal (95% CI)	**31**		**29**			**37.9 %**	**58.57 [17.76, 99.38]**
Heterogeneity: Tau^2 = 74.49; Chi^2 = 1.06, df = 1 (P = 0.30); I^2 =6%							
Test for overall effect: Z = 2.81 (P = 0.0049)							
Total (95% CI)	**58**		**58**			**100.0 %**	**91.52 [53.36, 129.68]**
Heterogeneity: Tau^2 = 1008.13; Chi^2 = 11.02, df = 3 (P = 0.01); I^2 =73%							
Test for overall effect: Z = 4.70 (P < 0.00001)							

Analysis 2.6. Comparison 2 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding contemporary groups, Outcome 6 Blood loss (mL).

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 2 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding contemporary groups

Outcome: 6 Blood loss (mL)

Study or subgroup	LA-IPAA N	Mean(SD)	Open-IPAA N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
1 Low-quality trials							
Araki 2001	21	218 (268)	11	238 (102)		52.7 %	-20.00 [-149.51, 109.51]
Otani 2001	10	177 (142)	18	363 (262)		47.3 %	-186.00 [-335.65, -36.35]
Total (95% CI)	**31**		**29**			**100.0 %**	**-98.59 [-261.04, 63.86]**

Heterogeneity: Tau^2 = 8680.02; Chi^2 = 2.70, df = 1 (P = 0.10); I^2 =63%

Test for overall effect: Z = 1.19 (P = 0.23)

Analysis 2.7. Comparison 2 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding contemporary groups, Outcome 7 Time to regular diet (days).

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 2 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding contemporary groups

Outcome: 7 Time to regular diet (days)

Study or subgroup	LA-IPAA N	Mean(SD)	Open-IPAA N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 High-quality trials							
Dunker 2001	15	5.6 (1.3)	17	7 (2.2)		98.9 %	-1.40 [-2.64, -0.16]
Subtotal (95% CI)	**15**		**17**			**98.9 %**	**-1.40 [-2.64, -0.16]**
Heterogeneity: not applicable							
Test for overall effect: Z = 2.22 (P = 0.026)							
2 Low-quality trials							
Otani 2001	10	10.3 (3.5)	18	19.2 (25.3)		1.1 %	-8.90 [-20.79, 2.99]
Subtotal (95% CI)	**10**		**18**			**1.1 %**	**-8.90 [-20.79, 2.99]**
Heterogeneity: not applicable							
Test for overall effect: Z = 1.47 (P = 0.14)							
Total (95% CI)	**25**		**35**			**100.0 %**	**-1.48 [-2.71, -0.25]**
Heterogeneity: Chi^2 = 1.51, df = 1 (P = 0.22); I^2 =34%							
Test for overall effect: Z = 2.36 (P = 0.018)							
Test for subgroup differences: Chi^2 = 1.51, df = 1 (P = 0.22), I^2 =34%							

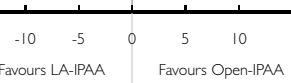
Analysis 2.8. Comparison 2 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding contemporary groups, Outcome 8 Hospital stay (days).

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 2 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding contemporary groups

Outcome: 8 Hospital stay (days)

Study or subgroup	LA-IPAA N	Mean(SD)	Open-IPAA N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 High-quality trial							
Berdah 2004	12	11.92 (3.68)	12	14.9 (6.3)		15.4 %	-2.98 [-7.11, 1.15]
Dunker 2001	15	9.9 (2.4)	17	12.5 (2.7)		84.0 %	-2.60 [-4.37, -0.83]
Subtotal (95% CI)	**27**		**29**			**99.4 %**	**-2.66 [-4.28, -1.03]**
Heterogeneity: Chi^2 = 0.03, df = 1 (P = 0.87); I^2 =0.0%							
Test for overall effect: Z = 3.21 (P = 0.0013)							
2 Low-quality trial							
Araki 2001	21	36.1 (31.4)	11	39.3 (28.3)		0.6 %	-3.20 [-24.65, 18.25]
Subtotal (95% CI)	**21**		**11**			**0.6 %**	**-3.20 [-24.65, 18.25]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.29 (P = 0.77)							
Total (95% CI)	**48**		**40**			**100.0 %**	**-2.66 [-4.28, -1.04]**
Heterogeneity: Chi^2 = 0.03, df = 2 (P = 0.99); I^2 =0.0%							
Test for overall effect: Z = 3.22 (P = 0.0013)							
Test for subgroup differences: Chi^2 = 0.00, df = 1 (P = 0.96), I^2 =0.0%							



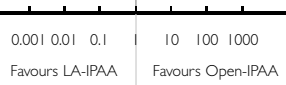
Analysis 2.9. Comparison 2 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding contemporary groups, Outcome 9 Reoperation.

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 2 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding contemporary groups

Outcome: 9 Reoperation

Study or subgroup	LA-IPAA n/N	Open-IPAA n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 High-quality trials					
Berdah 2004	0/12	1/12		11.5 %	0.33 [0.01, 7.45]
Dunker 2001	1/15	1/17		7.2 %	1.13 [0.08, 16.59]
Larson 2006	3/100	13/200		66.4 %	0.46 [0.13, 1.58]
Schmitt 1994	1/22	0/20		4.0 %	2.74 [0.12, 63.63]
Subtotal (95% CI)	**149**	**249**		**89.1 %**	**0.60 [0.23, 1.57]**
Total events: 5 (LA-IPAA), 15 (Open-IPAA)					
Heterogeneity: Chi^2 = 1.42, df = 3 (P = 0.70); I^2 =0.0%					
Test for overall effect: Z = 1.04 (P = 0.30)					
2 Low-quality trials					
Brown 2001	1/12	1/13		7.4 %	1.08 [0.08, 15.46]
Hashimoto 2001	1/11	0/13		3.5 %	3.50 [0.16, 78.19]
Subtotal (95% CI)	**23**	**26**		**10.9 %**	**1.87 [0.27, 13.04]**
Total events: 2 (LA-IPAA), 1 (Open-IPAA)					
Heterogeneity: Chi^2 = 0.32, df = 1 (P = 0.57); I^2 =0.0%					
Test for overall effect: Z = 0.63 (P = 0.53)					
Total (95% CI)	**172**	**275**		**100.0 %**	**0.74 [0.32, 1.71]**
Total events: 7 (LA-IPAA), 16 (Open-IPAA)					
Heterogeneity: Chi^2 = 2.62, df = 5 (P = 0.76); I^2 =0.0%					
Test for overall effect: Z = 0.70 (P = 0.48)					

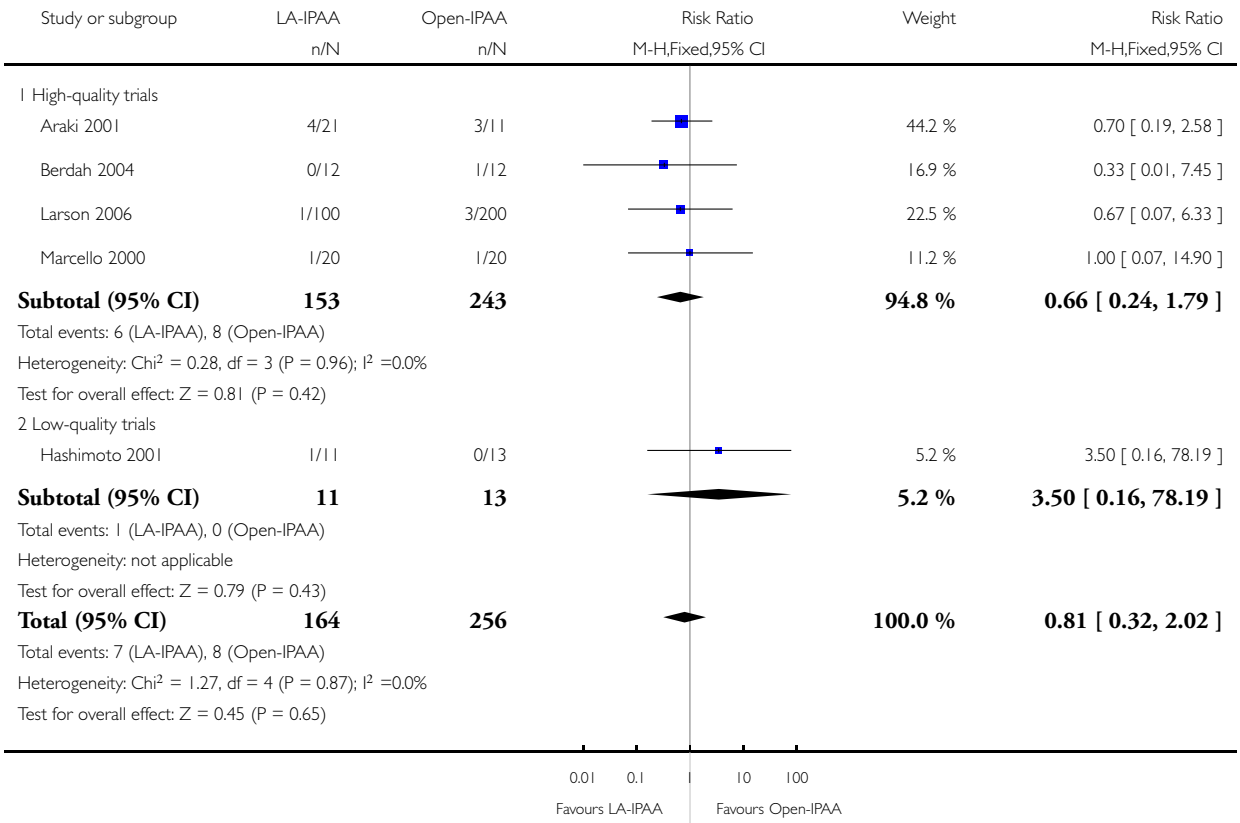


Analysis 3.1. Comparison 3 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding baseline equivalence, Outcome 1 Procedure specific complications.

