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A systematic review and meta-analysis of laparoscopic *vs* open restorative proctocolectomy

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Abstract

Aim The benefits of a laparoscopic approach to restorative proctocolectomy (RPC) are controversial. The aim of this meta-analysis was to compare the outcome following laparoscopic and open RPC, with particular attention to adverse events and long-term function.

Method A systematic search of the MEDLINE, EMBASE and Ovid databases was performed for studies published until March 2012. The primary end-point was long-term function. Secondary end-points were intra-operative details, short-term postoperative outcome and postoperative adverse events. Weighted mean difference (WMD) and odds ratio (OR) were calculated using fixed/random effect meta-analytic techniques.

Results The final analysis included 27 comparative studies of 2428 patients, of whom 1097 (45.1%) underwent laparoscopic surgery. A laparoscopic approach was associated with a significantly longer operation time (WMD 70.1 min, $P < 0.001$), shorter length of hospital stay (WMD −1.00 day, $P < 0.001$), reduced intra-operative blood loss (WMD −89.10 ml, $P < 0.001$) and a lower incidence of wound infection (OR 0.60, $P < 0.005$). No significant differences were observed in the rate of pouch failure. Although there was no significant difference in the number of daily bowel movements (OR 0.04, $P = 0.950$), laparoscopic surgery led to fewer nocturnal bowel movements (WMD −1.14, $P < 0.001$) and reduced pad usage during the day (OR 0.22, $P < 0.001$) and night (OR 0.33, $P < 0.001$). The *post hoc* power to detect differences in adverse event rates ranged from 5% to 42%.

Conclusion Laparoscopic and open approaches to RPC produced equivalent adverse event rates and long-term functional results. However, the present evidence is underpowered to detect true differences in adverse event rates.

Keywords Ileal pouch anal anastomosis, ileal pouch, restorative proctocolectomy, meta-analysis

Introduction

Restorative proctocolectomy (RPC) was described in 1978 using the distal section of the ileum to form an S-shaped ileal reservoir which was then anastomosed to the upper anal canal [1]. The J- and W-reservoirs were subsequently developed to facilitate spontaneous evacuation [2–4]. It is now the procedure of choice when surgery is indicated for ulcerative colitis and in most adult patients with familial adenomatous polyposis [5,6].

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Two previous meta-analyses have demonstrated that laparoscopic RPC is associated with intra-operative and early postoperative advantage compared with an open approach [7,8]. Although feasible, laparoscopic RPC is a complex procedure [9]. Potential advantages include a reduced length of hospital stay, reduced blood loss, reduced postoperative pain and improved cosmetic appearance [10,11]. However, whether laparoscopic RPC confers a benefit in terms of long-term function and any differences in adverse events, including retained rectal cuff or ileal pouch failure, are unknown.

The aim of the present meta-analysis was to review the literature comparing function, intra-operative outcome, postoperative parameters and adverse events in patients undergoing laparoscopic or open RPC.

Method

Study selection

A systematic review of all published literature was undertaken using the Medical Literature Analysis and Retrieval System Online (MEDLINE via PubMed), Excerpta Medica (EMBASE) and Ovid databases. The following terms were used for the search: 'laparoscopic', 'IPAA', 'ileal pouch', 'J-pouch', 'ileal pouch anal anastomosis', 'laparoscopic *vs* open', 'restorative proctocolectomy', 'hand-assisted', 'laparoscopic-assisted' and 'totally laparoscopic'. These terms were searched for both alone and in various combinations, and the 'related articles' function in PubMed was used to widen the search. All titles, abstracts, studies and citations were scanned and assessed for inclusion. A manual search of all references also took place. Date limits were set between January 1990 and March 2012, with no language limits. The search was performed on 22 April 2012.

Inclusion and exclusion criteria

To be included in the meta-analysis, the study must have (1) compared laparoscopic and open approaches to RPC or a 'hand-assisted' laparoscopic approach with a 'laparoscopic-assisted' approach; (2) been a randomized controlled trial, prospective observational or retrospective study; (3) reported data on at least intra-operative details, postoperative outcome, postoperative adverse events or long-term function; (4) reported the indication for RPC in patients included the study; and (5) had a minimum sample size of 10 patients in each intervention group. For studies which had been completed at the same centre or by the same author, the highest quality study or the study with the greatest sample size was chosen to eliminate duplication. Studies were excluded from the analysis if (1) extractable data on the outcome of laparoscopic and open RPC were not made available separately in the study and (2) the paper was a case report, review or letter. In cases of overlap or duplication, the highest quality study was included.

Data extraction

Two authors independently identified studies for inclusion and extracted data for the end-points. Discrepancies in outcome extraction were resolved by re-examination of the relevant study until consensus was achieved. The primary end-point was long-term function (more than 1 year after surgery). Aspects of function included frequency of defaecation (the mean number of bowel movements over a 24-h period), nocturnal frequency of defaecation, continence and pad usage. Other end-points included failure and quality of life. Failure was indicated by the absence of anal function through removal of the pouch with a permanent ileostomy or indefinite defunctioning.

The secondary end-points analysed were (1) intra-operative details including length of operation and estimated operative blood loss; (2) postoperative parameters including time to first bowel movement, time to resumption of liquid diet, time to resumption of regular solid diet and length of hospital stay following surgery (all expressed as the postoperative day on which the event occurred); (3) postoperative adverse events including rate of wound infection, pelvic sepsis, anastomotic leakage, ileus, small bowel obstruction, re-operation, abscess formation and urinary tract infection.

The following definitions for laparoscopic surgery were used.

1. Hand-assisted laparoscopic surgery (HALS): A hand-assist device allowing a hand to be introduced into the peritoneal cavity to aid the procedure.
2. Laparoscopic-assisted surgery (LAS): The use of laparoscopic dissection with extra-corporeal pouch formation through a lengthened incision.
3. Totally laparoscopic surgery (TLS): A fully laparoscopic approach to RPC with no lengthened or additional skin incisions.

Comparison of the primary and secondary end-points was carried out in three separate analyses including (i) any laparoscopic approach to RPC *vs* open RPC, (ii) totally laparoscopic RPC *vs* open RPC and (iii) HALS *vs* LAS.

Statistical analysis

The meta-analysis was conducted in accordance with guidelines from the Preferred Reporting Items for Systematic Reviews and Meta-analysis group (PRISMA) [12]. Dichotomous variables were compared using odds ratio (OR) with 95% confidence intervals via the Mantel-Haenszel method. The OR was defined as the probability of an event occurring in the laparoscopic compared with the open group. Continuous variables were compared using the weighted mean difference (WMD) method with 95% confidence intervals, where weights represented the quantity of available data from each study.

