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Pouch-anal anastomosis vs straight ileoanal anastomosis in pediatric patients: a meta-analysis

Henry S. Tilney[a], Vasilis Constantinides[a], Adonis S. Ioannides[b], Paris P. Tekkis[a,*], Ara W. Darzi[a], Munther J. Haddad[b]

[a]*Department of Surgical Oncology and Technology, Imperial College London, St. Mary's Hospital, W2 1NY London, UK*
[b]*Department of Paediatric Surgery, Chelsea and Westminster Hospital, SW10 9NH London, UK*

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Abstract

Background: Restorative proctocolectomy is the treatment of choice for pediatric patients with refractory colitis, inherited polyposis syndromes, and some with colonic aganglionosis. Evidence concerning the optimal method of reconstruction is, however, sparse.

Methods: Studies comparing outcomes from ileal pouch-anal anastomosis (IPAA) and straight ileoanal anastomosis (SIAA) were identified by searching Medline, Ovid, and Embase. Suitable studies were selected and data extracted for meta-analysis.

Results: Of 13 studies identified by literature search, 5 satisfied the inclusion criteria, comprising a total of 306 patients, 86 of whom (28.1%) underwent SIAA, and the remainder, IPAA. Pouch failure was more common in the SIAA group (odds ratio, 3.21; confidence interval, 1.24-8.34), as were abdominal salvage procedures (odds ratio, 9.5; confidence interval, 3.14-28.77). Short-term adverse events were similar between the 2 groups, with the exception of perianal sepsis, the higher frequency of which, in SIAA, just reached statistical significance. Bowel frequency was lower in the IPAA patients, although few studies presented functional data in a comparable form.

Conclusions: There are few good-quality studies that compare the outcomes from SIAA and IPAA, meaning that caution should be exercised in the generalization of the results of this meta-analysis, which suggests pouch procedures to be favorable in terms of reconstruction survival and functional outcome.

Proctocolectomy in children is unusual but is necessary in the relatively small proportion of those with ulcerative colitis (UC) whose symptoms cannot be controlled with medical therapy [1]. Furthermore, the aim for children with UC is to achieve cure before any irreversible effects on growth and to allow maximal participation in social and physical activities at a critical period of their lives. It is also indicated in patients with inherited polyposis syndromes [2] where the progression to malignancy in young adulthood is considered inevitable. Other indications for resection include total colonic aganglionosis (TCA) [3] where proctectomy can be used to salvage failed traditional ileal pull-through procedures with ileorectal anastomosis or as a primary procedure.

Of key importance when considering such surgery in this vulnerable age group are the avoidance of permanent stoma, with its attendant psychological sequelae; minimization of operative risk and complications; and the formation of a

* Corresponding author. Tel.: +44 207 8861110; fax: +44 207 8861810.
E-mail address: p.tekkis@imperial.ac.uk (P.P. Tekkis).

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continent neorectum with acceptable function. The main types of reconstruction can be broadly divided into straight ileoanal anastomosis (SIAA) and the formation of reservoir in the form of an ileal pouch (ileal pouch-anal anastomosis [IPAA]). Although each has its proponents, evidence directly comparing the 2 is sparse, with the obvious difficulties in performing a randomized trial in young patients when the numbers undergoing such surgery is relatively small.

In an attempt to clarify the risks and benefits of both forms of surgery a literature search was performed to identify studies comparing the outcomes from both forms of reconstruction. Data were extracted in a standardized manner, and a meta-analysis was performed.

1. Materials and methods

1.1. Study selection

A Medline, Ovid, and Embase search was performed on all studies published between 1980 and 2005 reporting on IPAA reconstruction for children undergoing proctocolectomy (for all diagnoses) and comparing this to SIAA. The following Mesh search headings were used: "comparative study AND restorative proctocolectomy," "restorative proctocolectomy," "pediatrics," "child," "adolescent," "colitis, ulcerative," "hirschprung disease," "adenomatous polyposis coli" and "hereditary nonpolyposis." The "related articles" function was used to broaden the search, and all abstracts, studies and citations scanned were reviewed. The most recent search was performed in June 2005.