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 3 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding baseline equivalence

Outcome: 1 Procedure specific complications

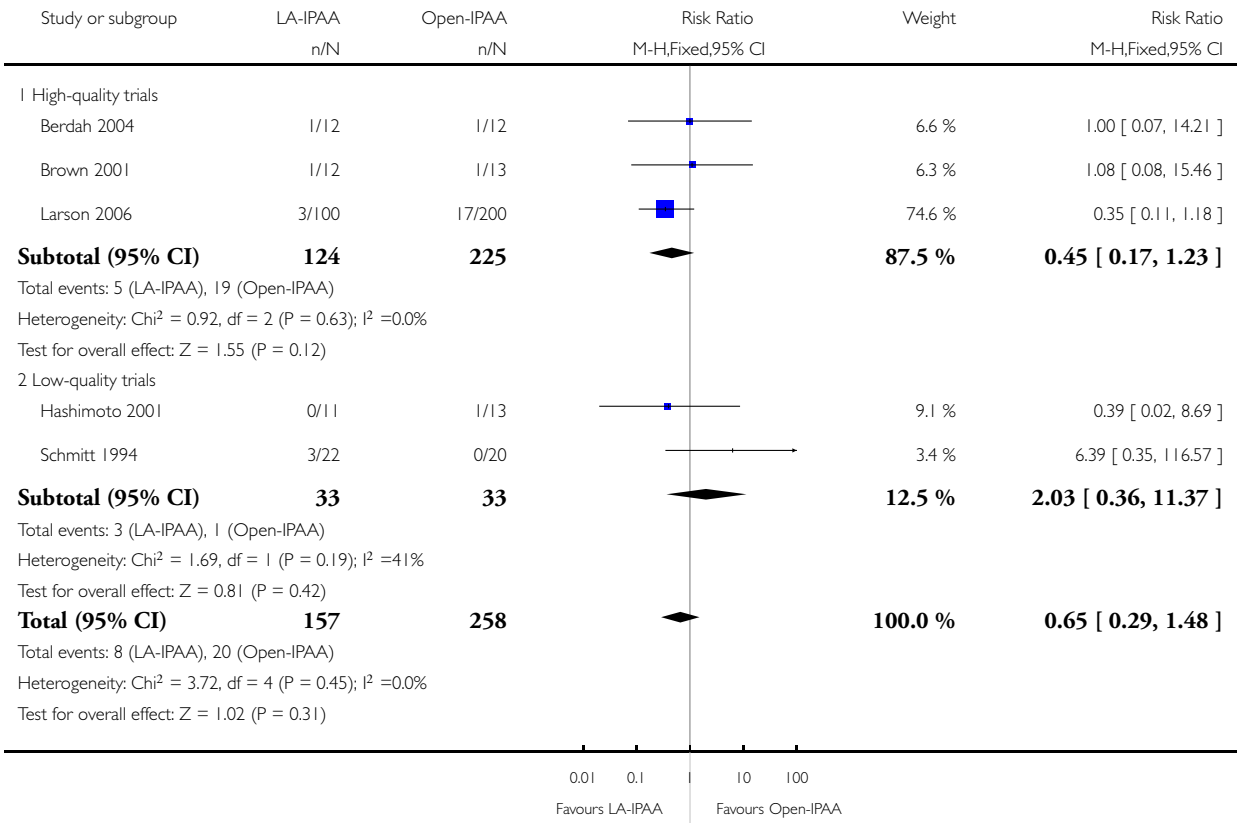


Analysis 3.2. Comparison 3 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding baseline equivalence, Outcome 2 Severe postoperative complications.

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 3 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding baseline equivalence

Outcome: 2 Severe postoperative complications



Analysis 3.3. Comparison 3 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding baseline equivalence, Outcome 3 Minor complications.

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 3 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding baseline equivalence

Outcome: 3 Minor complications

Study or subgroup	LA-IPAA n/N	Open-IPAA n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 High-quality trials					
Araki 2001	7/21	4/11		8.3 %	0.92 [0.34, 2.46]
Berdah 2004	3/12	1/12		1.6 %	3.00 [0.36, 24.92]
Brown 2001	1/12	0/13		0.8 %	3.23 [0.14, 72.46]
Larson 2006	26/100	64/200		67.7 %	0.81 [0.55, 1.20]
Marcello 2000	3/20	4/20		6.3 %	0.75 [0.19, 2.93]
Subtotal (95% CI)	**165**	**256**		**84.7 %**	**0.88 [0.63, 1.24]**
Total events: 40 (LA-IPAA), 73 (Open-IPAA)					
Heterogeneity: Chi^2 = 2.18, df = 4 (P = 0.70); I^2 =0.0%					
Test for overall effect: Z = 0.73 (P = 0.46)					
2 Low-quality trials					
Dunker 2001	1/15	3/17		4.5 %	0.38 [0.04, 3.26]
Hashimoto 2001	6/11	4/13		5.8 %	1.77 [0.67, 4.71]
Schmitt 1994	12/22	3/20		5.0 %	3.64 [1.20, 11.04]
Subtotal (95% CI)	**48**	**50**		**15.3 %**	**1.97 [1.01, 3.84]**
Total events: 19 (LA-IPAA), 10 (Open-IPAA)					
Heterogeneity: Chi^2 = 3.47, df = 2 (P = 0.18); I^2 =42%					
Test for overall effect: Z = 2.00 (P = 0.045)					
Total (95% CI)	**213**	**306**		**100.0 %**	**1.05 [0.78, 1.41]**
Total events: 59 (LA-IPAA), 83 (Open-IPAA)					
Heterogeneity: Chi^2 = 10.20, df = 7 (P = 0.18); I^2 =31%					
Test for overall effect: Z = 0.31 (P = 0.76)					

Analysis 3.4. Comparison 3 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding baseline equivalence, Outcome 4 Total Complications.

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 3 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding baseline equivalence

Outcome: 4 Total Complications

Study or subgroup	LA-IPAA n/N	Open-IPAA n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 High-quality trials					
Araki 2001	11/21	7/11		9.5 %	0.82 [0.45, 1.51]
Berdah 2004	4/12	3/12		3.1 %	1.33 [0.38, 4.72]
Brown 2001	2/12	2/13		2.0 %	1.08 [0.18, 6.53]
Larson 2006	36/100	95/200		65.2 %	0.76 [0.56, 1.02]
Marcello 2000	4/20	5/20		5.1 %	0.80 [0.25, 2.55]
Subtotal (95% CI)	**165**	**256**		**84.8 %**	**0.80 [0.62, 1.03]**
Total events: 57 (LA-IPAA), 112 (Open-IPAA)					
Heterogeneity: Chi^2 = 0.87, df = 4 (P = 0.93); I^2 =0.0%					
Test for overall effect: Z = 1.74 (P = 0.082)					
2 Low-quality trials					
Dunker 2001	1/15	3/17		2.9 %	0.38 [0.04, 3.26]
Hashimoto 2001	7/11	5/13		4.7 %	1.65 [0.73, 3.76]
Schmitt 1994	15/22	7/20		7.5 %	1.95 [1.00, 3.78]
Subtotal (95% CI)	**48**	**50**		**15.2 %**	**1.56 [0.95, 2.56]**
Total events: 23 (LA-IPAA), 15 (Open-IPAA)					
Heterogeneity: Chi^2 = 2.12, df = 2 (P = 0.35); I^2 =6%					
Test for overall effect: Z = 1.75 (P = 0.080)					
Total (95% CI)	**213**	**306**		**100.0 %**	**0.91 [0.73, 1.14]**
Total events: 80 (LA-IPAA), 127 (Open-IPAA)					
Heterogeneity: Chi^2 = 9.73, df = 7 (P = 0.20); I^2 =28%					
Test for overall effect: Z = 0.80 (P = 0.42)					

Analysis 3.5. Comparison 3 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding baseline equivalence, Outcome 5 Operative time (minutes).