Heterogeneity was judged using the chi-squard test, with $P < 0.050$ being regarded as significant. The I^2 method was used to quantify heterogeneity, with a low degree of heterogeneity being regarded as < 50%. In these cases, a fixed effects model was used to compare the outcome for both continuous and dichotomous

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data. Where significant heterogeneity existed ($I^2 \geq 50\%$), a random effects analysis was applied [13]. The random effects model was regarded as superior for this purpose as it assumes that variation in effect size between studies exists, and accounts for differences in study population, comorbidity and surgical protocol which would otherwise lead to bias. It is also preferable when meta-analysing data from retrospective, non-randomized studies. Funnel plots were also used to assess for publication bias [14].

For studies which did not present the standard deviation of the mean values for continuous data, this was calculated according to statistical algorithms, in accordance with Cochrane Collaboration guidelines [15]. For adverse events, a *post hoc* power analysis was performed to identify the power when patients and results are pooled from the relevant studies. Statistical analysis was performed using Review Manager 5.1 (The Nordic Cochrane Centre, The Cochrane Collaboration, Copenhagen, 2011).

Quality assessment and sensitivity analysis

The quality of studies was assessed using the Newcastle–Ottawa scale (NOS), with high quality studies being defined as those which scored 7 or more stars out of a possible 9 [16]. Studies were assessed for method of patient selection, comparability of the two intervention groups and methods of measuring end-points. A pre-planned sensitivity analysis was carried out for the subgroups high quality studies (NOS score > 7), studies published during or after the year 2005 and studies with a minimum number of 30 patients in each intervention group.

Results

Eligible studies

After exclusions, 27 studies were included in the final meta-analysis incorporating data on 2428 unique patients between the years 1991 and 2012 (Table 1).

Table 1 Study characteristics.

Study	Location	Design	L (*n*)	O (*n*)	Men (*n*) (%)	Comparison	NOS stars
Araki *et al.* [33]	Kurume, Japan	R	21	11	10 (31.3)	LAS v O	5
Bartels *et al.* [24]	Amsterdam, The Netherlands	R	27	23	0	TLS, HALS v O	7
Berdah *et al.* [34]	Marseille, France	RM	12	12	12 (50.0)	LAS v O	6
Brown *et al.* [21]	Singapore, Singapore	R	12	13	9 (36.0)	LAS v O	6
Dolejs *et al.* [35]	Madison, Wisconsin, USA	R	100	290	217 (55.6)	LAS v O	7
Dunker *et al.* [23]	Amsterdam, The Netherlands	RM	15	17	13 (41.6)	LAS v O	7
El-Gazzaz *et al.* [36]	Cleveland, Ohio, USA	RM	119	238	179 (50.1)	LAS v O	8
Fajardo *et al.* [37]	Missouri and Indianapolis, USA	R	69	55	61 (49.1)	LAS v O	6
Fichera *et al.* [38]	Chicago, Illinois, USA	R	73	106	98 (54.7)	LAS v O	7
Fleming *et al.* [39]	Rochester, New York, USA	R	339	337	676 (58.1)	LAS v O	7
Gu *et al.* [19]	Cleveland, Ohio, USA	RM	47	96	72 (50.3)	LAS v O	7
Hashimoto *et al.* [40]	Miyagi, Japan	R	11	13	11 (45.8)	LAS v O	3
Kelly *et al.* [26]	Cork, Ireland	RM	10	10	10 (50.0)	SLS v O	8
Larson *et al.* [17]	Rochester, Minnesota, USA	RM	100	200	180 (60.0)	LAS v O	8
Larson *et al.* [18]	Rochester, Minnesota, USA	PM	33	33	12 (18.1)	HALS, LAS v O	8
Maartense *et al.* [20]	Amsterdam, The Netherlands	RCT	30	30	24 (40.0)	HALS v O	7
Otani *et al.* [41]	Tokyo, Japan	R	10	18	10 (35.7)	LAS v O	6
Ouaissi *et al.* [42]	Paris, France	RM	23	22	26 (62.0)	LAS v O	8
Ozawa *et al.* [25]	Kanagawa, Japan	RM	20	20	24 (60.0)	TLS v O	7
Polle *et al.* [30]	Amsterdam, The Netherlands	RM	35	30	35 (36.8)	LAS v HALS	8
Rivadeneira *et al.* [43]	Burlington, Vermont, USA	RM	13	10	16 (70.0)	LAS v HALS	7
Schmitt *et al.* [44]	Lauderdale, Florida, USA	PM	22	20	22 (52.4)	LAS v O	6
Polle *et al.* [22]	Amsterdam, The Netherlands	R	26	27	14 (25.8)	LAS v O	7
Sylla *et al.* [45]	New York, New York, USA	R	50	155	110 (53.7)	LAS v O	5
Tan and Jaffray [46]	Newcastle, UK	PM	11	11	12 (54.5)	LAS v O	8
Tsurata *et al.* [47]	Tokyo, Japan	RM	40	30	41 (58.6)	LAS v HALS	7
Zhang *et al.* [48]	Texas, USA, and Jinan, China	RM	21	25	20 (43.5)	TLS v O	7

R, retrospective; RM, retrospective case-matched; PM, prospective case-matched; RCT, randomized controlled trial; HALS, hand-assisted laparoscopic surgery; TLS, totally laparoscopic surgery; LAS, laparoscopic-assisted surgery; L, laparosopic surgery; O, open surgery; *n*, number of patients; NOS, Newcastle–Ottawa scale.

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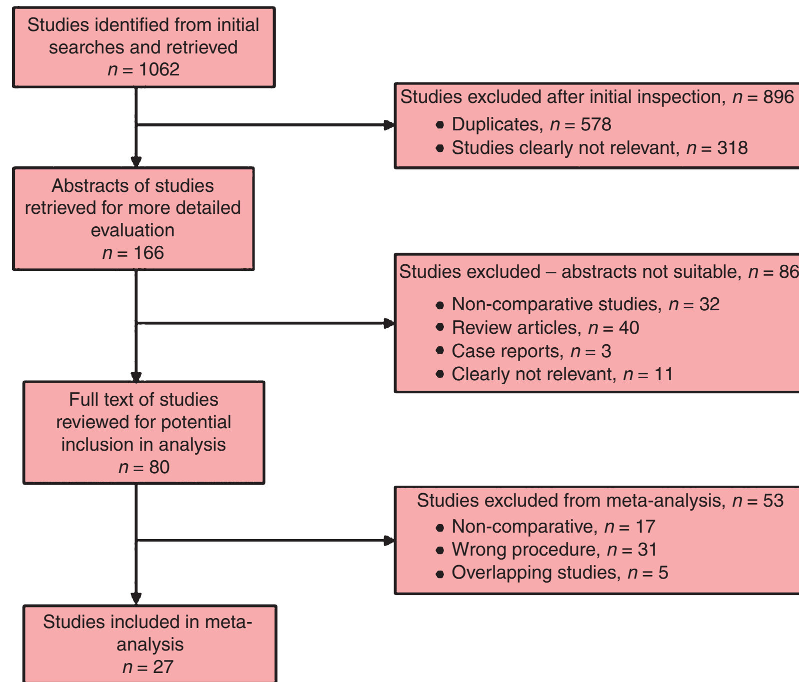

Figure 1 PRISMA diagram.

