



Loop transverse colostomy versus loop ileostomy for defunctioning of colorectal anastomosis: a systematic review, updated conventional meta-analysis, and cumulative meta-analysis

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Abstract

Defunctioning of colorectal anastomosis either with loop transverse colostomy or ileostomy was evaluated using updated and cumulative meta-analyses. Studies were identified by a systematic search of Embase, PubMed, Cochrane Library, and Google Scholar databases and were selected as per the PRISMA checklist. Both randomised control trials (RCTs) and retrospective studies were included. A sensitivity analysis was performed, and a cumulative meta-analysis was performed to monitor evidence over time. Significantly more male patients underwent loop ileostomy than transverse colostomy [odds ratio (OR) = 0.59 (95% confidence interval (CI) 0.39, 0.90), $p < 0.001$, $I^2 = 48\%$]. Significantly more colostomies were complicated by stoma prolapse than by ileostomies [OR = 6.32 (95% CI 2.78, 14.35), $p < 0.001$, $I^2 = 0\%$]. Patients with ileostomy demonstrated a significantly higher complication rate of high-output stoma than patients with colostomies [Peto OR = 0.16 (95% CI 0.04, 0.55), $p = 0.004$, $I^2 = 0\%$]. Patients with colostomies demonstrated significantly more complications related to stoma reversal, such as wound infections and incisional hernias, than patients with ileostomies [OR = 3.45 (95% CI 2.00, 5.95), $p < 0.001$, $I^2 = 0\%$; OR = 4.80 (95% CI 1.85, 12.44), $p < 0.001$, $I^2 = 0\%$, respectively]. Overall complications related to stoma formation and closure did not demonstrate significant differences; however, their I^2 values were 82% and 76%, respectively, suggesting high heterogeneity, which may have influenced the results. A subgroup analysis of RCTs showed no discrepancies when compared to the whole sample. In the cumulative meta-analysis, the effect size of each study was non-significant for the entire period. The demonstrated significant differences did not translate in favour of ileostomy when the overall complications of stoma formation and reversal were evaluated. Confounding factors and underpowered samples may have influenced the results. Future multicentre RCTs with homogeneous populations and adequate power may demonstrate more conclusive evidence regarding the superiority of one procedure over the other.

Keywords Loop colostomy · Temporary transverse colostomy · Loop ileostomy · Defunctioning stoma · Colorectal anastomosis

Introduction

The change in the paradigm that started with the introduction of total mesorectal excision (TME) by Heald dramatically increased the rate of sphincter-preserving low-anterior

resection [1]. TME became accepted as a standard procedure because of the observed low recurrence rate and prolonged survival [2, 3]. However, its Achilles' heel is associated symptomatic anastomotic leakage, which can result in increased morbidity and mortality as well as an elevated recurrence rate [4–6]. Based on existing evidence, an advanced age, male sex, obesity, cardiovascular comorbidities, corticosteroid use, malnutrition, clinical obstruction, preoperative chemoradiotherapy, transfusion, contamination of the operative field, technical failures, and anastomosis 5 cm from the anal verge are indications for routine stoma defunctioning via either colostomy or ileostomy for any extraperitoneal anastomosis [7–9].

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There has been conclusive evidence that stoma defunctioning with either transverse colostomy or ileostomy mitigates the serious consequences of anastomotic leakage [5–7]. However, whether transverse colostomy or ileostomy is preferred for defunctioning a colorectal anastomosis remains controversial. Indeed, among five randomised control trials (RCTs), two support colostomies [20, 24], and three support ileostomies [18, 19, 22]. Furthermore, three published meta-analyses failed to determine the superiority of one procedure over the other [10–12].

The aim of this study was to determine whether or not one procedure was superior to the other using updated conventional and cumulative meta-analyses.

Methods

This systematic review and meta-analysis was carried out in accordance with the guidelines set out in the preferred reporting in systematic review and meta-analysis (PRISMA) checklist.

Literature search

A systematic literature search of articles published in the last 32 years was performed using the Embase, MEDLINE (PubMed), Cochrane library, and Google Scholar databases with free text and MeSH search terms (loop colostomy; loop ileostomy; temporary transverse colostomy; defunctioning ileostomy; colorectal anastomosis; randomised or randomised controlled trial). A grey literature search of the clinicaltrials.gov website was also performed. References in the retrieved articles were checked manually for further analyses. Disagreements between authors were resolved by consensus.

Study selection and inclusion and exclusion criteria

RCTs, retrospective studies, and case-matched studies that compared temporary loop transverse colostomy to loop ileostomy for defunctioning of colorectal anastomosis were included in the study. All non-comparative studies, reviews, and narrative articles were excluded.