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 3 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding baseline equivalence

Outcome: 5 Operative time (minutes)

Study or subgroup	LA-IPAA N	LA-IPAA Mean(SD)	Open-IPAA N	Open-IPAA Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
1 High-quality trials							
Araki 2001	21	215 (141)	11	198 (112)		12.2 %	17.00 [-72.54, 106.54]
Berdah 2004	12	402.5 (35.96)	12	305 (42.1)		30.0 %	97.50 [66.17, 128.83]
Subtotal (95% CI)	**33**		**23**			**42.2 %**	**68.63 [-7.05, 144.30]**
Heterogeneity: Tau^2 = 2068.86; Chi^2 = 2.77, df = 1 (P = 0.10); I^2 =64%							
Test for overall effect: Z = 1.78 (P = 0.075)							
2 Low-quality trials							
Dunker 2001	15	292.3 (39)	17	159.9 (35)		32.1 %	132.40 [106.59, 158.21]
Otani 2001	10	377 (58.8)	18	308 (46.9)		25.7 %	69.00 [26.60, 111.40]
Subtotal (95% CI)	**25**		**35**			**57.8 %**	**103.02 [41.06, 164.99]**
Heterogeneity: Tau^2 = 1689.08; Chi^2 = 6.27, df = 1 (P = 0.01); I^2 =84%							
Test for overall effect: Z = 3.26 (P = 0.0011)							
Total (95% CI)	**58**		**58**			**100.0 %**	**91.52 [53.36, 129.68]**
Heterogeneity: Tau^2 = 1008.13; Chi^2 = 11.02, df = 3 (P = 0.01); I^2 =73%							
Test for overall effect: Z = 4.70 (P < 0.00001)							

Analysis 3.6. Comparison 3 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding baseline equivalence, Outcome 6 Blood loss (mL).

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 3 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding baseline equivalence

Outcome: 6 Blood loss (mL)

Study or subgroup	LA-IPAA N	LA-IPAA Mean(SD)	Open-IPAA N	Open-IPAA Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
1 High-quality trials							
Araki 2001	21	218 (268)	11	238 (102)		52.7 %	-20.00 [-149.51, 109.51]
Subtotal (95% CI)	**21**		**11**			**52.7 %**	**-20.00 [-149.51, 109.51]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.30 (P = 0.76)							
2 Low-quality trials							
Otani 2001	10	177 (142)	18	363 (262)		47.3 %	-186.00 [-335.65, -36.35]
Subtotal (95% CI)	**10**		**18**			**47.3 %**	**-186.00 [-335.65, -36.35]**
Heterogeneity: not applicable							
Test for overall effect: Z = 2.44 (P = 0.015)							
Total (95% CI)	**31**		**29**			**100.0 %**	**-98.59 [-261.04, 63.86]**
Heterogeneity: Tau^2 = 8680.02; Chi^2 = 2.70, df = 1 (P = 0.10); I^2 =63%							
Test for overall effect: Z = 1.19 (P = 0.23)							

Analysis 3.7. Comparison 3 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding baseline equivalence, Outcome 7 Time to regular diet (days).

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 3 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding baseline equivalence

Outcome: 7 Time to regular diet (days)

Study or subgroup	LA-IPAA N	Mean(SD)	Open-IPAA N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 Low-quality trials							
Dunker 2001	15	5.6 (1.3)	17	7 (2.2)		98.9 %	-1.40 [-2.64, -0.16]
Otani 2001	10	10.3 (3.5)	18	19.2 (25.3)		1.1 %	-8.90 [-20.79, 2.99]
Total (95% CI)	**25**		**35**			**100.0 %**	**-1.48 [-2.71, -0.25]**

Heterogeneity: Chi^2 = 1.51, df = 1 (P = 0.22); I^2 =34%

Test for overall effect: Z = 2.36 (P = 0.018)

Test for subgroup differences: Not applicable

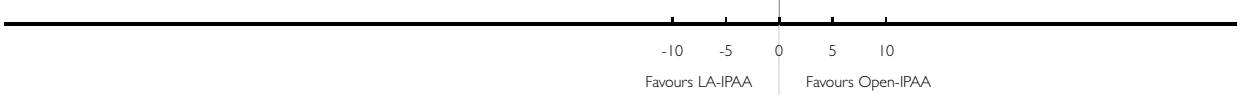
Analysis 3.8. Comparison 3 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding baseline equivalence, Outcome 8 Hospital stay (days).

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 3 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding baseline equivalence

Outcome: 8 Hospital stay (days)

Study or subgroup	LA-IPAA N	Mean(SD)	Open-IPAA N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 High-quality trial							
Araki 2001	21	36.1 (31.4)	11	39.3 (28.3)		0.6 %	-3.20 [-24.65, 18.25]
Berdah 2004	12	11.92 (3.68)	12	14.9 (6.3)		15.4 %	-2.98 [-7.11, 1.15]
Subtotal (95% CI)	**33**		**23**			**16.0 %**	**-2.99 [-7.04, 1.07]**
Heterogeneity: Chi^2 = 0.00, df = 1 (P = 0.98); I^2 =0.0%							
Test for overall effect: Z = 1.44 (P = 0.15)							
2 Low-quality trial							
Dunker 2001	15	9.9 (2.4)	17	12.5 (2.7)		84.0 %	-2.60 [-4.37, -0.83]
Subtotal (95% CI)	**15**		**17**			**84.0 %**	**-2.60 [-4.37, -0.83]**
Heterogeneity: not applicable							
Test for overall effect: Z = 2.88 (P = 0.0039)							
Total (95% CI)	**48**		**40**			**100.0 %**	**-2.66 [-4.28, -1.04]**
Heterogeneity: Chi^2 = 0.03, df = 2 (P = 0.99); I^2 =0.0%							
Test for overall effect: Z = 3.22 (P = 0.0013)							
Test for subgroup differences: Chi^2 = 0.03, df = 1 (P = 0.86), I^2 =0.0%							



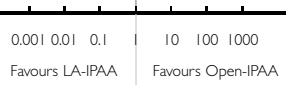
Analysis 3.9. Comparison 3 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding baseline equivalence, Outcome 9 Reoperation.

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 3 LA-IPAA vs Open-IPAA - high-quality and low-quality trials regarding baseline equivalence

Outcome: 9 Reoperation

Study or subgroup	LA-IPAA n/N	Open-IPAA n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 High-quality trials					
Berdah 2004	0/12	1/12		11.5 %	0.33 [0.01, 7.45]
Brown 2001	1/12	1/13		7.4 %	1.08 [0.08, 15.46]
Larson 2006	3/100	13/200		66.4 %	0.46 [0.13, 1.58]
Subtotal (95% CI)	**124**	**225**		**85.3 %**	**0.50 [0.18, 1.41]**
Total events: 4 (LA-IPAA), 15 (Open-IPAA)					
Heterogeneity: Chi^2 = 0.41, df = 2 (P = 0.82); I^2 =0.0%					
Test for overall effect: Z = 1.31 (P = 0.19)					
2 Low-quality trials					
Dunker 2001	1/15	1/17		7.2 %	1.13 [0.08, 16.59]
Hashimoto 2001	1/11	0/13		3.5 %	3.50 [0.16, 78.19]
Schmitt 1994	1/22	0/20		4.0 %	2.74 [0.12, 63.63]
Subtotal (95% CI)	**48**	**50**		**14.7 %**	**2.14 [0.41, 11.25]**
Total events: 3 (LA-IPAA), 1 (Open-IPAA)					
Heterogeneity: Chi^2 = 0.34, df = 2 (P = 0.85); I^2 =0.0%					
Test for overall effect: Z = 0.90 (P = 0.37)					
Total (95% CI)	**172**	**275**		**100.0 %**	**0.74 [0.32, 1.71]**
Total events: 7 (LA-IPAA), 16 (Open-IPAA)					
Heterogeneity: Chi^2 = 2.62, df = 5 (P = 0.76); I^2 =0.0%					
Test for overall effect: Z = 0.70 (P = 0.48)					

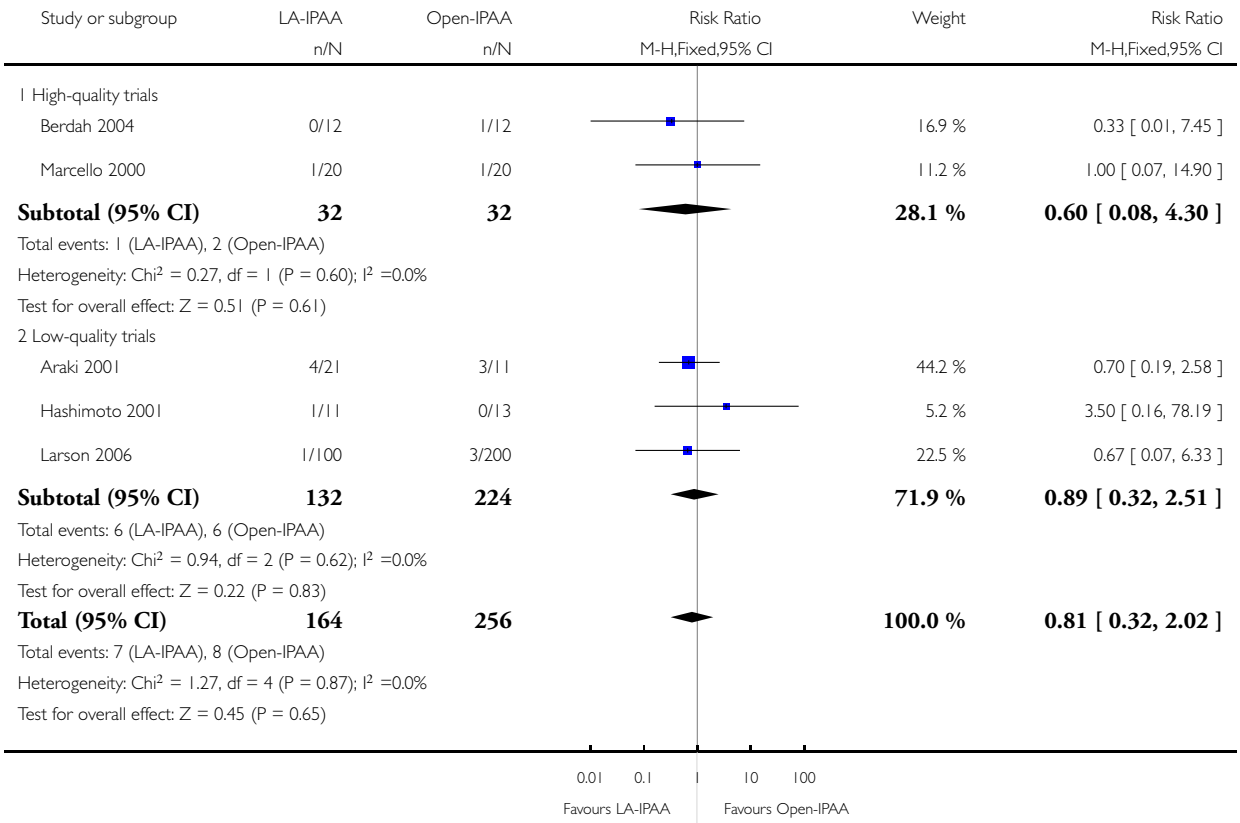


Analysis 4.1. Comparison 4 LA-IPAA vs Open-IPAA - highest-quality trials versus other trials, Outcome 1 Procedure specific complications.