Details of the search results are shown in the PRISMA diagram (Fig. 1). Of these, 1097 (45.1%) underwent RPC by a laparoscopic approach. Most studies were from centres in the USA (38.5%, 10/26) and Europe (30.8%, 8/26) followed by Japan (19.2%, 5/26) and South East Asia (7.8%, 2/26). There were 1807 (75.9%) men in the analysis. The most common indication for surgery was ulcerative colitis (85.4% and 85.6%, laparoscopic and open groups), followed by dysplasia (12.9% and 10.7%). Other indications included 24 patients with Crohn's disease (2.0% of total) and nine (< 1%) with colorectal malignancy.

Twenty-four studies compared the outcome following open and all types of laparoscopic surgery, while the remaining three compared HALS with LAS. Three studies from the same centre were included since the end-points measured differed between them, although they were not entered into the same analysis [17–19]. The study characteristics and details of patient demographics are shown in Tables 1 and 2.

Fifteen studies scored seven or more stars on the Newcastle–Ottawa scale and 15 were published during or after 2005. One included study was a randomized controlled trial [20]. In three studies, data were collected prospectively with case matching. In the remaining 23 studies data were collected retrospectively with 11 being case matched (Table 2).

Intraoperative details

Operation time was found to be significantly longer in the laparoscopic group by 70.1 min (95% CI 47.9, 92.2; $P < 0.001$), but there was significant heterogeneity ($I^2 = 94.0\%$, $P < 0.001$). Estimated operative blood loss was significantly lower in the laparoscopic group, being 89.1 ml less than the open group (95% CI −125.4, −52.8; $P < 0.001$). Postoperative length of hospital stay in the laparoscopic group was shorter by 1.0 day (95% CI −1.1, −0.84; $P = 0.010$). This result was also associated with significant heterogeneity ($I^2 = 54.0\%$; $P < 0.010$). Only one study compared the height of anastomosis between the two groups, with a median of 3 cm (13 patients, range 1–4 cm) in the open group and 3 cm (12 patients, range 2–4 cm) in the laparoscopic group [21].

Postoperative outcome

Time to first postoperative bowel movement was shorter by 0.7 days in the laparoscopic group (95% CI −1.3, −0.2; $P < 0.010$; Fig. 2). There was substantial heterogeneity associated with this result ($I^2 = 93\%$, $P < 0.001$). Time to resumption of a solid diet was significantly shorter for patients undergoing laparoscopic surgery (WMD −1.2 days; 95% CI −1.6, −0.7;

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Table 2 Demographic characteristics of included studies.

Study	Mean age		P. diversion		Matching	Diagnosis	Conversion (*n*) (%)
	Lap	Open	Lap	Open			
Araki *et al.* [33]	27.2	31.1	21	11	1, 2, 3, 4	a	N/C
Bartels *et al.* [24]	27	23	N/C	N/C	Nil	a, b	N/C
Berdah *et al.* [34]	32	31	11	12	1, 2, 3, 4	a	3 (25.0)
Brown *et al.* [21]	32	29	12	13	Nil	a, b, d	0
Dolejs *et al.* [35]	37.5	38.7	100	290	Nil	a	N/C
Dunker *et al.* [23]	30.6	39.2	15	17	3, 4, 7	a, b	0
El-Gazzaz *et al.* [36]	35.5	35.8	22	41	1, 2, 3, 7, 9	a, b, d, e, f	9 (7.6)
Fajardo *et al.* [37]	37.4	42.6	55	69	Nil	a, b	N/C
Fichera *et al.* [38]	36.9	36.3	49	76	Nil	a	1 (1.4)
Fleming *et al.* [39]	39	41.2	339	337	Nil	a, b	N/C
Gu *et al.* [19]	43.1	42.1	43	81	1, 2, 3, 4	a, b	1 (2.1)
Hashimoto *et al.* [40]	30	30	11	13	1, 2, 4	a, b	0
Kelly *et al.* [26]	N/C	N/C	10	10	1, 2, 3, 4	a, b	1 (10.0)
Larson *et al.* [17]	28	27	30	33	1, 2, 3, 7, 9	a, b	6 (6.0)
Larson *et al.* [18]	32	32	100	200	1, 2, 3, 7, 9	a, b	N/C
Maartense *et al.* [20]	29	35	8	7	2, 3, 7	a, b	0
Otani *et al.* [41]	30.2	39.6	10	18	Nil	a	N/C
Ouaissi *et al.* [42]	41	44	23	22	1, 2, 3, 4, 8	a, e, f	1 (4.5)
Ozawa *et al.* [25]	29.5	35	20	20	2, 3, 8	a, b	0
Polle *et al.* [30]	36	35	8	7	1, 2, 3	a, b	0
Rivadeneira *et al.* [43]	30	34	30	34	Nil	a, b	0
Schmitt *et al.* [44]	31	34	22	20	1, 2, 4	a, b, c, d	N/C
Polle *et al.* [22]	32.6	37.5	26	27	1, 2, 3	a, b	N/C
Sylla *et al.* [45]	32	39.5	50	155	Nil	a, b, f	N/C
Tan and Jaffray [46]	14	12	11	11	5	a, b, c, f	N/C
Tsurata *et al.* [47]	34	41	40	30	1, 2, 3, 8	a, b, d	0
Zhang *et al.* [48]	34	35	N/C		1, 2, 3, 4, 7	a, b	0

P. diversion, number of patients who underwent proximal diversion; 1, age; 2, sex; 3, body mass index; 4, diagnosis; 5, number of stages; 6, operating surgeon; 7, procedure; 8, ASA score; 9, date of operation; a, ulcerative colitis; b, familial adenomatous polyposis; c, other polyposis; d, malignancy; e, acute colitis; f, Crohn's disease; N/C, no comments.

$P < 0.001$). There was no difference in time to resumption of a liquid diet (Table 3).

Postoperative adverse events

Most of the studies reviewed reported postoperative adverse events. These included wound infection, pelvic sepsis, anastomotic leakage, small bowel obstruction, re-operation, pouch failure, abscess and urinary tract infection (Table 3). The rate of conversion for laparoscopic surgery was reported by 15 studies, with 21 conversions (3.9%) being required (Table 2). Wound infection was significantly less likely with laparoscopic than with open surgery (OR 0.60; 95% CI 0.43, 0.85; $P < 0.050$). There was no significant difference in the rate of pouch failure between laparoscopic (0.8%, 2/251) and open groups [1.2% (5/404); OR 0.76; 95% CI 0.22, 2.63; $P = 0.67$), as reported from four studies with between 13 and 30 months follow-up. *Post hoc* analysis revealed power to detect differences in adverse event rates between open and laparoscopic groups of between 5% and 42% (Table S1).