Data extraction and outcomes

Two reviewers (PG and DA) independently extracted the following summary data for the included studies: name of authors; age, sex, diagnosis, stoma not reversed, overall complications of stoma formation, high output, skin irritation, skin retraction, parastomal sepsis, parastomal hernia, stoma prolapse, overall complications of stoma reversal, time to stoma reversal, operative time, ileus/obstruction,

wound infections, anastomotic leak/fistula, incisional hernia after stoma reversal, and mortality related to stoma formation and closure.

Assessing the risk of bias in the included studies

Two authors (PG, DA) independently assessed the risk of selection, attrition, detection, performance, and reporting bias for each included RCT. The above items were categorised according to the Cochrane Handbook for Systematic Reviews of Interventions as a high, low, or unclear risk [13]. Furthermore, the methodological quality of all included studies was assessed with the validated Newcastle–Ottawa scale (NOS) [14]; studies that scored ≥ 7 were considered of a high quality. The NOS is an assessment tool used to measure the quality of retrospective studies included in systematic reviews and meta-analyses. Using this tool, each study was assessed for eight parameters, categorised into three groups: first, the selection of the study groups; second, the comparability of the groups; and third, the ascertainment of either the exposure or outcome of interest for case-control studies, respectively. One point was awarded for each quality item. The highest quality studies were awarded up to nine points [14].

Definitions

The indications for defunctioning stoma were described by the authors. The operative time was defined as time from scalpel to skin until the last skin stitch. The length of stay was defined as the number of days from the operation day until the day of discharge. All variables were reported as described by the authors of each of the included studies. The authors of the included studies did not specify the importance of the hierarchy of the outcomes included in the overall complications of the stoma formation and reversal.

Statistical analyses

Statistical analyses were conducted using the Review Manager 5.3 software programme (Cochrane Collaboration, Oxford, UK). Heterogeneity was assessed through the I^2 statistic, and cut-off values of 25%, 50%, and 75% were considered low, moderate, and high, respectively [15]. In such cases, both fixed- and random-effects models were produced, and the conclusions compared, with the latter used preferentially in cases where there were discrepancies between the two models. In cases of I^2 values less than 25%, fixed-effects models were used throughout.

Dichotomous variables were analysed based on the odds ratios (ORs) with 95% confidence intervals (CIs). For the analysed outcomes, the reference categories were selected so that an OR < 1 favoured loop colostomy. Continuous

variables were combined based on both the mean difference (MD) and the standardised mean difference (SMD). The studies were then combined using the Mantel–Haenszel method in the first instance, with the Peto approach used when the cross-table had zero cells [13]. For studies that did not report the means and variances for the two groups, these values were estimated from the median, range, and sample size where possible using the technique described by Hozo et al. [16]. In all analyses, the significance level was set at $p < 0.05$. Cumulative meta-analyses were conducted using the STATA software programme (version 15; Stata Corp LP, College Station, TX, USA).

Sensitivity analyses

Analyses of the outcomes were conducted using both random-effects and fixed-effects models to assess the impact of heterogeneity on the results. A subgroup analysis of the RCTs was also performed. Publication bias was not estimated because fewer than ten studies were included in each outcome [17]. Cumulative meta-analyses were performed to detect the accumulation of evidence over time.

Results

Search strategy and included study characteristics

Ten studies including a total of 1534 patients were selected from a pool of 329 studies (Fig. 1) [18–27]. Of these patients, 628 (41%) with loop transverse colostomies and 906 (59%) with ileostomies were included in this study. Six studies were excluded because of incomplete reporting of outcomes.

Seven of the ten studies scored more than 7 points in the NOS and were, therefore, characterized as being of a high quality (Table 1) [19–24, 27].

Quality of RCTs

Generally, the RCT quality was poor (Table 2) [18–20, 22, 24]. There was a high, widespread risk of inadequate blinding of outcome assessors. Only one study adequately addressed the sequence generation. Allocation was adequately concealed in three of five studies, and none of the