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 4 LA-IPAA vs Open-IPAA - highest-quality trials versus other trials

Outcome: 1 Procedure specific complications



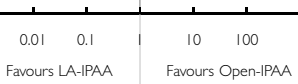
Analysis 4.2. Comparison 4 LA-IPAA vs Open-IPAA - highest-quality trials versus other trials, Outcome 2 Severe postoperative complications.

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 4 LA-IPAA vs Open-IPAA - highest-quality trials versus other trials

Outcome: 2 Severe postoperative complications

Study or subgroup	LA-IPAA n/N	Open-IPAA n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 High-quality trials					
Berdah 2004	1/12	1/12		6.6 %	1.00 [0.07, 14.21]
Subtotal (95% CI)	**12**	**12**		**6.6 %**	**1.00 [0.07, 14.21]**
Total events: 1 (LA-IPAA), 1 (Open-IPAA)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.0 (P = 1.0)					
2 Low-quality trials					
Brown 2001	1/12	1/13		6.3 %	1.08 [0.08, 15.46]
Hashimoto 2001	0/11	1/13		9.1 %	0.39 [0.02, 8.69]
Larson 2006	3/100	17/200		74.6 %	0.35 [0.11, 1.18]
Schmitt 1994	3/22	0/20		3.4 %	6.39 [0.35, 116.57]
Subtotal (95% CI)	**145**	**246**		**93.4 %**	**0.63 [0.26, 1.49]**
Total events: 7 (LA-IPAA), 19 (Open-IPAA)					
Heterogeneity: Chi^2 = 3.59, df = 3 (P = 0.31); I^2 =16%					
Test for overall effect: Z = 1.05 (P = 0.29)					
Total (95% CI)	**157**	**258**		**100.0 %**	**0.65 [0.29, 1.48]**
Total events: 8 (LA-IPAA), 20 (Open-IPAA)					
Heterogeneity: Chi^2 = 3.72, df = 4 (P = 0.45); I^2 =0.0%					
Test for overall effect: Z = 1.02 (P = 0.31)					



Analysis 4.3. Comparison 4 LA-IPAA vs Open-IPAA - highest-quality trials versus other trials, Outcome 3 Minor complications.

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 4 LA-IPAA vs Open-IPAA - highest-quality trials versus other trials

Outcome: 3 Minor complications

Study or subgroup	LA-IPAA n/N	Open-IPAA n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 High-quality trials					
Berdah 2004	3/12	1/12		1.6 %	3.00 [0.36, 24.92]
Marcello 2000	3/20	4/20		6.3 %	0.75 [0.19, 2.93]
Subtotal (95% CI)	**32**	**32**		**7.9 %**	**1.20 [0.40, 3.57]**
Total events: 6 (LA-IPAA), 5 (Open-IPAA)					
Heterogeneity: Chi² = 1.18, df = 1 (P = 0.28); I² =15%					
Test for overall effect: Z = 0.33 (P = 0.74)					
2 Low-quality trials					
Araki 2001	7/21	4/11		8.3 %	0.92 [0.34, 2.46]
Brown 2001	1/12	0/13		0.8 %	3.23 [0.14, 72.46]
Dunker 2001	1/15	3/17		4.5 %	0.38 [0.04, 3.26]
Hashimoto 2001	6/11	4/13		5.8 %	1.77 [0.67, 4.71]
Larson 2006	26/100	64/200		67.7 %	0.81 [0.55, 1.20]
Schmitt 1994	12/22	3/20		5.0 %	3.64 [1.20, 11.04]
Subtotal (95% CI)	**181**	**274**		**92.1 %**	**1.03 [0.76, 1.41]**
Total events: 53 (LA-IPAA), 78 (Open-IPAA)					
Heterogeneity: Chi² = 8.99, df = 5 (P = 0.11); I² =44%					
Test for overall effect: Z = 0.21 (P = 0.83)					
Total (95% CI)	**213**	**306**		**100.0 %**	**1.05 [0.78, 1.41]**
Total events: 59 (LA-IPAA), 83 (Open-IPAA)					
Heterogeneity: Chi² = 10.20, df = 7 (P = 0.18); I² =31%					
Test for overall effect: Z = 0.31 (P = 0.76)					

Analysis 4.4. Comparison 4 LA-IPAA vs Open-IPAA - highest-quality trials versus other trials, Outcome 4 Total Complications.

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 4 LA-IPAA vs Open-IPAA - highest-quality trials versus other trials

Outcome: 4 Total Complications

Study or subgroup	LA-IPAA n/N	Open-IPAA n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 High-quality trials					
Berdah 2004	4/12	3/12		3.1 %	1.33 [0.38, 4.72]
Marcello 2000	4/20	5/20		5.1 %	0.80 [0.25, 2.55]
Subtotal (95% CI)	**32**	**32**		**8.2 %**	**1.00 [0.43, 2.34]**
Total events: 8 (LA-IPAA), 8 (Open-IPAA)					
Heterogeneity: Chi^2 = 0.34, df = 1 (P = 0.56); I^2 =0.0%					
Test for overall effect: Z = 0.0 (P = 1.0)					
2 Low-quality trials					
Araki 2001	11/21	7/11		9.5 %	0.82 [0.45, 1.51]
Brown 2001	2/12	2/13		2.0 %	1.08 [0.18, 6.53]
Dunker 2001	1/15	3/17		2.9 %	0.38 [0.04, 3.26]
Hashimoto 2001	7/11	5/13		4.7 %	1.65 [0.73, 3.76]
Larson 2006	36/100	95/200		65.2 %	0.76 [0.56, 1.02]
Schmitt 1994	15/22	7/20		7.5 %	1.95 [1.00, 3.78]
Subtotal (95% CI)	**181**	**274**		**91.8 %**	**0.90 [0.72, 1.14]**
Total events: 72 (LA-IPAA), 119 (Open-IPAA)					
Heterogeneity: Chi^2 = 9.35, df = 5 (P = 0.10); I^2 =47%					
Test for overall effect: Z = 0.85 (P = 0.40)					
Total (95% CI)	**213**	**306**		**100.0 %**	**0.91 [0.73, 1.14]**
Total events: 80 (LA-IPAA), 127 (Open-IPAA)					
Heterogeneity: Chi^2 = 9.73, df = 7 (P = 0.20); I^2 =28%					
Test for overall effect: Z = 0.80 (P = 0.42)					

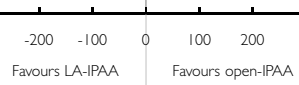
Analysis 4.5. Comparison 4 LA-IPAA vs Open-IPAA - highest-quality trials versus other trials, Outcome 5 Operative time (minutes).

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 4 LA-IPAA vs Open-IPAA - highest-quality trials versus other trials

Outcome: 5 Operative time (minutes)

Study or subgroup	LA-IPAA N	Mean(SD)	Open-IPAA N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
1 High-quality trials							
Berdah 2004	12	402.5 (35.96)	12	305 (42.1)		30.0 %	97.50 [66.17, 128.83]
Subtotal (95% CI)	**12**		**12**			**30.0 %**	**97.50 [66.17, 128.83]**
Heterogeneity: not applicable							
Test for overall effect: Z = 6.10 (P < 0.00001)							
2 Low-quality trials							
Araki 2001	21	215 (141)	11	198 (112)		12.2 %	17.00 [-72.54, 106.54]
Dunker 2001	15	292.3 (39)	17	159.9 (35)		32.1 %	132.40 [106.59, 158.21]
Otani 2001	10	377 (58.8)	18	308 (46.9)		25.7 %	69.00 [26.60, 111.40]
Subtotal (95% CI)	**46**		**46**			**70.0 %**	**83.03 [21.45, 144.61]**
Heterogeneity: Tau^2 = 2244.88; Chi^2 = 10.63, df = 2 (P = 0.005); I^2 =81%							
Test for overall effect: Z = 2.64 (P = 0.0082)							
Total (95% CI)	**58**		**58**			**100.0 %**	**91.52 [53.36, 129.68]**
Heterogeneity: Tau^2 = 1008.13; Chi^2 = 11.02, df = 3 (P = 0.01); I^2 =73%							
Test for overall effect: Z = 4.70 (P < 0.00001)							



Analysis 4.6. Comparison 4 LA-IPAA vs Open-IPAA - highest-quality trials versus other trials, Outcome 6 Blood loss (mL).