Function

Frequency of defaecation over a 24-h period did not differ between the laparoscopic and open groups (WMD 0.04; 95% CI −1.24, 1.33; $P = 0.950$; Fig. 3). Nocturnal frequency was significantly lower in the laparoscopic group (WMD −1.14; 95% CI −2.2, −0.07; $P < 0.001$). The proportion of patients with incontinence was no different between the two groups (OR 0.72; 95% CI 0.46, 1.13; $P = 0.150$). There was no difference between the two groups in the frequency of anti-diarrhoeal medication and dietary restrictions (Fig. 4). Two studies reported quantified pad usage,

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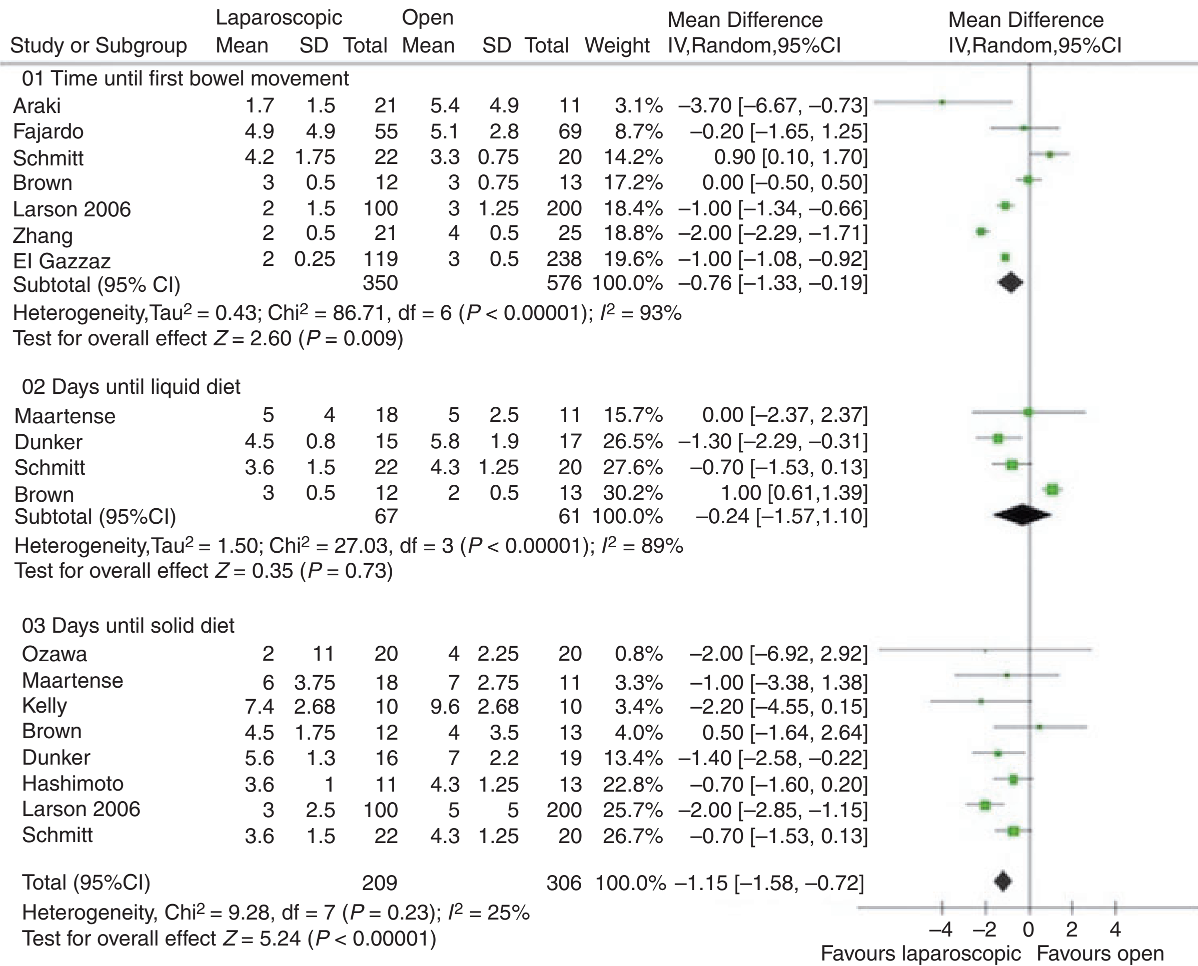

Figure 2 Forest plot illustrating the meta-analysis of postoperative outcomes.

which was significantly lower in the laparoscopic group for both day and night.

Qualitative analysis of quality of life

Five studies reported outcome for quality of life following laparoscopic and open RPC, but meta-analysis of these data was not possible due to significant methodological heterogeneity. Thus a qualitative analysis of these end-points was carried out. Two studies used the Gastrointestinal Quality of Life Index (GIQLI) and Short Form 36 (SF-36) to compare quality of life between the two groups and noted no difference between laparoscopic and open. Polle *et al.* and Dunker *et al.* reported significantly higher scores for cosmesis in the laparoscopic group at 2.7 years and 1.5 years [22,23]. Polle *et al.* also noted that cosmesis scores did not differ between the two groups for men, whilst they were significantly higher amongst women who underwent laparoscopic surgery (median score 21 *vs* 14 on cosmesis scale; $P = 0.006$).

One study found that women undergoing laparoscopic RPC had a significantly higher pregnancy rate compared with those having open RPC. Among 23 patients undergoing an open and 27 a laparoscopic procedure, all of whom were attempting to conceive, there was a significantly reduced time to pregnancy in the laparoscopic group (log rank $P = 0.023$) [24].

Comparison of laparoscopic technique

Three studies compared a totally laparoscopic with an open operation. The duration of the operation was significantly lower in the open group (WMD 62.0 min; 95% CI 46.3, 77.8; $P < 0.001$). Estimated blood loss was significantly lower in the totally laparoscopic group with a larger WMD observed than for the overall comparison of laparoscopic with open (WMD −137.4 ml; 95% CI −177.7, −97.2; $P < 0.001$). The length of stay was reduced by 2 days (95% CI −3.5, −0.7; $P < 0.004$) in the TLS group compared with open surgery.