Fig. 1 Flow diagram of the search strategy

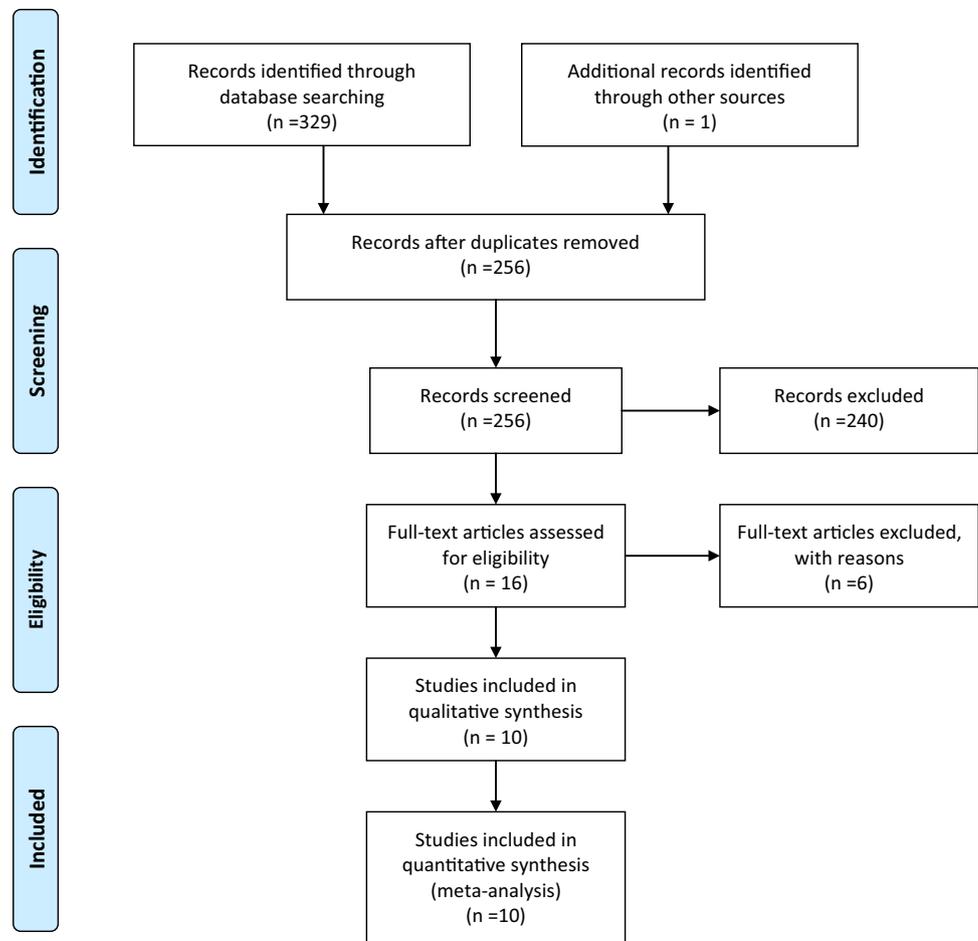


Table 1 Study characteristics

Study	Number of patients LC-LI	Age LC-LI	Gender LC-LI male, <i>N</i> (%)	Proportion of neoplasms LC-LI	Indications for stoma formation	Stoma not reversed, <i>N</i> (%)	Mortality of stoma formation and closure	NOS Max = 9
Klink C, RS, 2011, Germany	100–100	62 ± 12 64 ± 13 <i>p</i> = 0.259	58 (58) 57 (57) <i>p</i> = 1.00	76 (76) 70 (70) <i>p</i> = 0.744	B, D, E, F	0–0	0–0	8
Mala T, RS, 2008, Norway	10–61	NR	NR	NR	NR	0–0	0–2 <i>p</i> = 1.00	5
Gastinger I, PNR, 2005, Germany	229–407	66 ± 11 65 ± 10 <i>p</i> = 0.243	Similar	All	NR	40 (15) 48 (11) <i>p</i> = 0.099	0–2 <i>p</i> = 0.539	4
Law W, RCT, 2002, HK	38–42	68 ± 8 65 ± 5 <i>p</i> = 0.045	23 (61) 26 (62) <i>p</i> = 1.00	All	F	0 (0) 7 (17) <i>p</i> = 0.016	0–2 <i>p</i> = 0.496	8
Rullier E, RS, 2001, France	60–107	64 ± 13.8 63 ± 15.8 <i>p</i> = 0.682	40 (67) 81 (76) <i>p</i> = 0.706	All	A, E	10 (17) 11 (10) <i>p</i> = 0.341	0–0	7
Edwards D, RCT, 2001, UK	36–34	68 ± 14.5 63 ± 11.3 <i>p</i> = 0.113	22 (61) 27 (79) <i>p</i> = 0.576	35 (97) 33 (97) <i>p</i> = 1.00	NR	5 (14) 2 (6) <i>p</i> = 0.438	0–0	8
Sakai Y, CMS, 2001, Japan	63–63	64 ± 15 64 ± 13 <i>p</i> = 1.00	20 (32) 42 (67) <i>p</i> = 0.028	48 (76) 48 (76) <i>p</i> = 1.00	B, D, E, F	NR	4–1 <i>p</i> = 0.365	8
Gooszen A, RCT, 1998, Netherlands	39–37	65 ± 14 63 ± 13 <i>p</i> = 0.521	13 (33) 14 (38) <i>p</i> = 0.825	19 (49) 14 (38) <i>p</i> = 0.676	B, E, F	2 (5) 2 (5) <i>p</i> = 1.00	1–5 <i>p</i> = 0.202	8
Khoury G, RCT, 1987, UK	29–32	65 ± 9 65 ± 10 <i>p</i> = 1.00	13 (46) 23 (69) <i>p</i> = 0.296	24 (73) 24 (85) <i>p</i> = 0.848	A, B, C, D, E	NR	0–0	7
Williams N, RCT, 1986, UK	24–23	71 ± 13 67 ± 14 <i>p</i> = 0.315	11 (46) 12 (50) <i>p</i> = 1.00	18 (75%) 20 (87%) <i>p</i> = 0.828	Personal view of the surgeon	0–0	0–0	6
Pooled differences	628(41%)- 906(59%) Total:1534	MD = 1.11 (– 0.06, 2.27) <i>p</i> = 0.06	OR = 0.59 (0.39, 0.90) <i>p</i> = 0.01	OR = 1.21 (0.82, 1.79) <i>p</i> = 0.33		OR = 1.40 (0.96, 2.06) <i>p</i> = 0.8	OR = 0.62 (0.24, 1.64) <i>p</i> = 0.34	HQ = 7