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 4 LA-IPAA vs Open-IPAA - highest-quality trials versus other trials

Outcome: 6 Blood loss (mL)

Study or subgroup	LA-IPAA N	Mean(SD)	Open-IPAA N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
1 Low-quality trials							
Araki 2001	21	218 (268)	11	238 (102)		52.7 %	-20.00 [-149.51, 109.51]
Otani 2001	10	177 (142)	18	363 (262)		47.3 %	-186.00 [-335.65, -36.35]
Total (95% CI)	**31**		**29**			**100.0 %**	**-98.59 [-261.04, 63.86]**

Heterogeneity: $Tau^2 = 8680.02$; $Chi^2 = 2.70$, df = 1 (P = 0.10); $I^2 = 63\%$

Test for overall effect: Z = 1.19 (P = 0.23)

Analysis 4.7. Comparison 4 LA-IPAA vs Open-IPAA - highest-quality trials versus other trials, Outcome 7 Time to regular diet (days).

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 4 LA-IPAA vs Open-IPAA - highest-quality trials versus other trials

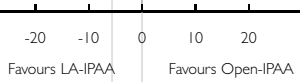
Outcome: 7 Time to regular diet (days)

Study or subgroup	LA-IPAA N	Mean(SD)	Open-IPAA N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 Low-quality trials							
Dunker 2001	15	5.6 (1.3)	17	7 (2.2)		98.9 %	-1.40 [-2.64, -0.16]
Otani 2001	10	10.3 (3.5)	18	19.2 (25.3)		1.1 %	-8.90 [-20.79, 2.99]
Total (95% CI)	**25**		**35**			**100.0 %**	**-1.48 [-2.71, -0.25]**

Heterogeneity: $Chi^2 = 1.51$, df = 1 (P = 0.22); $I^2 = 34\%$

Test for overall effect: Z = 2.36 (P = 0.018)

Test for subgroup differences: Not applicable



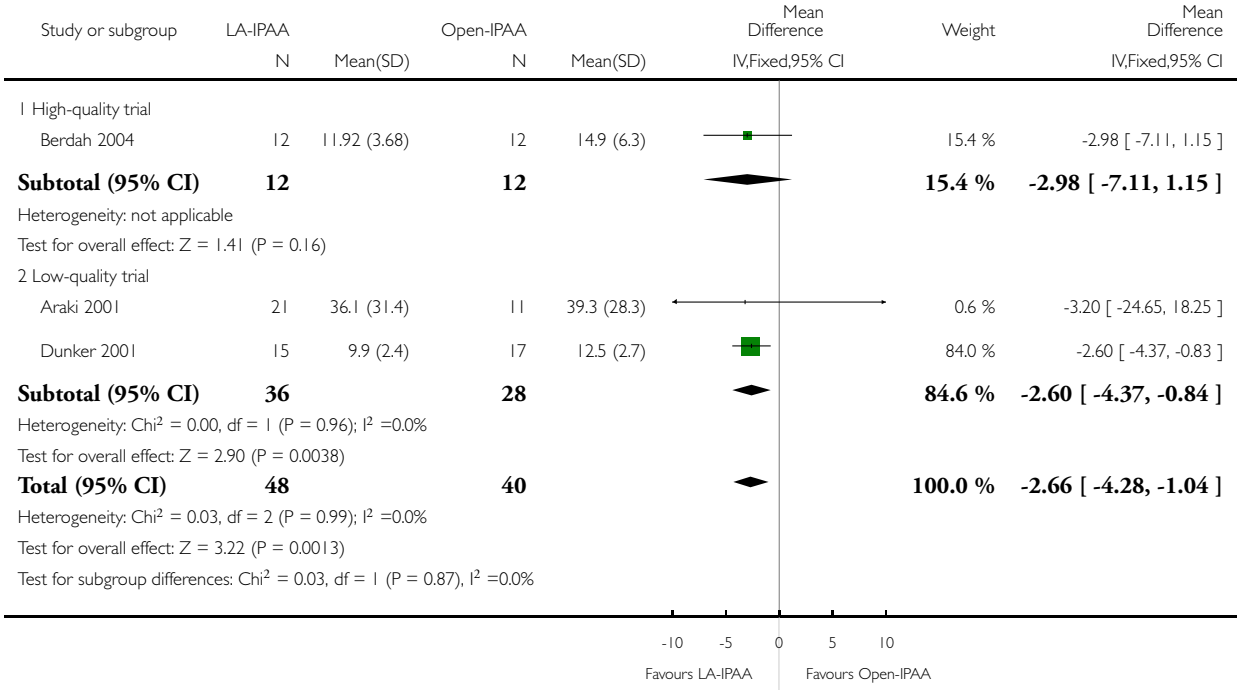
Analysis 4.8. Comparison 4 LA-IPAA vs Open-IPAA - highest-quality trials versus other trials, Outcome 8 Hospital stay (days).

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 4 LA-IPAA vs Open-IPAA - highest-quality trials versus other trials

Outcome: 8 Hospital stay (days)

Study or subgroup	LA-IPAA N	Mean(SD)	Open-IPAA N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 High-quality trial							
Berdah 2004	12	11.92 (3.68)	12	14.9 (6.3)		15.4 %	-2.98 [-7.11, 1.15]
Subtotal (95% CI)	**12**		**12**			**15.4 %**	**-2.98 [-7.11, 1.15]**
Heterogeneity: not applicable							
Test for overall effect: Z = 1.41 (P = 0.16)							
2 Low-quality trial							
Araki 2001	21	36.1 (31.4)	11	39.3 (28.3)		0.6 %	-3.20 [-24.65, 18.25]
Dunker 2001	15	9.9 (2.4)	17	12.5 (2.7)		84.0 %	-2.60 [-4.37, -0.83]
Subtotal (95% CI)	**36**		**28**			**84.6 %**	**-2.60 [-4.37, -0.84]**
Heterogeneity: Chi^2 = 0.00, df = 1 (P = 0.96); I^2 =0.0%							
Test for overall effect: Z = 2.90 (P = 0.0038)							
Total (95% CI)	**48**		**40**			**100.0 %**	**-2.66 [-4.28, -1.04]**
Heterogeneity: Chi^2 = 0.03, df = 2 (P = 0.99); I^2 =0.0%							
Test for overall effect: Z = 3.22 (P = 0.0013)							
Test for subgroup differences: Chi^2 = 0.03, df = 1 (P = 0.87), I^2 =0.0%							



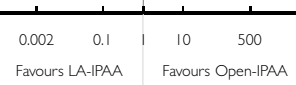
Analysis 4.9. Comparison 4 LA-IPAA vs Open-IPAA - highest-quality trials versus other trials, Outcome 9 Reoperation.

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 4 LA-IPAA vs Open-IPAA - highest-quality trials versus other trials

Outcome: 9 Reoperation

Study or subgroup	LA-IPAA n/N	Open-IPAA n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 High-quality trials					
Berdah 2004	0/12	1/12		11.5 %	0.33 [0.01, 7.45]
Subtotal (95% CI)	**12**	**12**		**11.5 %**	**0.33 [0.01, 7.45]**
Total events: 0 (LA-IPAA), 1 (Open-IPAA)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.69 (P = 0.49)					
2 Low-quality trials					
Brown 2001	1/12	1/13		7.4 %	1.08 [0.08, 15.46]
Dunker 2001	1/15	1/17		7.2 %	1.13 [0.08, 16.59]
Hashimoto 2001	1/11	0/13		3.5 %	3.50 [0.16, 78.19]
Larson 2006	3/100	13/200		66.4 %	0.46 [0.13, 1.58]
Schmitt 1994	1/22	0/20		4.0 %	2.74 [0.12, 63.63]
Subtotal (95% CI)	**160**	**263**		**88.5 %**	**0.79 [0.33, 1.91]**
Total events: 7 (LA-IPAA), 15 (Open-IPAA)					
Heterogeneity: Chi^2 = 2.34, df = 4 (P = 0.67); I^2 =0.0%					
Test for overall effect: Z = 0.52 (P = 0.60)					
Total (95% CI)	**172**	**275**		**100.0 %**	**0.74 [0.32, 1.71]**
Total events: 7 (LA-IPAA), 16 (Open-IPAA)					
Heterogeneity: Chi^2 = 2.62, df = 5 (P = 0.76); I^2 =0.0%					
Test for overall effect: Z = 0.70 (P = 0.48)					



Analysis 5.1. Comparison 5 LA-IPAA vs Open-IPAA - sensitivity analsyses, Outcome 1 Sensitivity analysis 1: Imputing means and standard deviations in operative time (minutes).