1.2. Data extraction

Two reviewers (HST and PPT) independently extracted the following data from each study: first author, year of publication, study population characteristics, study design, and number of subjects operated on with each technique and end point data (pouch failure rates, length of postoperative hospital stay, postoperative bowel function, postoperative complications, and mortality).

Postoperative complications included were need for pouch revision, perianal sepsis, enterovaginal fistula, anastomotic leak, pelvic sepsis, anastomotic stricture, pouchitis, ileostomy stenosis, and small bowel obstruction.

1.3. Inclusion criteria

To enter the analysis, studies had to (1) report the operative results of restorative proctocolectomy in children or adolescents; (2) compare IPAA and SIAA operations; (3) report on at least one of the outcome measures mentioned below; (4) contain a previously unreported group (if patient material was reported more than once, we chose the most informative and/or recent article); and (5) when 2 studies were reported by the same institution, the analysis included either the one of better quality or the most recent publication.

1.4. Exclusion criteria

The following criteria were used to exclude studies: (1) studies in which the outcomes of interest (mentioned below) were not reported on the 2 techniques or it was impossible to deduce these from the published results, (2) studies that displayed a zero for the outcomes of interest in both IPAA and SIAA groups, (3) studies in which no differentiation was made between the type of operation performed, (4) studies in which no clear distinction was made between individual complications of reconstruction (leak rate, perianal sepsis/fistula, inflammation of the neorectum, small bowel obstruction, and anastomotic stricture) and type of operation performed, and (5) studies in which the SD of the mean or the range for continuous outcomes of interest (postoperative bowel frequency) was not reported.

1.4.1. Primary and secondary end points of interest

Ileal pouch-anal anastomosis and SIAA were compared with regard to failure of reconstruction (primary end point). Other long-term adverse outcomes were the need for abdominal salvage procedures, anastomotic stricture, and inflammation of the neorectum. Short-term adverse outcomes measured were rates of perianal sepsis, enterovaginal fistula, small bowel obstruction, and anastomotic leaks. The functional consequences of interest were bowel frequency per 24 hours, nocturnal defecation, and nocturnal seepage of feces. The adverse and functional outcomes represented secondary outcomes. Data were also collected on the rates of defunctioning stoma formation, ileostomy stenosis, the method of ileoanal anastomosis (stapled or handsewn), and the proportions of patients receiving immunosuppressive therapy at the time of surgery between IPAA and SIAA.

1.5. Definitions

Mortality was defined as death occurring within 30 days of the operation. Anastomotic leak was defined as the presence of contrast medium leakage at the level of the anastomosis during radiologic examination, presence of digestive contents in abdominal drains, or the finding of anastomotic separation during reoperation on the same admission. Pouch failure was defined as the continued presence of an ileostomy after reconstruction with or without excision of the pouch. Abdominal salvage was considered to be those instances where repeat laparotomy was required to refashion the ileoanal anastomosis or to convert from one type of reconstruction to another. Pelvic sepsis was defined according to the clinical findings of abdominal guarding and/or rebound tenderness, pain, fever, diminished bowel sounds, and/or intraoperative findings on reoperation. Length of stay was defined as days spent as an inpatient after surgery. Immunosuppression at the time of surgery was defined as the use or corticosteroids, mesalazine, azothioprine, mercaptopurine, or cyclosporin within 3 months of proctocolectomy. Inflammation of the neorectum was considered to be chronic, recurrent episodes of

inflammation of a pouch or straight anastomosis such that multiple courses of antibiotics or anti-inflammatory medications were required.

1.6. Statistical analysis

Meta-analysis was performed in line with recommendations from the Cochrane Collaboration and the Quality of Reporting of Meta-analyses guidelines [4-6]. Statistical analysis for categorical variables was carried out using the odds ratio as the summary statistic. This ratio represents the odds of an adverse event occurring in the treatment (IPAA) group compared with the reference (SIAA) group. An odds ratio of less than 1 favors the treatment group, and the point estimate of the odds ratio is considered statistically significant at the $P < .05$ level, if the 95% confidence interval (CI) does not include the value of 1.