Indications for stoma formation: (A) severe cardiovascular disease, (B) colonic obstruction, (C) poor bowel preparation, (D) extensive loco-regional malignancy, (E) technical Anastomotic problem, (F) anastomosis below 5 cm

RS retrospective study, PNR prospective non-randomised, RCT randomised control trial, CMS case-matched study, MD mean difference, OR odds ratio, HQ high quality, N number, NOS Newcastle–Ottawa scale

Table 2 Risk of bias of RCTs

Author	Sequence generation	Allocation concealment	Incomplete outcome data	Blinding
Law	Unclear	Low	High	High
Edwards	Unclear	Low	High	High
Gooszen	Unclear	Unclear	High	High
Khoury	Low	Unclear	High	High
Williams	Unclear	Low	High	High
Pooled results	Low risk 1	Low risk 3	Low risk 0	Low risk 0

RCT randomised control trial

studies performed an intention-to-treat analysis for the missing data.

Demographic and tumour characteristics

There was no significant difference in the demographics, proportion of malignancies, and rate of non-reversed stomas between the two groups (Tables 1, 3).

Complications related to stoma formation

- High-output stoma.

Four of the ten studies reported high-output stoma, [21–24]. No cases in the colostomy cohort developed high-output complications, compared to 4% (10/246) in the ileostomy cohort [Peto OR = 0.16 (95% CI 0.04–0.55), $p = 0.004$].

- Stoma prolapse.

Six of the ten studies reported stoma prolapse complications, [18, 20, 22–24, 27]. There were significantly fewer complications in the ileostomy cohort (2%; 6/343) than in the colostomy cohort (11%; 33/297) [OR = 6.32 (95% CI 2.78–14.35), $p < 0.001$] (Table 3).

- Skin irritation, skin retraction, parastomal hernia, parastomal sepsis, stoma prolapse and overall complication rate.

There was no evidence of significant differences between the colostomy and ileostomy cohorts for any of the above outcomes (Table 3).

Complications related to stoma reversal

- Wound infections.

Nine of the ten studies reported wound infections, [18–24, 26, 27]. Significantly more wound infections occurred in the colostomy cohort (5%; 14/299) than in the ileostomy cohort (1%; 8/575) [OR = 3.45 (95% CI 2.00–5.95), $p < 0.001$] (Fig. 2; Table 3).

- Incisional hernia.

Three of the ten studies reported incisional hernias, [22, 23, 26]. Significantly more incisional hernias occurred in the colostomy cohort (5%; 14/299) than in the ileostomy cohort (1%; 8/575) [OR = 3.45 (95% CI 2.00–5.95), $p < 0.001$].

- Time to stoma reversal, operative time, anastomotic leakage/fistula, length of hospital stay, mortality of stoma formation and closure and overall complications.

There was no evidence of significant differences between the colostomy and ileostomy cohorts for any of the above outcomes (Table 3).

Sensitivity analyses

Analyses of the outcomes using both fixed-effects and random-effects models did not demonstrate significant differences between the results. Furthermore, a subgroup analysis of the RCTs showed no discrepancies when compared to the whole sample. However, many insignificant outcomes, such as stoma with no reversal, overall complications, skin irritation, skin retraction, parastomal sepsis, parastomal hernia, stoma prolapse, overall complications after stoma formation and reversal, operative time, wound infections, anastomotic leak/fistula, and length of hospital stay, demonstrated point estimates in favour of ileostomy (OR > 1; Table 3).

Cumulative meta-analyses

Cumulative meta-analyses did not detect a significant positive or negative impact on the effect size by any of the included studies. Discrepancies were detected between conventional and cumulative meta-analyses in the evaluation of overall complications of stoma reversal. In the conventional meta-analysis, the study by Gastinger favoured colostomy [OR = 0.63 (95% CI 0.41–0.96)]. However, in the cumulative meta-analysis, the effect size became non-significant [OR = 0.73 (95% CI 0.52–1.04)] (Fig. 3). Similarly, the study by Klink in the conventional meta-analysis favoured ileostomy [OR = 3.08 (95% CI 1.58–6.03)], but the result became non-significant in the cumulative meta-analysis (OR = 1.21 [95% CI 0.91–1.61]) (Fig. 3).