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

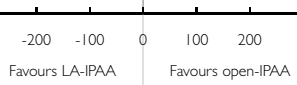
Comparison: 5 LA-IPAA vs Open-IPAA - sensitivity analsyses

Outcome: 1 Sensitivity analysis 1: Imputing means and standard deviations in operative time (minutes)

Study or subgroup	LA-IPAA N	Mean(SD)	Open-IPAA N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Araki 2001	21	215 (141)	11	198 (112)		4.6 %	17.00 [-72.54, 106.54]
Berdah 2004	12	402.5 (35.96)	12	305 (42.1)		12.4 %	97.50 [66.17, 128.83]
Brown 2001	12	161.25 (39.51)	13	123.75 (21.76)		13.5 %	37.50 [12.21, 62.79]
Dunker 2001	15	292.3 (39)	17	159.9 (35)		13.4 %	132.40 [106.59, 158.21]
Hashimoto 2001	11	500 (62.55)	13	431 (110.97)		6.3 %	69.00 [-1.75, 139.75]
Larson 2006	100	333 (68.17)	200	230 (47.83)		15.2 %	103.00 [88.08, 117.92]
Marcello 2000	20	330 (75)	20	232.5 (30)		11.6 %	97.50 [62.10, 132.90]
Otani 2001	10	377 (58.8)	18	308 (46.9)		10.3 %	69.00 [26.60, 111.40]
Schmitt 1994	22	232.5 (52.5)	20	165 (45)		12.7 %	67.50 [38.00, 97.00]
Total (95% CI)	**223**		**324**			**100.0 %**	**82.66 [59.99, 105.33]**

Heterogeneity: $Tau^2 = 824.97$; $Chi^2 = 36.29$, df = 8 (P = 0.00002); $I^2 = 78\%$

Test for overall effect: Z = 7.15 (P < 0.00001)



Analysis 5.2. Comparison 5 LA-IPAA vs Open-IPAA - sensitivity analsyses, Outcome 2 Sensitivity analysis 2: Imputing means and standard deviations in blood loss (mL).

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 5 LA-IPAA vs Open-IPAA - sensitivity analsyses

Outcome: 2 Sensitivity analysis 2: Imputing means and standard deviations in blood loss (mL)

Study or subgroup	LA-IPAA N	Mean(SD)	Open-IPAA N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Araki 2001	21	218 (268)	11	238 (102)		31.7 %	-20.00 [-149.51, 109.51]
Hashimoto 2001	11	442.25 (271.68)	13	693 (369.01)		11.9 %	-250.75 [-507.68, 6.18]
Marcello 2000	20	325 (150)	20	500 (275)		29.7 %	-175.00 [-312.28, -37.72]
Otani 2001	10	177 (142)	18	363 (262)		26.7 %	-186.00 [-335.65, -36.35]
Total (95% CI)	**62**		**62**			**100.0 %**	**-137.75 [-234.64, -40.86]**

Heterogeneity: Tau² = 3331.90; Chi² = 4.57, df = 3 (P = 0.21); I² =34%

Test for overall effect: Z = 2.79 (P = 0.0053)

Analysis 5.3. Comparison 5 LA-IPAA vs Open-IPAA - sensitivity analsyses, Outcome 3 Sensitivity analysis 3: Imputing means and standard deviations in time to bowel movement (days).

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 5 LA-IPAA vs Open-IPAA - sensitivity analsyses

Outcome: 3 Sensitivity analysis 3: Imputing means and standard deviations in time to bowel movement (days)

Study or subgroup	LA-IPAA N	Mean(SD)	Open-IPAA N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Araki 2001	21	1.7 (1.5)	11	5.4 (4.9)		16.9 %	-3.70 [-6.67, -0.73]
Larson 2006	100	2 (1)	200	3 (0.83)		49.9 %	-1.00 [-1.23, -0.77]
Marcello 2000	20	3 (1.75)	20	5.5 (3)		33.2 %	-2.50 [-4.02, -0.98]
Total (95% CI)	**141**		**231**			**100.0 %**	**-1.96 [-3.45, -0.46]**

Heterogeneity: Tau² = 1.16; Chi² = 6.74, df = 2 (P = 0.03); I² =70%

Test for overall effect: Z = 2.56 (P = 0.011)

Analysis 5.4. Comparison 5 LA-IPAA vs Open-IPAA - sensitivity analsyses, Outcome 4 Sensitivity analysis 4: Imputing means and standard deviations in time to regular diet (days).

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 5 LA-IPAA vs Open-IPAA - sensitivity analsyses

Outcome: 4 Sensitivity analysis 4: Imputing means and standard deviations in time to regular diet (days)

Study or subgroup	LA-IPAA N	Mean(SD)	Open-IPAA N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Brown 2001	12	5 (2.04)	13	6.5 (4.29)		7.7 %	-1.50 [-4.10, 1.10]
Dunker 2001	15	5.6 (1.3)	17	7 (2.2)		22.9 %	-1.40 [-2.64, -0.16]
Hashimoto 2001	11	3.8 (1.16)	13	4.4 (1.44)		27.4 %	-0.60 [-1.64, 0.44]
Larson 2006	100	3 (1.67)	200	5 (3.3)		41.6 %	-2.00 [-2.56, -1.44]
Otani 2001	10	10.3 (3.5)	18	19.2 (25.3)		0.4 %	-8.90 [-20.79, 2.99]
Total (95% CI)	**148**		**261**			**100.0 %**	**-1.47 [-2.25, -0.69]**

Heterogeneity: $Tau^2 = 0.30$; $Chi^2 = 7.00$, df = 4 (P = 0.14); $I^2 = 43\%$

Test for overall effect: Z = 3.68 (P = 0.00023)

Analysis 5.5. Comparison 5 LA-IPAA vs Open-IPAA - sensitivity analsyses, Outcome 5 Sensitivity analysis 5: Imputing means and standard deviations in hospital stay (days).

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

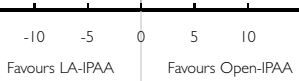
Comparison: 5 LA-IPAA vs Open-IPAA - sensitivity analsyses

Outcome: 5 Sensitivity analysis 5: Imputing means and standard deviations in hospital stay (days)

Study or subgroup	LA-IPAA N	Mean(SD)	Open-IPAA N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Araki 2001	21	36.1 (31.4)	11	39.3 (28.3)		0.2 %	-3.20 [-24.65, 18.25]
Berdah 2004	12	11.92 (3.68)	12	14.9 (6.3)		5.0 %	-2.98 [-7.11, 1.15]
Brown 2001	12	8.75 (3.54)	13	8.5 (3.33)		9.9 %	0.25 [-2.45, 2.95]
Dunker 2001	15	9.9 (2.4)	17	12.5 (2.7)		16.8 %	-2.60 [-4.37, -0.83]
Hashimoto 2001	11	24.3 (6.64)	13	32.4 (8.97)		2.4 %	-8.10 [-14.36, -1.84]
Larson 2006	100	4 (3.17)	200	7 (4.67)		27.4 %	-3.00 [-3.90, -2.10]
Marcello 2000	20	8 (2.5)	20	9.75 (2.75)		18.2 %	-1.75 [-3.38, -0.12]
Schmitt 1994	22	9.35 (1.5)	20	10.45 (3)		20.1 %	-1.10 [-2.56, 0.36]
Total (95% CI)	**213**		**306**			**100.0 %**	**-2.12 [-3.12, -1.12]**

Heterogeneity: Tau² = 0.74; Chi² = 12.33, df = 7 (P = 0.09); I² =43%

Test for overall effect: Z = 4.15 (P = 0.000033)



Analysis 5.6. Comparison 5 LA-IPAA vs Open-IPAA - sensitivity analsyses, Outcome 6 Sensitivity analysis 6: Imputing means and standard deviations in incision length (cm).

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 5 LA-IPAA vs Open-IPAA - sensitivity analsyses

Outcome: 6 Sensitivity analysis 6: Imputing means and standard deviations in incision length (cm)

Study or subgroup	LA-IPAA N	Mean(SD)	Open-IPAA N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Brown 2001	12	9.5 (3.23)	13	16.5 (3.75)		47.7 %	-7.00 [-9.74, -4.26]
Dunker 2001	15	15.4 (3.9)	17	23.9 (3.6)		52.3 %	-8.50 [-11.11, -5.89]
Total (95% CI)	**27**		**30**			**100.0 %**	**-7.79 [-9.68, -5.90]**

Heterogeneity: $Chi^2 = 0.60$, df = 1 (P = 0.44); $I^2 = 0.0\%$

Test for overall effect: Z = 8.07 (P < 0.00001)

Test for subgroup differences: Not applicable

Analysis 5.7. Comparison 5 LA-IPAA vs Open-IPAA - sensitivity analsyses, Outcome 7 Sensitivity analysis 8: Imputing means and standard deviations in defecation frequency day (times/day).

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

Comparison: 5 LA-IPAA vs Open-IPAA - sensitivity analsyses

Outcome: 7 Sensitivity analysis 8: Imputing means and standard deviations in defecation frequency day (times/day)

Study or subgroup	LA-IPAA N	Mean(SD)	Open-IPAA N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Dunker 2001	15	5.7 (1.3)	17	6.3 (2)		50.7 %	-0.60 [-1.76, 0.56]
Larson 2005	33	7 (2.75)	33	6 (2.25)		49.3 %	1.00 [-0.21, 2.21]
Total (95% CI)	**48**		**50**			**100.0 %**	**0.19 [-1.38, 1.76]**

Heterogeneity: $Tau^2 = 0.91$; $Chi^2 = 3.50$, df = 1 (P = 0.06); $I^2 = 71\%$

Test for overall effect: Z = 0.24 (P = 0.81)

Analysis 5.8. Comparison 5 LA-IPAA vs Open-IPAA - sensitivity analsyses, Outcome 8 Sensitivity analysis 9: Imputing means and standard deviations in defecation frequency night (times/night).