Combination of the odds ratios of the outcomes of interest was performed with the Mantel-Haenszel χ^2 method. Yates correction was used for those studies that contained a zero in 1 cell for the number of events of interest in 1 of the 2 groups [7]. These "zero cells" create problems with the computation of ratio measure and its SE of the treatment effect. This was resolved by adding the value 0.5 in each cell of the 2×2 table for the study in question, and if there were no events for both IPAA and SIAA groups, the study was discarded from the meta-analysis.

In this study, we used both fixed and random effect models. In a fixed-effect model, it is assumed that the treatment effect in each study is the same, whereas in a random-effect model, it is assumed that there is variation between studies, and thus, the calculated odds ratio has a more conservative value [8,9]. In surgical research, meta-analysis using the random effect model is preferable particularly because patients who are operated on in different centers have varying risk profiles and selection criteria for each surgical technique.

In the illustration of our results (Figs. 1 and 2), for dichotomous variables, squares indicate point estimates of treatment effect (odds ratio [OR]), with 95% CIs indicated by horizontal bars. The diamond represents the summary odds ratio from the pooled studies with 95% CIs. For continuous variables such as length of stay and operative time, statistical analysis was carried out using the random-effect weighted mean difference (WMD) as the summary statistic [10]. The point estimate is considered statistically significant at the $P < .05$ level if the 95% CI does not include the vertical bar.

This study was performed in line with the recommendations of the proposal for reporting meta-analysis of observational studies in epidemiology, which was produced in Atlanta [6]. The quality of the nonrandomized studies was assessed by using the Newcastle-Ottawa Scale with some modifications to match the needs of this study. The quality of the studies was evaluated by examining 3 items: patient selection, comparability of IPAA and SIAA groups, and assessment of outcome. Studies achieving 3 stars or above were considered as being of higher quality.

Three strategies were used to quantitatively assess heterogeneity. First, data were reanalyzed using both random- and fixed-effect models. Second, graphic exploration with funnel plots (Fig. 3) was used to evaluate publication bias [9,10]. Third, sensitivity analysis was undertaken using subgroup analysis. To do this, the following variables were evaluated: (i) all studies, (ii) study size (more than 50 patients in study), (iii) studies of higher quality ($\geq$3 stars), and (iv) studies with mean age below 18 years.

Analysis was conducted by using the statistical software Statistical Package for Social Sciences version 12.0 for Windows (SPSS Inc, Chicago, Ill), Intercooled Stata version 8.0 for Windows (Stata Corporation, College Station, TX), and Review Manager version 4.2 (The Cochrane Collaboration, Software Update, Oxford, UK).

2. Results

Thirteen studies published between 1984 and 2004 [3,11-22] matched the search criteria, comparing IPAA and SIAA and reporting the incidence of mortality, postoperative complications, pouch failure, or postoperative functional outcomes. Three studies were excluded because they did not include pediatric patients [16-18]. Four studies [3,13,15,19] were excluded because they were dual publications reporting on the same patient groups as other included studies. In 1 case [21], a study was included in which the patient group had been reported elsewhere [12], although only those outcomes which were not reported in both series were analyzed. One further study [11] was excluded because the results were presented in such a way that it was impossible to differentiate between patients undergoing IPAA or SIAA procedures. Five studies [12,14,20-22] therefore satisfied the criteria for inclusion and were suitable for analysis. All 5 were retrospective series with a combined total of 306 patients. Of these, 86 (28.1%) underwent SIAA, and 220, (71.9%) IPAA. Of the pouch procedures, 75 (34.1%) were J-pouches; 18 (8.2%), S-pouches; and 127 (57.7%), lateral pouches. On review of the data extraction, there was 100% agreement between the 2 reviewers.