Discussion

The aim of this study was to compare the complication rates of loop colostomy and ileostomy for defunctioning of colorectal anastomosis using updated conventional meta-analyses. In addition, the trend and the positive or negative effects of each new study on the pre-existing evidence were estimated using a cumulative meta-analysis.

There were no significant differences in the patient age. However, significantly more male patients underwent ileostomy than colostomy. The proportion of malignancy was 75% in the colostomy cohort and 72% in the ileostomy cohort; although non-significant, this characteristic may have contributed to the clinical heterogeneity of the sample.

Table 3 Outcomes of interest

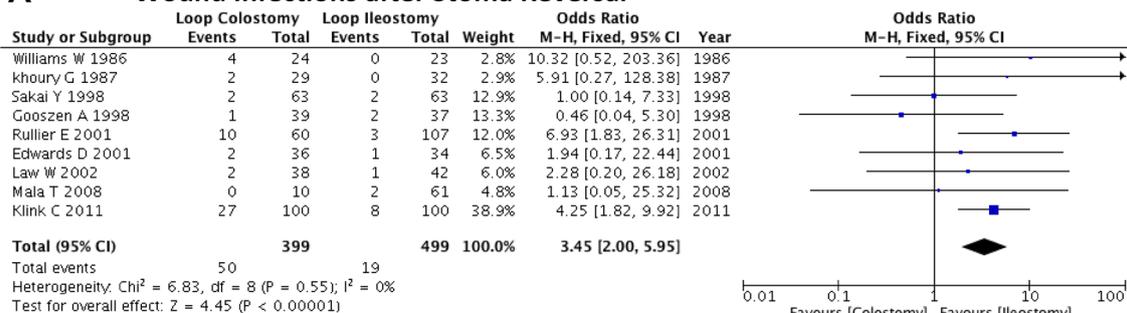
Outcome of interest	Number of studies and patients (%; events/total)	Statistical method, estimated effect, 95% CI	<i>p</i> value	<i>I</i> ² (%)
Age [18–25, 27]	9, 1463	MD = 1.11 (– 0.06 to 2.27)	0.06	0
Male Sex [18–24, 27]	8, 827 (51%; 200/389) (64%; 282/438)	OR = 0.59 (0.39 to 0.90)	0.001	33
Neoplasms [18–25, 27]	6, 580 (76%; 220/291) (72%; 209/289)	OR = 1.21 (0.82 to 1.79)	0.33	0
Stoma not reversed [18–27]	5, 1029 (14%; 57/402) (11%; 70/627)	OR = 1.40 (0.96 to 2.06)	0.08	62
Overall complications after stoma formation				
Overall complications of stoma formation [18–27]	10, 1534 (24%; 153/628) (23%; 207/906)	OR = 1.35 (0.63 to 2.92)	0.44	82
Overall complications of RCTs [18–20, 22, 24]	5, 334 (39%; 64/166) (28%; 47/168)	OR = 2.23 (0.57, 8.69)	0.25	70
High output [21–24]	4, 453 (0%; 0/197) (4%; 10/246)	Peto OR = 0.16 (0.04 to 0.55)	0.004	0
Skin irritation [18–21, 23, 24, 27]	7, 757 (11%; 38/353) (9%; 35/404)	OR = 1.51 (0.54 to 4.24)	0.43	63
Skin retraction [20, 21, 23, 27]	4, 564 (3%; 7/262) (2%; 5/302)	OR = 1.57 (0.22 to 11.04)	0.65	51
Parastomal sepsis [18–20, 22–24, 26, 27]	8, 772 (3%; 10/336) (2%; 6/343)	OR = 1.80 (0.74 to 4.35)	0.19	0
Parastomal hernia [20–24, 26, 27]	7, 790 (4%; 14/346) (4%; 15/444)	OR = 1.41 (0.48 to 4.15)	0.53	38
Stoma prolapse [18, 20, 22–24, 27]	6, 640 (11%; 33/297) (2%; 6/343)	OR = 6.32 (2.78 to 14.35)	0.001	0
Overall complications after Stoma reversal				
Overall complications after stoma reversal [20, 22, 23, 25–27]	9, 1472 (20%; 122/599) (18%; 158/874)	OR = 1.31 (0.66 to 2.63)	0.44	76
Overall complications of RCTs [18, 20, 22, 24]	4, 273 (16%; 22/137) (17%; 23/136)	OR = 0.97 (0.40, 2.34)	0.95	38
Time to stoma reversal [21–23, 27]	4, 563	MD = – 1.23 (– 17.24 to 14.77)	0.88	62
Operative time [18, 21, 22]	3, 243	MD = – 1.07 (– 5.45 to 3.32)	0.63	0
Ileus/Obstruction [18, 20–23, 25, 26]	7, 1193 (2%; 8/461) (4%; 27/732)	OR = 0.53 (0.25 to 1.12)	0.10	0
Wound infections [18–24, 26, 27]	9, 898 (13%; 50/399) (4%; 19/499)	OR = 3.45 (2.00 to 5.95)	0.001	0
Anastomotic leak/fistula [19, 20, 23, 25, 27]	5, 1140 (1%; 6/457) (2%; 11/683)	OR = 1.14 (0.19 to 6.70)	0.80	43