Review: Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis

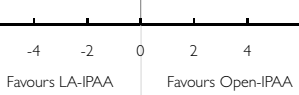
Comparison: 5 LA-IPAA vs Open-IPAA - sensitivity analsyses

Outcome: 8 Sensitivity analysis 9: Imputing means and standard deviations in defecation frequency night (times/night)

Study or subgroup	LA-IPAA N	Mean(SD)	Open-IPAA N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Dunker 2001	15	1 (0.7)	17	1.3 (0.7)		48.6 %	-0.30 [-0.79, 0.19]
Larson 2005	33	1 (1)	33	2 (0.75)		51.4 %	-1.00 [-1.43, -0.57]
Total (95% CI)	**48**		**50**			**100.0 %**	**-0.66 [-1.35, 0.03]**

Heterogeneity: Tau² = 0.19; Chi² = 4.50, df = 1 (P = 0.03); I² =78%

Test for overall effect: Z = 1.89 (P = 0.059)



ADDITIONAL TABLES

Table 1. Search strategies

Database	Search strategy	Time span of search	Hits
The Cochrane Library	((ulcerative colitis OR colitis ulcerosa OR "uc" OR "ibd" OR inflammatory bowel disease) OR (familial adenomatous polyposis OR familial polyposis OR adenomatous polyposis coli OR polyposis coli OR FAP)) AND (surgery OR surgical OR surgically OR laparoscopy OR laparoscopic OR laparoscopically OR ileo pouch OR ileal pouch OR pouch-anal anastomosis OR pelvic pouch OR "IPAA" OR restorative proctocolectomy OR "RPC" OR "RP" OR colorectal surgery OR colonic pouch)	Issue 1, 2007	649

Table 1. Search strategies (*Continued*)

Pubmed	((ulcerative colitis [TIAB] OR colitis ulcerosa [TIAB] OR "uc" [TIAB] OR "ibd" [TIAB] OR inflammatory bowel disease [TIAB] OR Colitis, Ulcerative [MH] OR Inflammatory Bowel Diseases [MH]) OR (familial adenomatous polyposis [TIAB] OR familial polyposis [TIAB] OR "FAP"[TIAB] OR adenomatous polyposis coli [TIAB] OR polyposis coli [TIAB] OR adenomatous polyposis coli [MH])) AND (surgery[TIAB] OR surgery [MH] OR surgery [Subheading] OR surgical[TIAB] OR surgically[TIAB] OR laparoscopy[TIAB] OR laparoscopy [MH] OR laparoscopic [TIAB] OR laparoscopically [TIAB] OR ileo pouch[TIAB] OR ileal pouch [TIAB] OR pelvic pouch[TIAB] OR pouch-anal anastomosis [TIAB] OR "IPAA" OR restorative proctocolectomy[TIAB] OR colorectal surgery [MH] OR surgical procedures, operative [MH] OR Surgical Procedures, Minor [MeSH] OR proctocolectomy, restorative [MH] OR Colonic Pouches [MH]) AND (Randomized Controlled Trial [pt] OR Controlled Clinical Trial [pt] OR Randomized Controlled Trials [mh] OR Random Allocation [mh] OR double-blind method [mh] OR single-blind method [mh] OR clinical trial [pt] OR clinical trials [mh] OR ("clinical trial" [tw]) OR ((singl* [tw] OR	1990 - 19 April 2007	4455

Table 1. Search strategies (*Continued*)

	doubl* [tw] OR trebl* [tw] OR tripl* [tw]) AND (mask* [tw] OR blind* [tw])) OR (placebos [mh] OR placebo* [tw] OR random* [tw] OR research design [mh:no exp] OR comparative study [publication type] OR evaluation studies [mh] OR follow-up studies [mh] OR prospective studies [mh] OR control* [tw] OR prospectiv* [tw] OR volunteer* [tw]) NOT (animals [mh] NOT human [mh]))		
Embase	Search strategy will be conducted through the advanced search feature of EMBASE, with the next options tagged on: -Map to preferred terminology -Also search as keyword -Include sub-terms/derivatives (explosion search) -1990 - 2006 -EMBASE Only ('colitis ulcerosa':ti,ab OR 'ulcerative colitis':ti,ab OR 'uc':ti,ab OR 'ibd':ti,ab OR 'inflammatory bowel disease':ti,ab OR 'colitis, ulcerative'/exp OR 'inflammatory bowel diseases'/exp OR 'familial adenomatous polyposis':ti,ab OR 'familial polyposis':ti,ab OR 'FAP':ti,ab OR 'polyposis coli':ti,ab OR 'adenomatous polyposis coli'/exp OR 'familial adenomatous polyposis'/exp) AND ("surgery":ti,ab OR "surgical":ti,ab OR "surgically":ti,ab OR "surgery"/exp OR "laparoscopy":ti,ab OR "laparoscopic":ti,ab OR "laparoscopically":ti,ab OR "laparoscopy"/	1990 - 19 April 2007	6890

Table 1. Search strategies (*Continued*)

	exp OR "ileo pouch":ti,ab OR "ileal pouch":ti,ab OR "pelvic pouch":ti,ab OR "pouch-anal anastomosis":ti,ab OR "IPAA":ti,ab OR "restorative proctocolectomy":ti,ab OR "colorectal surgery"/exp OR "surgical procedures, operative"/exp OR "proctocolectomy, restorative"/exp OR "Colonic Pouches"/exp) AND ("randomisation"/exp OR "controlled clinical trial"/exp OR "randomised controlled trials"/exp OR "random allocation"/exp OR "double-blind method"/exp OR "single-blind method"/exp OR "clinical trials"/exp OR "clinical trial":ti,ab OR Random* :ti,ab OR "comparative studies"/exp OR "evaluation studies"/exp OR "follow-up studies"/exp OR "prospective studies"/exp OR control* :ti,ab OR prospectiv* :ti,ab OR volunteer* :ti,ab)		
ISI Web of Knowledge	#1 (ulcerative colitis OR colitis ulcerosa OR uc OR ibd OR inflammatory bowel disease) #2 (familial adenomatous polyposis OR familial polyposis OR adenomatous polyposis coli OR polyposis coli OR FAP) #3 (surgery OR surgical OR surgically OR laparoscopy OR laparoscopic OR laparoscopically OR ileo pouch OR ileal pouch OR pouch-anal anastomosis OR pelvic pouch OR IPAA OR restorative proctocolectomy OR RPC OR colorectal surgery OR colonic pouch) #4 (randomised controlled trial OR controlled clinical trial OR randomised controlled trials OR random allocation OR	1990 - 19 April 2007	1573

Table 1. Search strategies (*Continued*)

	double-blind method OR single-blind method OR clinical trial OR clinical trials OR clinical trial OR ((singl* OR doubl* OR trebl* OR tripl*) AND (mask* OR blind*)) OR placebos OR placebo* OR random* OR comparative study OR evaluation stud* OR follow-up stud* OR prospective stud* OR control* OR prospectiv* OR volunteer*) #5 ((#1 OR #2) AND #3 AND #4)		
The Cochrane IBD/FBD Group Specialized Trial Register (Non Medline Records)	Full manual search.	April 2007	930
Webcasts of the Annual Meetings of the ASCRS	Full manual search.	All online available web casts (1997 - 2006)	Not applicable.

Table 2. Modified Methodological Index for Non-Randomised Studies (MINORS)

Item*
1. Inclusion of consecutive patients: all patients potentially fit for inclusion (satisfying the criteria for inclusion) have been included in the study during the study period (no exclusion or details about the reasons for exclusion)
2. Prospective collection of data: data were collected according to a protocol established before the beginning of the study
3. Unbiased assessment of the study endpoint: blind evaluation of objective endpoints and double-blind evaluation of subjective endpoints. Otherwise the reasons for not blinding should be stated
4. Follow-up period appropriate to the aim of the study: the follow-up should be sufficiently long to allow the assessment of the main endpoint and possible adverse events
5. Loss to follow up less then 5%^: all patients should be included in the follow up. Otherwise, the proportion lost to follow up should not exceed the proportion experiencing the major endpoint; or if the numbers and reasons for dropouts and withdrawals in all intervention groups were described
6. An adequate control group: having a gold standard diagnostic test or therapeutic intervention recognized as the optimal intervention according to the available published data
7. Contemporary groups: control and studied group should be managed during the same time period (no historical comparison)

Table 2. Modified Methodological Index for Non-Randomised Studies (MINORS) (*Continued*)

8. Baseline equivalence of groups **: the groups should be similar regarding the criteria other than the studied endpoints, i.e. absence of confounding factors that could bias the interpretation of the results

* Items were scored 'adequate' if condition was satisfied, 'inadequate' if condition was not satisfied and 'unclear' if information regarding item was not reported.

^ Measured at time of discharge, since most trials only followed patients until discharge.

** In this review baselines of the two groups should be equivalent regarding age, gender, BMI and distribution of diagnoses (UC/FAP).