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Table 3 Meta-analysis of all outcomes for laparoscopic versus restorative proctocolectomy

Outcome	Studies	OR/WMD	95% CI	*P*	H		
					I^2	X^2	*P*
Intra-operative details							
Length of operation	18	70.1	47.9, 92.2	**< 0.001**	94	283.73	**< 0.001**
Estimated blood loss	12	−89.1	125.4, −52.8	**< 0.001**	62	28.84	**0.002**
Postoperative parameters							
Length of stay	18	−1.0	−1.2, −0.8	**< 0.001**	46	31.56	**0.020**
Time until solid diet	8	−1.2	−1.6, −0.7	**< 0.001**	25	9.28	**0.230**
First bowel movement	7	−0.8	−1.3, −0.2	**0.009**	93	86.71	**< 0.001**
Time until liquid diet	4	0.5	0.1, 0.8	0.730	89	27.03	**< 0.001**
Postoperative adverse events							
Wound infection	13	0.60	0.43, 0.85	**0.003**	7	12.84	0.380
Abscess	4	0.50	0.19, 1.29	0.150	0	2.34	0.50
Small bowel obstruction	10	1.26	0.89, 1.79	0.190	0	7.86	0.550
Ileus	8	0.72	0.40, 1.30	0.280	0	3.73	0.810
Urinary tract Infection	5	1.13	0.64, 2,01	0.680	0	2.93	0.570
Anastomotic leak	9	0.92	0.52, 1.63	0.780	0	7.59	0.470
Re-operation	10	0.96	0.62, 1.49	0.860	0	4.48	0.880
Sepsis	4	1.07	0.33, 3.47	0.910	68	9.50	**0.020**
Pouch failure	4	0.76	0.22, 2.63	0.670	19	3.70	0.300
Pouchitis	2	1.71	0.56, 5.18	0.340	5	1.06	0.300
Function							
No. of bowel movements in 24 h	3	0.04	−1.24, 1.33	0.950	77	8.56	**< 0.010**
No. of bowel movements per night	4	−1.14	−2.2, −0.07	**0.040**	94	47.05	**< 0.001**
Use of pads during the night	2	0.33	0.17, 0.65	**< 0.001**	0	0.19	0.670
Use of pads during the day	2	0.22	0.09, 0.51	**< 0.001**	0	0.41	0.520
Incontinence	7	0.72	0.46, 1.13	0.150	26	8.14	0.230
Absence of dietary restrictions	3	1.84	0.72, 4.68	0.200	66	5.85	0.050
Use of anti-diarrhoeal medication	4	0.82	0.52, 1.29	0.400	0	2.85	0.420

H, heterogeneity; WMD, weighted mean difference. Numbers in bold denote statistically significant *P*-values.

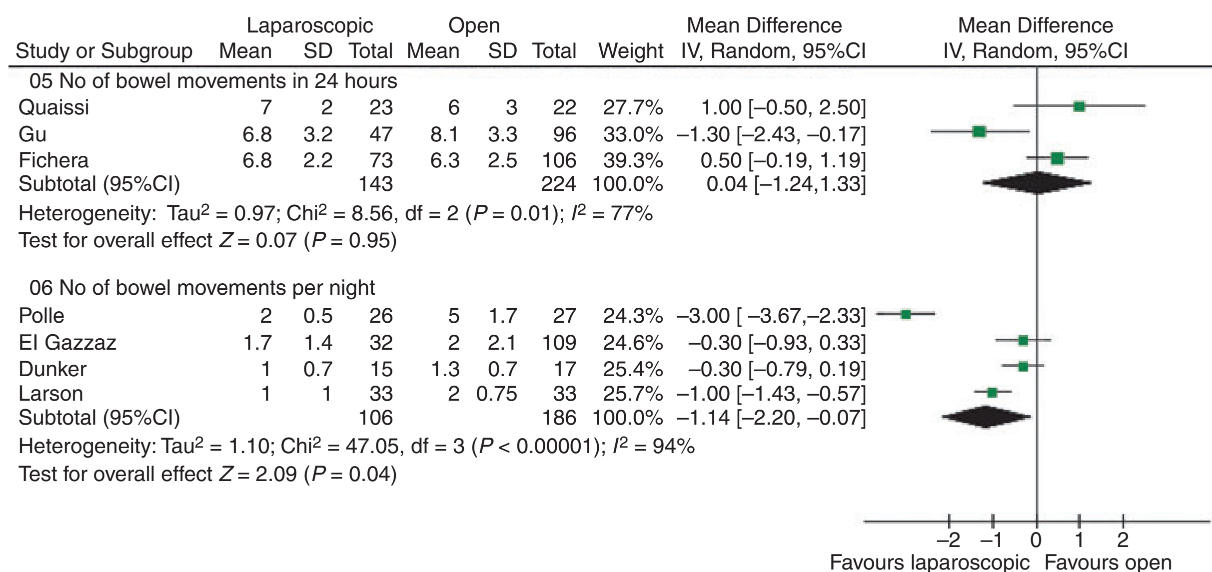

Figure 3 Forest plot illustrating the meta-analysis of functional outcomes (continuous data).

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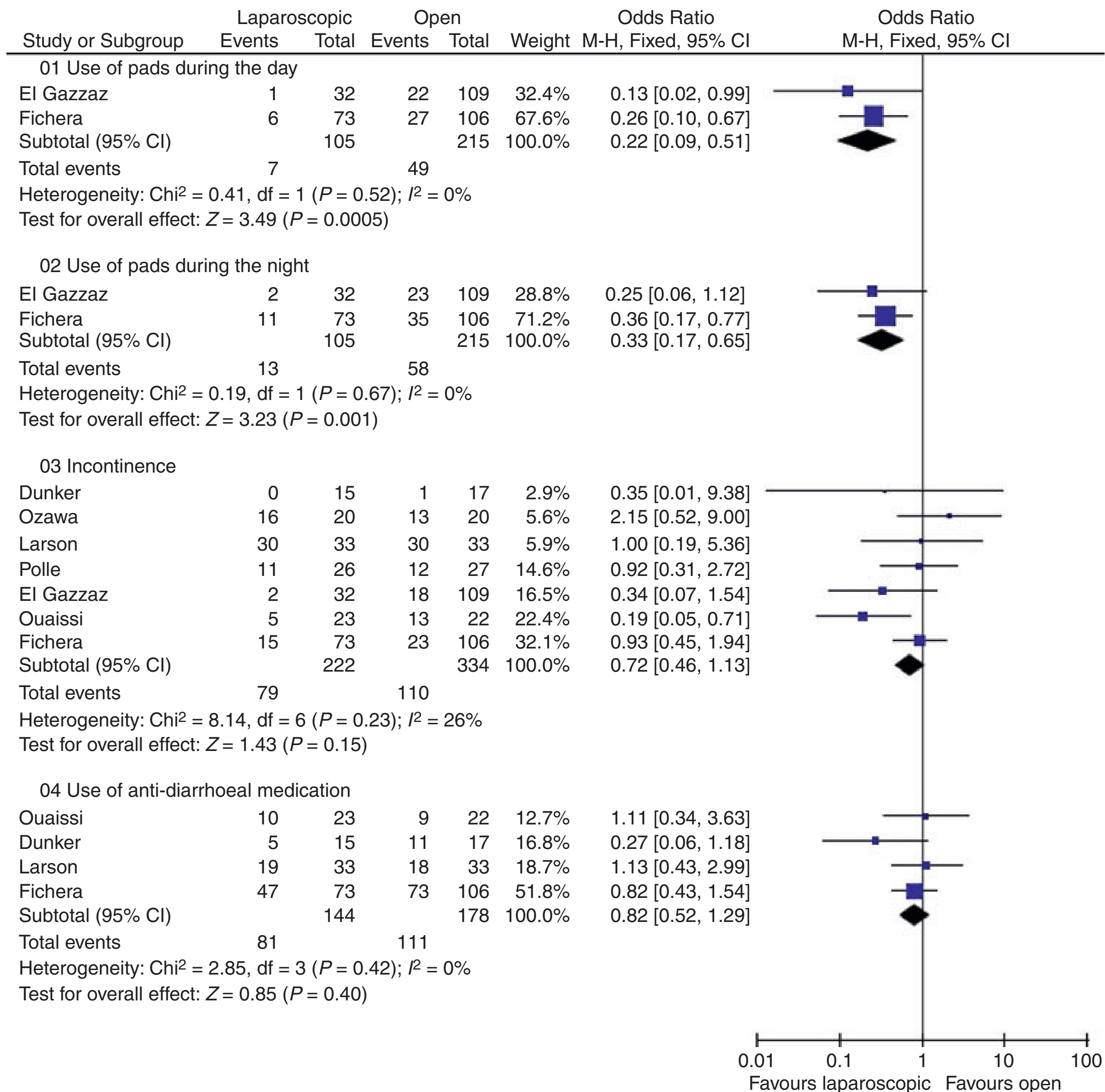