Table 3 (continued)

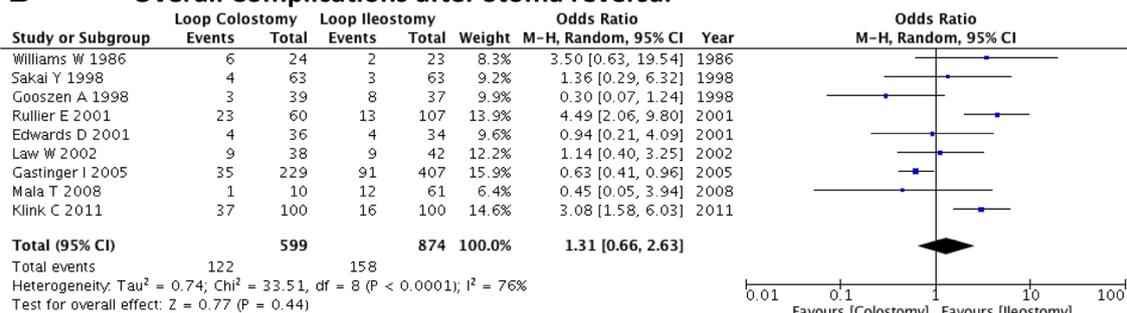
Outcome of interest	Number of studies and patients (%; events/total)	Statistical method, estimated effect, 95% CI	<i>p</i> value	<i>I</i> ² (%)
Incisional hernia [22, 23, 26]	3, 874 (5%; 14/299) (1%; 8/575)	OR=4.80 (1.85 to 12.44)	0.001	0
Length of stay [18, 21, 27]	3, 373	MD=1.84 (− 0.01 to 3.69)	0.05	64
Mortality of stoma formation and closure [18–27]	10,1534 (1%; 5/379) (2%; 12/610)	OR=0.62 (0.24 to 1.64)	0.34	19

MD mean difference, *OR* odds ratio, *CI* confidence interval, *I*² heterogeneity, *RCT* randomised control trial

A Wound Infections after Stoma Reversal



B Overall Complications after Stoma reversal



C Overall complications after Stoma reversal of RCTs

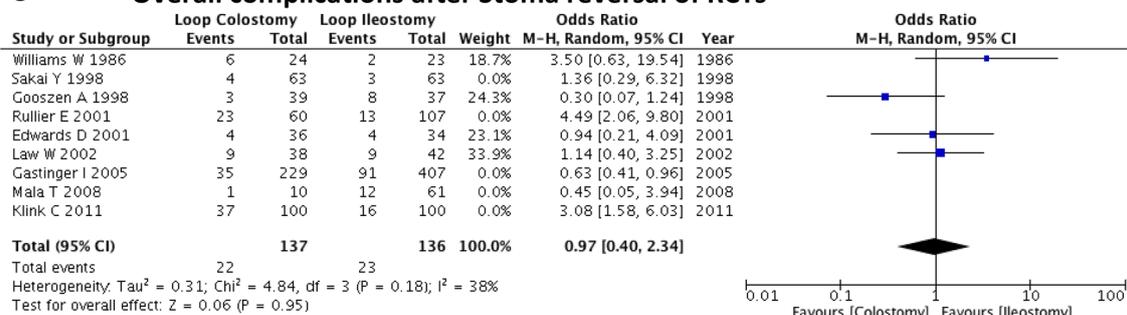
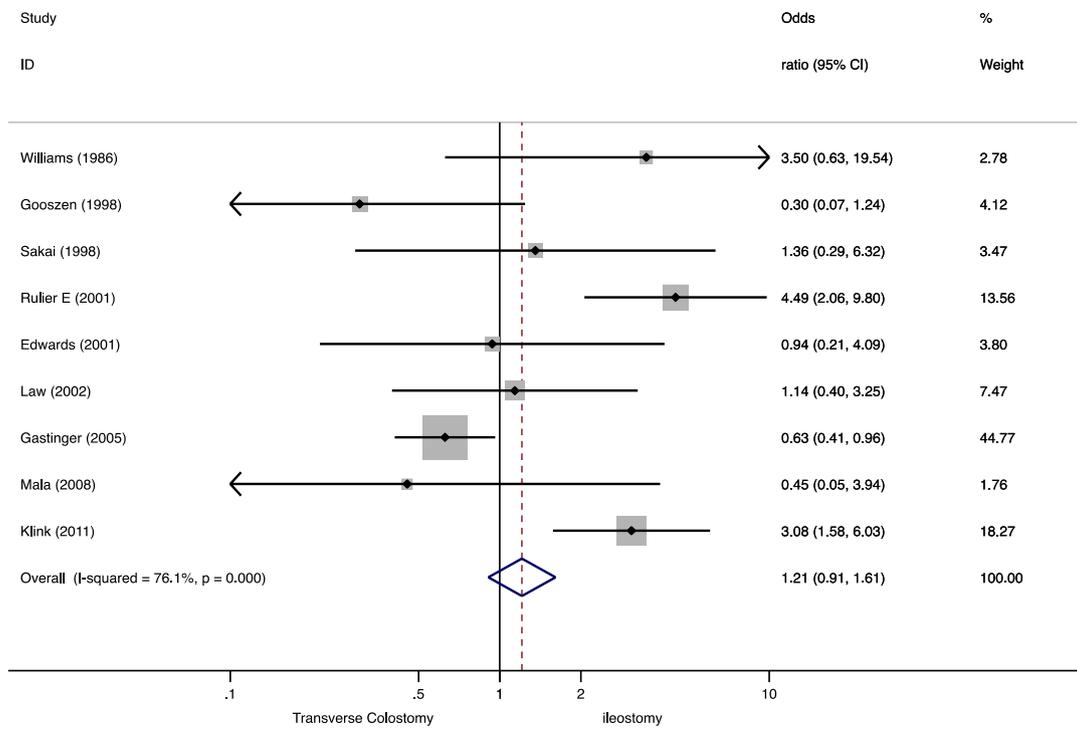