The characteristics of these studies are demonstrated in Table 1, and a summary of outcomes reported by each study can be found in Table 2. The study design was retrospective in all studies. Three studies contained at least 50 patients in total, and 2 studies had a recent year of publication (in or after 1990). Three studies were matched for the underlying diagnosis, which was most commonly UC (92.4% of patients); the only other diagnosis encountered in the analyzed studies was familial adenomatous polyposis coli. There were 4 studies matched for sex of patients; overall, 166 patients (54.2%) were female. The mean age of patients varied from 13 to 22.4 years (1 study with mean age

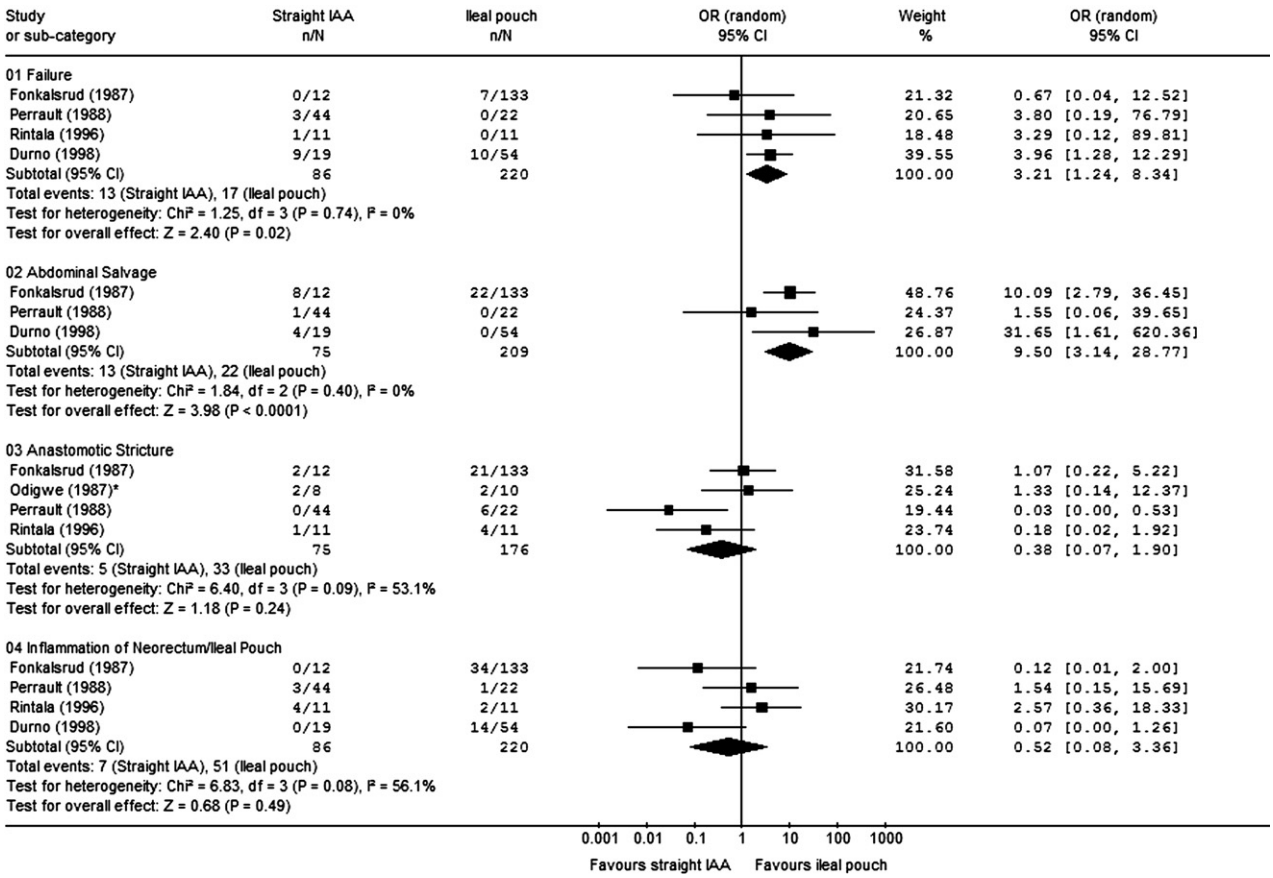

Fig. 1 Forest plot comparing long-term adverse outcomes of children undergoing SIAA with children undergoing IPAA.

above 18 years was excluded in sensitivity analysis [14]). Follow-up was explicitly stated in 4 studies and ranged from 3 to 11.2 years. Three studies were considered to have a star rating of ≥3 on a modified quality assessment tool of nonrandomized studies. The results from meta-analysis of the studies with regard to long- and short-term adverse outcomes and functional outcomes are summarized below and in Table 3. The results of sensitivity analysis are shown in Table 4.