Figure 4 Forest plot illustrating the meta-analysis of functional outcomes (categorical data).

Four studies directly compared HALS with LAS. One was excluded from this analysis due to poor quality [18]. From three studies, the length of operation was significantly lower in the HALS groups (WMD −94.6 min; 95% CI −141.6, −47.7; $P < 0.001$). No difference in length of stay was observed.

Sensitivity analysis

Sensitivity analysis for high quality studies, studies published after 2005 and studies with $n > 30$ showed no difference in terms of intra-operative details (Table S2). Publication bias was assessed using funnel plots. There was significant asymmetry in funnel plots, indicating the presence of a degree of publication bias, most probably arising from the pooling of results from low quality and small numbered studies as seen for length of stay. A significant reduction in bias was observed when only high quality studies were included (Fig. 5).

Sensitivity analyses for studies published during or after 2005 and for studies with 30 or more patients in each group gave similar results to the high quality analysis. For postoperative parameters, time until resumption of a liquid diet was slightly shorter than in the

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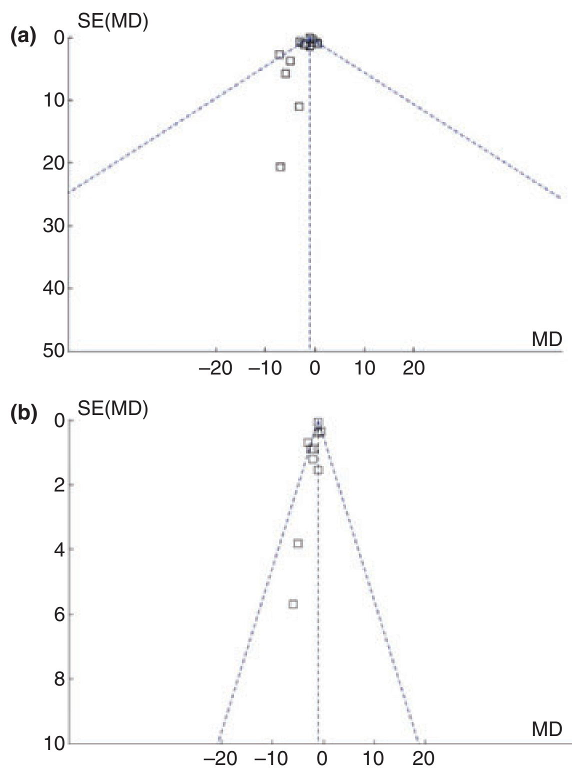

Figure 5 Funnel plot for (a) overall meta-analysis of length of stay (LOS) and (b) high quality sensitivity analysis for LOS. The narrower confidence intervals in (b) demonstrate a reduction in publication bias.

laparoscopic group amongst high quality studies (WMD −0.88; 95% CI −1.50, −0.27; $P < 0.005$), in contrast with the overall analysis which showed no difference. Sensitivity analysis did not produce significantly different results to the overall analysis for all other postoperative parameters.

Amongst adverse events, the proportion of patients diagnosed with a postoperative abscess was found to be lower in the laparoscopic group in high quality studies (OR 0.37; 95% CI 0.14, 0.98; $P < 0.050$) compared with the overall analysis (OR 0.50; 95% CI 0.19, 1.29; $P = 0.150$). The results of all other adverse events were not affected by the sensitivity analysis.

Regarding function, the frequency of nocturnal defaecation was not significantly different (WMD −1.65; 95% CI −4.29, 1.00; $P = 0.22$).

Discussion

The present meta-analysis showed that laparoscopic RPC led to similar adverse event rates and long-term function compared with an open approach. Some modest improvements were found with laparoscopic RPC including a slight reduction of frequency of nocturnal defaecation (0.6 movements) and a lower proportion of patients requiring the use of a pad (66%). The 24-h bowel frequency, which is a key measure of function following RPC, was not significantly different between the two groups. Although the adverse event rates were not significantly different between the laparoscopic and open groups, the pooled studies were not adequately powered to detect any true difference.

Other factors also need to be considered when considering laparoscopic surgery. It is important to prevent tension whilst ensuring a low enough anastomosis to prevent a retained cuff with its increased risk of poor function and failure. There is potential for increased tension during a laparoscopic procedure due to difficulty in achieving a high level of mesenteric arterial division. Only one study reported the height of the anastomosis during laparoscopic and open RPC (median 3.0 cm from the anal verge for both) [21].

Although there was no significant difference between pouch failure for laparoscopic (0.8%) and open (1.2%), follow-up is currently insufficient and 5-year results are awaited. The number of included patients in the present study was too low to detect adequately a true difference. Further randomized trials including more patients are required.

This meta-analysis has confirmed previous findings that laparoscopic RPC is associated with less intra-operative blood loss, a longer duration of surgery and a reduced postoperative hospital stay compared with open RPC [8]. We have also shown a faster time to the resumption of intestinal function, a lower risk of wound infection and a lower risk of abscess formation with laparoscopic surgery. The differences in length of procedure were less pronounced than in previously reported data. The conversion rate from laparoscopic to open surgery was below 1% which is less than the rates from early laparoscopic reports of RPC [25]. These improvements illustrate the effect of the learning curve and improved patient selection over the last decade. Several authors have suggested that the laparoscopic approach should only be attempted by surgeons who have performed a predetermined number of laparoscopic colectomies, and that such procedures should be performed exclusively in specialist centres [26,27].

The comparison of HALS and LAS showed that laparoscopic hand-assisted procedures were significantly faster to perform but maintained an equivalent short-term outcome. In particular, easier retraction of organs, easier identification of vascular structures by palpation and faster omental dissection are cited as advantages of a hand-assisted approach [28,29]. The improved operation time of this technique was not offset by an increase in hospital stay. The most obvious advantage of a totally

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laparoscopic approach is improved cosmesis. Further comparisons of long-term function between HALS, LAS and TLS would be advantageous to determine the optimal approach to RPC.