Fig. 2 **a** Wound infections, **b** overall complications after stoma reversal, and **c** overall complications of RCTs

A Conventional Meta-Analysis of Overall Complications after reversal



B Cumulative Meta-Analysis of Overall Complications after Reversal

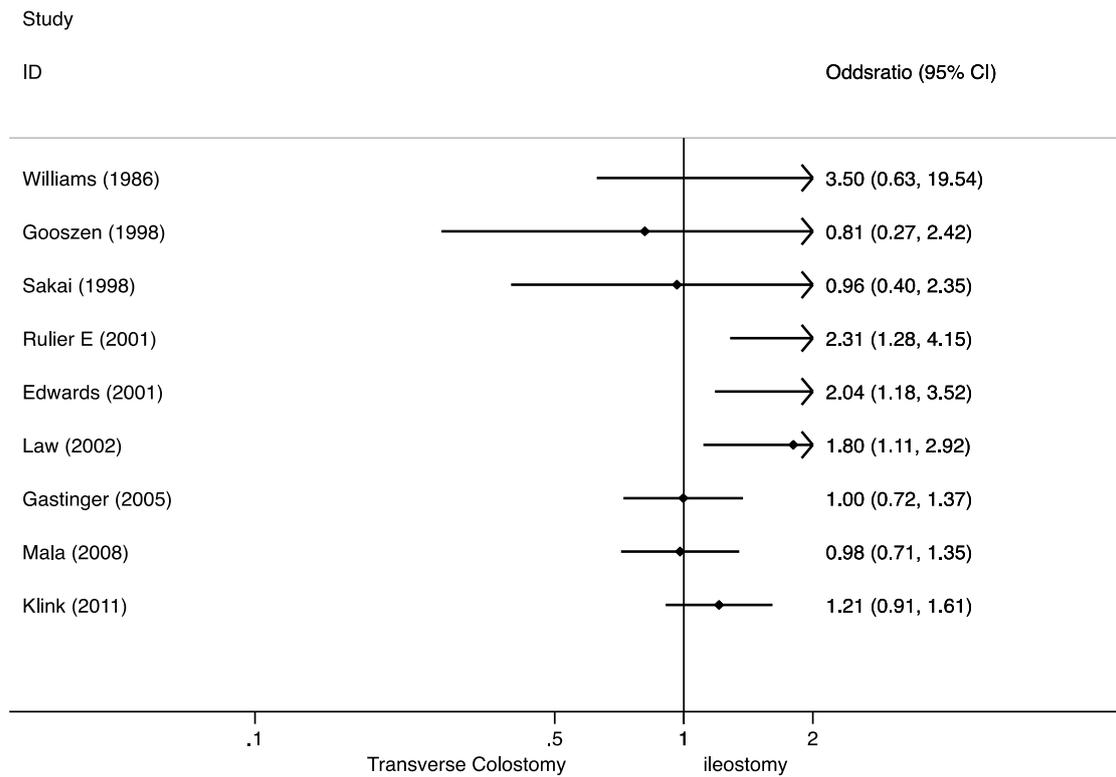


Fig. 3 a Overall complications after stoma reversal using a conventional meta-analysis. b Cumulative meta-analysis of overall complications after reversal

There were no significant differences between the percentages of non-reversed stomas between the two groups. However, the authors did not give further details on how this affected the degree of social restriction and quality of life.