Fig. 1 represents the meta-analytic outcome for long-term adverse outcomes in all the included studies including the primary outcome of interest (pouch failure). The results of meta-analysis of short-term outcomes of interest are illustrated in Fig. 2.

2.1. Primary outcome (pouch failure)

All included studies reported rates of pouch failure, that is, the number of patients in whom at the end of the follow-up period the stoma had been reformed or never reversed, with or without pouch excision. In 1 study [12], a statistically significant reduction in the rate of pouch failure was shown in the IPAA group, as compared with SIAA. Meta-analysis of all studies showed a significantly higher failure rate of 15.1% (13/86) in the SIAA group, compared with 7.7% (17/220) in the IPAA group (odds ratio [OR], 3.21; CI, 1.24-8.34). Sensitivity analysis of studies with at least 50 patients as sample size [12,14,20] showed a significant difference in failure with 16.0% (12/75) in the SIAA group, compared with 8.1% (17/209) in the IPAA group (OR, 3.21; CI, 1.18-8.69). This finding was mirrored in studies performed in or after 1990 [12,22], where the failure rate was 33.3% (10/30) in the SIAA group, compared with 15.4% (10/65) in the IPAA group (OR, 3.88; CI, 1.33-11.34). Studies from which data on pouch failure were extracted, which were of higher quality (>3*), were the same as those with mean age of patients younger than 18 years [12,20,22]. In subgroup analysis of these, there was once again a significantly higher rate of failure in the SIAA group 17.6% (13/74), as compared with the IPAA group 11.5% (10/87) (OR, 3.87; CI, 1.41-10.63).

2.2. Secondary outcomes

2.2.1. Short-term adverse outcomes

2.2.1.1. Perianal sepsis. Four studies reported on perianal sepsis following surgery. As one of these [21] contained patients included in other studies, 3 [12,14,20] were entered for meta-analysis. Although none of these studies alone showed a statistically significant difference between the