Some modest functional benefits were noted, although pre-selection limits the generalization of these results. The benefits included reduced nocturnal bowel frequency and reduced pad usage. The functional benefits may be explained by less intra-operative trauma and less damage to nerves and reduced disruption to the physiological state of the bowel. Objective assessment of quality of life is difficult and depends on the use of questionnaires. Various methods were used in the studies, including the GIQLI scale, SF-36 and the Cleveland Global Quality of Life scale. Two studies showed a significantly better cosmetic outcome for laparoscopic patients whilst another found no difference between the laparoscopic and open groups up to 5 years of follow-up. One study noted discrepancies in quality of life scores between men and women [30]. Variations in patient expectations, the possible low importance given to cosmesis and the subjective nature of current means of assessment may explain these findings. Future studies should use consistent tools for assessing quality of life to enable more robust comparisons.

One study has indicated that laparoscopic surgery may confer fertility benefits over open surgery (as measured by postoperative pregnancy rates) [24]. This may be due to reduced adhesion formation, as shown in a recent non-randomized, case-matched study where laparoscopic RPC was associated with lower incisional ($P = 0.004$) and adnexal ($P = 0.002$) adhesions compared with open RPC [31]. Thus young women who still wish to conceive may benefit from a laparoscopic approach.

Limitations of this analysis relate to the quality of included studies, with lack of randomization and blinding during follow-up. In addition, the follow-up period may have been insufficient to demonstrate significant differences in function. This is further reflected by the low power to detect true differences. Various end-points make comparison between studies difficult. Although a random effects model was used where statistical heterogeneity was present, the considerable clinical heterogeneity will always create a risk of bias, especially when meta-analysing data from observational studies as was the case in this review. This heterogeneity is also reflected by asymmetry of some forest plots, even when overall significant effects (and also non-significant effects) were observed.

Standardization of long-term function reporting would be beneficial to allow improved comparison between studies. The recently registered LapConPouch trial will contribute to the knowledge base by comparing laparoscopic and open RPC in a randomized controlled trial, although it may be some time for these data to mature enough for analysis [32]. In the meantime, this meta-analysis presents the best available data.

This study has found that laparoscopic and open RPC result in similar long-term function and adverse events. However, the present data may be underpowered to detect true differences in adverse event rates, and longer follow-up is needed to assess fully any potential difference in the rate of pouch failure. More comparative information is needed relating to anastomotic level. At present, a more pragmatic selection for a laparoscopic approach is recommended, which should be tailored to the individual patient. Factors may include age, gender, body mass index, and the future wish to conceive in young women. HALS may provide shorter operations with similar benefits to conventional laparoscopy, although further evidence is required.

Author contributions

Study conception and design: PS, AB, RJN, PT. Acquisition of data: PS, AB. Analysis and interpretation of data: PS, AB, RJN, PT. Writing the paper: PS, AB, RJN, PT.

Conflict of interest

None.

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References

1 Parks AG, Nicholls RJ. Proctocolectomy without ileostomy for ulcerative colitis. *Br Med J* 1978; **2:** 85–8.
2 McHugh SM, Diamant NE, McLeod R, Cohen Z. S-pouches vs. J-pouches. A comparison of functional outcomes. *Dis Colon Rectum* 1987; **30:** 671–7.
3 Nugent KP, Daniels P, Stewart B, Patankar R, Johnson CD. Quality of life in stoma patients. *Dis Colon Rectum* 1999; **42:** 1569–74.
4 Utsunomiya J, Iwama T, Imajo M *et al.* Total colectomy, mucosal proctectomy, and ileoanal anastomosis. *Dis Colon Rectum* 1980; **23:** 459–66.
5 Mowat C, Cole A, Windsor A *et al.* Guidelines for the management of inflammatory bowel disease in adults. *Gut* 2011; **60:** 571–607.
6 Kartheuser A, Stangherlin P, Brandt D, Remue C, Sempoux C. Restorative proctocolectomy and ileal pouch–anal

14631318, 2013, 7, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/codi.12231 by Columbia University Libraries, Wiley Online Library on [07/03/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

anastomosis for familial adenomatous polyposis revisited. *Fam Cancer* 2006; **5:** 241–60. discussion 61–2.

7 Ahmed Ali U, Keus F, Heikens JT *et al.* Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis. *Cochrane Database Syst Rev* 2009; **1:** CD006267.

8 Tilney HS, Lovegrove RE, Heriot AG *et al.* Comparison of short-term outcomes of laparoscopic vs open approaches to ileal pouch surgery. *Int J Colorectal Dis* 2007; **22:** 531–42.

9 Santoro E, Carlini M, Carboni F, Feroce A. Laparoscopic total proctocolectomy with ileal J pouch–anal anastomosis. *Hepatogastroenterology* 1999; **46:** 894–9.

10 Pace DE, Seshadri PA, Chiasson PM, Poulin EC, Schlachta CM, Mamazza J. Early experience with laparoscopic ileal pouch–anal anastomosis for ulcerative colitis. *Surg Laparosc Endosc Percutan Tech* 2002; **12:** 337–41.

11 Hasegawa H, Watanabe M, Baba H, Nishibori H, Kitajima M. Laparoscopic restorative proctocolectomy for patients with ulcerative colitis. *J Laparoendosc Adv Surg Tech A* 2002; **12:** 403–6.

12 Liberati A, Altman DG, Tetzlaff J *et al.* The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *J Clin Epidemiol* 2009; **62:** e1–34.

13 DerSimonian R, Laird N. Meta-analysis in clinical trials. *Control Clin Trials* 1986; **7:** 177–88.

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

15 Hozo SP, Djulbegovic B, Hozo I. Estimating the mean and variance from the median, range, and the size of a sample. *BMC Med Res Methodol* 2005; **5:** 13.

16 Wells GA, Shea B, O'Connell D *et al.* (2000) The Newcastle–Ottawa Scale (NOS) for assessing the quality of non-randomised studies in meta-analyses. In: *3rd Symposium on Systematic Reviews: Beyond the Basics. Improving Quality and Impact.*

17 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 case-matched series. *Dis Colon Rectum* 2005; **48:** 1845–50.

18 Larson DW, Cima RR, Dozois EJ *et al.* Safety, feasibility, and short-term outcomes of laparoscopic ileal-pouch–anal anastomosis: a single institutional case-matched experience. *Ann Surg* 2006; **243:** 667–70. discussion 70–2.

19 Gu J, Stocchi L, Geisler DP, Kiran RP. Staged restorative proctocolectomy: laparoscopic or open completion proctectomy after laparoscopic subtotal colectomy? *Surg Endosc* 2011; **25:** 3294–9.

20 Maartense S, Dunker MS, Slors JF *et al.* Hand-assisted laparoscopic versus open restorative proctocolectomy with ileal pouch anal anastomosis: a randomized trial. *Ann Surg* 2004; **240:** 984–91. discussion 91–2.