Table 3. Methodological assessment of included studies

Trial	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8
	Consecutive patients	Prospective design	Assessment of outcomes	FU-period	Loss to FU < 5%	Adequate control group	Contemporary control group	Baseline equivalence
Araki 2001	A	U	I	A	A	A	I	A
Berdah 2004	A	A	I	A	A	A	A	A
Brown 2001	A	I	I	A	A	A	I	A
Dunker 2001	A	I	I	A	A	A	A	I
Hashimoto 2001	A	I	I	A	A	A	I	I
Larson 2005	A	A	I	A	A	A	A	A
Larson 2006	A	I	I	A	A	A	A	A
Maartense 2004a	A	A	I	A	A	A	A	A
Marcello 2000	A	A	I	A	A	A	A	A
Otani 2001	A	U	I	A	A	A	U	I
Schmitt 1994	A	A	I	A	A	A	A	I

A: Adequate; I: Inadequate; U: Unclear

Table 4. Characteristics of studies included in the meta-analysis

Trial	N	Design	Matching^	Follow-up period	Loss to Follow-up	Loss to Follow-up	Conversion rate (%)
	Cases/ Controls				LA-IPAA	Open IPAA	
Araki 2001	21/11	R, NR	-	D/C	0	0	-
Berdah 2004	12/12	P, NR	1,2,3,4	> 3 years	0	0	3/12 (25%)
Brown 2001	12/13	R, NR	-	D/C	0	0	0/12 (0%)
Dunker 2001	15/17	R, NR	4,5,8	Mean 16 month	0	0	0/15 (0%)
Hashimoto 2001	11/13	R, NR	-	D/C	0	0	0/11 (0%)
Larson 2005	33/33	P, NR	1,2,3,4,6	> 12 months	4	N/A	-
Larson 2006	100/200	P+R, NR	1,2,3,5,6	90 days	0	0	6/100 (6%)
Maartense 2004a	30/30	RCT	-	30 days	2/30 (6,6%)	3/30 (10%)	0/30 (0%)
Marcello 2000	20/20	P, NR	1,2,3,4,7	D/C	0	0	0/20 (%)
Otani 2001	10/18	NS, NR	-	D/C	0	0	-
Schmitt 1994	22/20	P, NR	1,2,4	D/C	0	0	-
Totals	253/354*						9/200 (4,5%)

* Larson 2005 was not added up to the total of patients to avoid duplication patient duplication.
^ 1: age; 2: gender; 3: BMI; 4: diagnosis; 5: operative technique; 6: date of operation; 7: severity of disease; 8: Duration of follow-up. Each number indicates that the study had actively matched between the two groups regarding that item.
IPAA: ileo pouch anal anastomosis; LA-IPAA: laparoscopic (assisted) IPAA; R: retrospective; P: prospective; P+R: prospective for the LA-IPAA group, and retrospective for the open-IPAA group; NS: not specified; NR: non-randomised trial; RCT: randomised controlled trial; N/A: not applicable; D/C: until discharge

Table 5. Patients characteristics of included studies

Trial	N	Age	Age	Gender (M:F)	Gender (M:F)	BMI	BMI	Diagnosis (UC:FAP)	Diagnosis (UC:FAP)
	LA-IPAA / Open IPAA	LA-IPAA	Open IPAA	LA-IPAA	Open IPAA	LA-IPAA	Open IPAA	LA-IPAA	Open IPAA

Table 5. Patients characteristics of included studies (*Continued*)

Araki 2001	21/11	27.2(8.1)^	31.1(11.2)^	8:13	2:9	31.2(4.5)^	33.1(4.8)^	21:0	11:0
Berdah 2004	12/12	32 (16-60)	31 (21-58)	6:6	6:6	24 (17-29)	22 (20-26)	11:1	11:1
Brown 2001	12/13	32 (16-69)	29 (15-59)	4:8	5:8	-	-	2:9 + 1 other	6:7
Dunker 2001	15/17	30.6 (7.1) ^*	39.2 (8.4) ^*	4:11	9:8	23.6(4.6) ^	24.5 (3.2)	14:1	14:3
Hashimoto 2001	11/13	30.0 (19-47)	30.0 (18-49)	4:7	7:6	-	-	6:5	6:7
Larson 2005	33/33	28 (18-56)	27 (17-56)	6:27	6:27	21.7 (17-31)	22.3 (18-33)	31:2	31:2
Larson 2006	100/200	32 (17-66)	32 (17-64)	40:60	80:120	22.4 (17-34)	23 (16-32)	98:2	191:9
Maartense 2004a	30/30	29 (16-57) *	35 (16-57) *	9:21	15:15	22.6 (18.1-34.7)	23.3 (17.2-34.2)	20:10	20:10
Marcello 2000	20/20	25 (12-61)	26 (9-61)	15:5	15 :5	24 (18-32)	24 (18-30)	13:7	13:7
Otani 2001	10/18	30.2(11.8)^	39.6(17.7)^	-	-	-	-	10:0	18:0
Schmitt 1994	22/20	31 (12-59)	34 (17-64)	11:11	11:9	-	-	16:5 + 1 other	15:5

* significant difference; ^ mean (SD).
IPAA: ileo pouch anal anastomosis; LA-IPAA: laparoscopic (assisted) IPAA; M: male; F: female; UC: ulcerative colitis; FAP: familial adenomatous polyposis.

Table 6. Reported outcomes by Maartense 2004 (RCT)

Outcome	**LA-IPAA (N=30)**	**Open IPAA (N=30)**	
	N (%) / Median (range)	**N (%) / Median (range)**	**P-value***
Mortality	0 (0%)	0 (0%)	NS

Table 6. Reported outcomes by Maartense 2004 (RCT) (*Continued*)

Intraoperative complications	1 (3%)	1 (3%)	NS
Procedure specific complications	4 (13%)	6 (20%)	NS
Severe postoperative complications	0 (0%)	2 (7%)	NS
Mild postoperative complications	9 (30%)	7 (23%)	NS
Total complications	14 (47%)	16 (53%)	NS
Operative time	214 (149 - 400)	133 (97 - 260)	p=<0.001
Blood loss	263 (75-1200)	300 (50-800)	p=0.98
Time to regulat diet	6 (4 - 19)	7 (4 - 15)	0.6
Hospital stay	10 (5 - 13)	11 (6 - 28)	0.767
Readmission	5/23* (22%)	3/23* (13%)	NS
Reoperation	5 (17%)	5 (17%)	NS

* Only reported in a sub-group of patients (N=23).
IPAA: ileo pouch anal anastomosis; LA-IPAA: laparoscopic (assisted) IPAA. NS = not statistically significant.

Table 7. Available data for defecation frequency and costs.

Outcome		**N**	**LA-IPAA**	**Open IPAA**	
DEFECATION FREQUENCY	**Trial**	**LA-IPAA / Open-IPAA**	**Mean/Median (SD/ Range)**	**Mean/Median (SD/ Range)**	**P-value***
- during the day	Dunker 2001	15/17	5.70 (1.30)	6.30 (2.00)	NS
	Larson 2005	33/33	7 (3-14)	6 (3-12)	p=0.23*
	Maartense 2004	22/23	6.09 (2.29)	5.35 (1.82)	p=0.161
- during the night	Dunker 2001	15/17	1.0 (0.7)	1.3 (0.7)	NS
	Larson 2005	33/33	1 (1-5)	2 (1-4)	p=0.86*
	Maartense 2004	22/23	2.14 (1.91)	1.78 (1.41)	p=0.371

Table 7. Available data for defecation frequency and costs. (*Continued*)

- per 24 hours	Otani 2001	10/18	8.00 (2.3)	11.00 (1.0)	NS
COSTS (Euros)	**Trial**	**LA-IPAA / Open-IPAA**	**Mean (SD)**	**Mean (SD)**	**P-value***
- operative costs	Maartense 2004a	30/30	3467.35 (290.73)	1755.65 (170.89)	p< 0.001
- overall costs	Maartense 2004a	30/30	18,733.23 (8666.69)	16,830.29 (8625.96)	p=0.095

* As provided by author.
IPAA: ileo pouch anal anastomosis; LA-IPAA: laparoscopic (assisted) IPAA

WHAT'S NEW

Last assessed as up-to-date: 3 November 2008.

Date	Event	Description
1 November 2008	Amended	Editorial comments have been incorporated into the review
24 April 2008	Amended	Converted to new review format.

HISTORY

Protocol first published: Issue 4, 2006

Review first published: Issue 1, 2009

Date	Event	Description
24 November 2007	New citation required and conclusions have changed	Substantive amendment

CONTRIBUTIONS OF AUTHORS

U Ahmed Ali, F Keus, JT Heikens, HG Gooszen and CJHM van Laarhoven participated in the design of the review and drafting of the protocol.

U Ahmed Ali, F Keus and JT Heikens participated in the literature search, extraction of data and methodological quality assessement of studies.

U Ahmed Ali, F Keus and CJHM van Laarhoven participated in the statistical analysis and interpretation of results.

SV Berdah and WA Bemelman provided individual patient data and reviewed the protocol and final manuscript.

U Ahmed Ali and F Keus drafted the review.

CJHM van Laarhoven conceived the idea for the review and supervised the review.

All authors co-authored the writing of the review, read and approved the final manuscript.

DECLARATIONS OF INTEREST

None.

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

- Relative Risks (RR) are used as a summary statistic for dichotomous data in stead of Odds Ratios (OR). The RR were chosen over OR, because the were considered easier to understand and interpret.

- We used a modified version of the MINORS index in this review. Motivation and detailed information about the modifications can be found in the "Assessment of methodological quality of non-randomised clinical trials" section.

INDEX TERMS

Medical Subject Headings (MeSH)

*Laparoscopy; Adenomatous Polyposis Coli [*surgery]; Colitis, Ulcerative [*surgery]; Proctocolectomy, Restorative [*methods]

MeSH check words

Humans