Outcomes related to stoma formation, such as skin irritation, retraction, parastomal sepsis, and hernia, demonstrated non-significant differences between the two groups. However, the rate of stoma prolapse, which is also a technique-related parameter, was significantly higher in the colostomy cohort than in the ileostomy cohort. In contrast, significantly more high-output stomas were observed in the ileostomy cohort than in the colostomy cohort. Of note, when the overall complications arising from stoma formation were evaluated, the effect size became non-significant. Therefore, we can conclude that outcomes with a significant effect size were not able to influence the results. Furthermore, a subgroup analysis of the RCTs did not demonstrate significant differences when compared with the results of the whole sample. A cumulative meta-analysis is a sensitive and specific method used to detect any positive or negative impact on the effect size and to pinpoint the turning points over time [28]. In the present study, the cumulative meta-analysis did not detect any turning points over time, and the effect size of each study was non-significant.

There was no significant difference in the time span of stoma reversal between the two cohorts. Outcomes related to stoma reversal, such as operative time, small bowel obstruction, anastomotic leakage, length of hospital stay, and mortality, demonstrated non-significant differences between the groups. However, variables with differing prevalence over time, such as adhesional obstruction and mortality, may have influenced the widely range in the follow-up periods of the studies (1 month-to-5 years). One study reported a follow-up from 1–6 months, [23] two reported 1 year, [20, 25] and three reported up to 5 years, [22, 24, 26]. Wound infections and incisional hernias after stoma reversal were significantly less frequent in the ileostomy cohort than in the colostomy cohort. A subgroup analysis of the RCTs did not demonstrate any discrepancies with the results of the whole sample.

Of note, the overall complications arising after reversal of the stoma also demonstrated non-significant differences between the two procedures. Interestingly, the ileostomy cohort, with one outcome in favour (stoma prolapse), failed to positively influence the overall complications of stoma formation. Furthermore, with two outcomes in favour (wound infections and incisional hernias), the ileostomy cohort similarly failed to positively influence the result of overall complications after stoma reversal (Fig. 2b, c). Confounding factors or underpowered samples may have influenced these results.

We also investigated the accumulation of evidence over time using a cumulative meta-analysis, and the results were compared with those of conventional meta-analysis.

The cumulative meta-analysis showed that the effect size of individual studies was non-significant. Furthermore, a conventional meta-analysis of the study by Gastinger et al. demonstrated significant effect size in favour of colostomy [OR = 0.63 (95% CI 0.41–0.96)]. However, a cumulative meta-analysis demonstrated a non-significant effect size [OR = 0.73 (95% CI 0.52–1.04)] (Fig. 3). On the other hand, the study by Klink et al. demonstrated a significant effect size on favour of ileostomy [OR = 3.08 (95% CI 1.58–6.03)]. However, the cumulative meta-analysis showed a non-significant effect size [OR = 1.21 (95% CI 0.91–1.61)] (Fig. 3). Thus, the cumulative meta-analysis further confirmed that the currently available evidence is inconclusive.

The present study is the largest meta-analysis to date and included ten studies; all previous meta-analyses have included five studies each [10–12]. While those previous meta-analyses did detect significant differences in wound infections and incisional hernia outcomes, the differences in the overall complications of stoma formation and closure remained non-significant. Therefore, neither the present updated and cumulative meta-analyses nor the previous studies were able to determine the superiority of one procedure over the other when evaluating the overall complications of stoma formation and closure. Therefore, loop transverse colostomy and ileostomy can both be used, depending on the institutional preference and surgeons' experience. However, particular attention should be paid to patients with a marginal renal function who may not tolerate high-output complications of loop ileostomy; for this cohort colostomy is clearly the preferable procedure.

Limitations

However, the results of the above study must be treated cautiously because the included studies consisted of small sample sizes. Furthermore, the overall quality of the RCTs was poor, and retrospective studies may have been influenced by selection, institutional, and national biases. In addition, none of the studies classified morbidity according to the Clavien–Dindo standard definitions. The duration of follow-up in the studies also varied widely.

Implications for research

In conclusion, the evaluation of the existing evidence using both conventional and cumulative meta-analyses is inconclusive. Therefore, multicentre RCTs with adequate power are urgently needed, with morbidity outcomes defined and classified according to international standards; special attention should be given to patients with a marginal renal function, and the effects of complications on the degree of social restriction and quality of life should be studied as

well. Short- and long-term mortality should be reported for at least 3 years with an overall follow-up of 5 years.

Compliance with ethical standards

Conflict of interest The authors declare no conflicts of interest.

Ethical approval This report does not describe any study with human participants or animals performed by any of the authors.

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