21 Brown SR, Eu KW, Seow-Choen F. Consecutive series of laparoscopic-assisted vs. minilaparotomy restorative proctocolectomies. *Dis Colon Rectum* 2001; **44:** 397–400.

22 Polle SW, Dunker MS, Slors JF *et al.* Body image, cosmesis, quality of life, and functional outcome of hand-assisted laparoscopic versus open restorative proctocolectomy: long-term results of a randomized trial. *Surg Endosc* 2007; **21:** 1301–7.

23 Dunker MS, Bemelman WA, Slors JF, 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. *Dis Colon Rectum* 2001; **44:** 1800–7.

24 Bartels SA, D'Hoore A, Cuesta MA, Bensdorp AJ, Lucas C, Bemelman WA. Significantly increased pregnancy rates after laparoscopic restorative proctocolectomy: a cross-sectional study. *Ann Surg* 2012; **256:** 1045–8.

25 Ozawa H, Nakamura T, Ikeda A *et al.* Benefits of a straight laparoscopic restorative proctocolectomy with ileal pouch anal anastomosis for ulcerative colitis: a retrospective case-matched study. *Surg Laparosc Endosc Percutan Tech* 2012; **22:** 118–21.

26 Kelly J, Condon ET, Redmond HP, Kirwan WO. The benefits of a laparoscopic approach in ileal pouch anal anastomosis formation: a single institutional retrospective case-matched experience. *Ir J Med Sci* 2010; **179:** 197–200.

27 Marcello PW, Milsom JW, Wong SK *et al.* Laparoscopic restorative proctocolectomy: case-matched comparative study with open restorative proctocolectomy. *Dis Colon Rectum* 2000; **43:** 604–8.

28 Nakajima K, Nezu R, Ito T, Nishida T. Hand-assisted laparoscopic restorative proctocolectomy for ulcerative colitis: the optimization of instrumentation toward standardization. *Surg Today* 2010; **40:** 840–4.

29 Targarona EM, Gracia E, Garriga J *et al.* Prospective randomized trial comparing conventional laparoscopic colectomy with hand-assisted laparoscopic colectomy: applicability, immediate clinical outcome, inflammatory response, and cost. *Surg Endosc* 2002; **16:** 234–9.

30 Polle SW, Van Berge Henegouwen MI, Slors JF, Cuesta MA, Gouma DJ, Bemelman WA. Total laparoscopic restorative proctocolectomy: are there advantages compared with the open and hand-assisted approaches? *Dis Colon Rectum* 2008; **51:** 541–8.

31 Hull TL, Joyce MR, Geisler DP, Coffey JC. Adhesions after laparoscopic and open ileal pouch–anal anastomosis surgery for ulcerative colitis. *Br J Surg* 2012; **99:** 270–5.

32 Antolovic D, Kienle P, Knaebel HP *et al.* 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 Surg* 2006; **6:** 13.

33 Araki Y, Ishibashi N, Ogata Y, Shirouzu K, Isomoto H. The usefulness of restorative laparoscopic-assisted total colectomy for ulcerative colitis. *Kurume Med J* 2001; **48:** 99–103.

34 Berdah SV, Barthet M, Emungania O *et al.* Two stage videoassisted restorative proctocolectomy. Early experience of 12 cases. *Ann Chir* 2004; **129:** 332–6.

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35 Dolejs S, Kennedy G, Heise CP. Small bowel obstruction following restorative proctocolectomy: affected by a laparoscopic approach? *J Surg Res* 2011; **170:** 202–8.
36 El-Gazzaz GS, Kiran RP, Remzi FH, Hull TL, Geisler DP. Outcomes for case-matched laparoscopically assisted versus open restorative proctocolectomy. *Br J Surg* 2009; **96:** 522–6.
37 Fajardo AD, Dharmarajan S, George V *et al.* Laparoscopic versus open 2-stage ileal pouch: laparoscopic approach allows for faster restoration of intestinal continuity. *J Am Coll Surg* 2010; **211:** 377–83.
38 Fichera A, Silvestri MT, Hurst RD, Rubin MA, Michelassi F. Laparoscopic restorative proctocolectomy with ileal pouch anal anastomosis: a comparative observational study on long-term functional results. *J Gastrointest Surg* 2009; **13:** 526–32.
39 Fleming FJ, Francone TD, Kim MJ, Gunzler D, Messing S, Monson JR. A laparoscopic approach does reduce short-term complications in patients undergoing ileal pouch–anal anastomosis. *Dis Colon Rectum* 2011; **54:** 176–82.
40 Hashimoto A, Funayama Y, Naito H *et al.* Laparascope-assisted versus conventional restorative proctocolectomy with rectal mucosectomy. *Surg Today* 2001; **31:** 210–4.
41 Otani Y, Aihara N, Kokuba Y, Ihara AKA. Laparoscopy-assisted ileal-pouch anal-canal anastomosis for ulcerative colitis. *Japan J Gastroenterol Surg* 2001; **34:** 351–6.
42 Ouaissi M, Lefevre JH, Bretagnol F, Alves A, Valleur P, Panis Y. Laparoscopic 3-step restorative proctocolectomy: comparative study with open approach in 45 patients. *Surg Laparosc Endosc Percutan Tech* 2008; **18:** 357–62.
43 Rivadeneira DE, Marcello PW, Roberts PL *et al.* Benefits of hand-assisted laparoscopic restorative proctocolectomy: a comparative study. *Dis Colon Rectum* 2004; **47:** 1371–6.
44 Schmitt SL, Cohen SM, Wexner SD, Nogueras JJ, Jagelman DG. Does laparoscopic-assisted ileal pouch anal anastomosis reduce the length of hospitalization? *Int J Colorectal Dis* 1994; **9:** 134–7.
45 Sylla P, Chessin DB, Gorfine SR, Roth E, Bub DS, Bauer JJ. Evaluation of one-stage laparoscopic-assisted restorative proctocolectomy at a specialty center: comparison with the open approach. *Dis Colon Rectum* 2009; **52:** 394–9.
46 Tan YW, Jaffray B. A comparison of open and laparoscopic restorative proctocolectomy in children. *Pediatr Surg Int* 2009; **25:** 877–9.
47 Tsuruta M, Hasegawa H, Ishii Y *et al.* Hand-assisted versus conventional laparoscopic restorative proctocolectomy for ulcerative colitis. *Surg Laparosc Endosc Percutan Tech* 2009; **19:** 52–6.
48 Zhang H, Hu S, Zhang G *et al.* Laparoscopic versus open proctocolectomy with ileal pouch–anal anastomosis. *Minim Invasive Ther Allied Technol* 2007; **16:** 187–91.

Supporting Information

Additional Supporting Information may be found in the online version of this article:

Table S1. Rates of adverse events in each study.
Table S2. Sensitivity analysis of high quality studies.

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