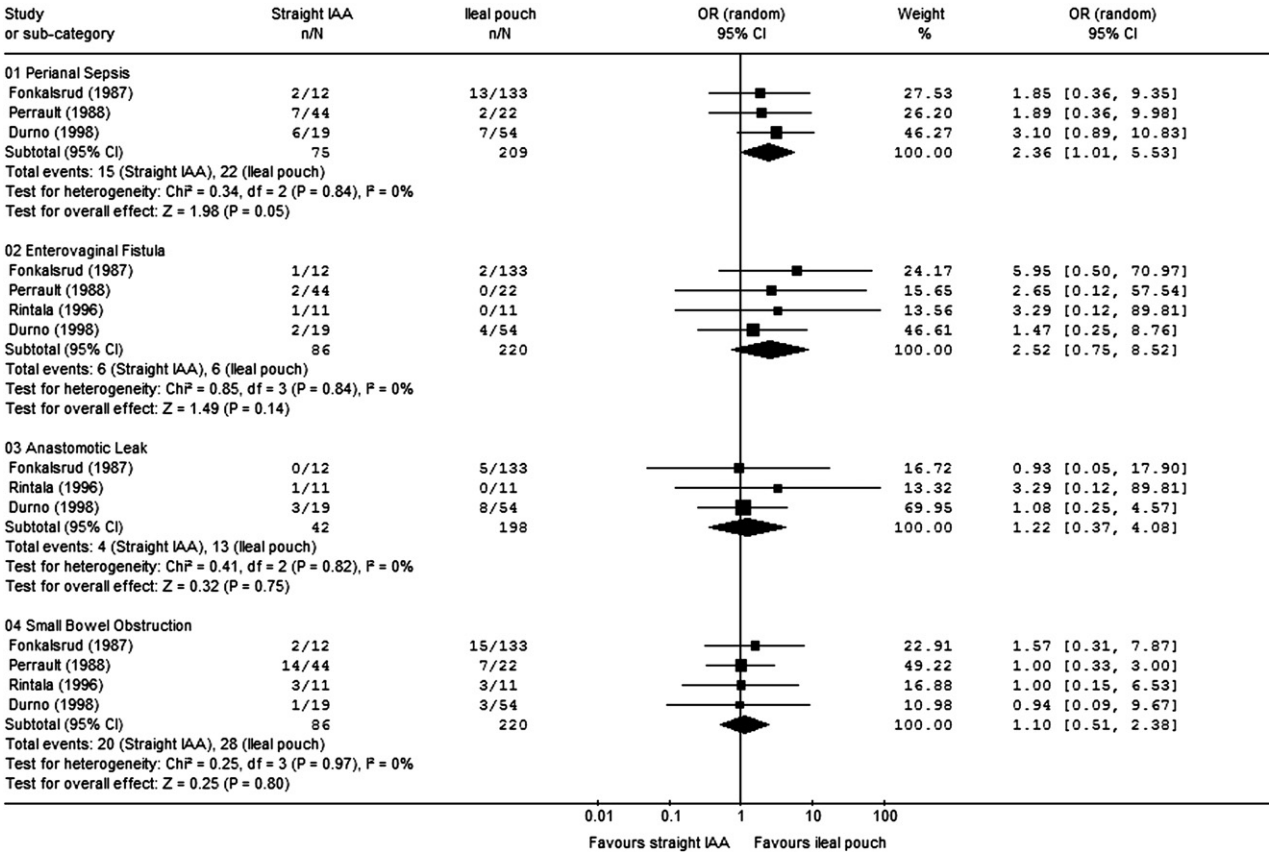

Fig. 2 Forest plot comparing short-term adverse outcomes of children undergoing SIAA with children undergoing IPAA.

groups, meta-analysis revealed a difference in favor of the pouch group, which just achieved significance, with an incidence of 20.0% (15/75) in the SIAA group, as compared with 10.5% (22/209) in IPAA (OR, 2.36; CI, 1.01-5.53). On sensitivity analysis, the effect was maintained when looking at studies with greater than 50 patients as the same 3 reports were included. However, on analysis of studies with mean age below 18 years [12,20] and high-quality studies [12,20], the statistical significance was lost (Table 4).

2.2.1.2. Enterovaginal fistula. Four studies [12,14,20,22] gave details of relative rates of enterovaginal fistula. For none was the difference between the groups individually significant, and it did not reach significance on meta-

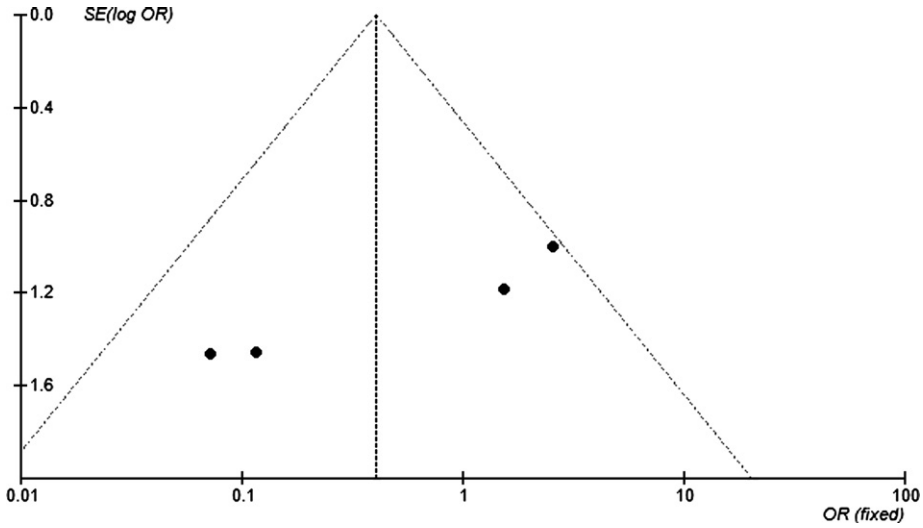

Fig. 3 Funnel plot evaluating publication bias for studies reporting results on inflammation of the neorectum or ileal pouch.

Table 1 Study characteristics

Author	Institution	Year	Design	Mean age (range)	Straight IAA	Ileal pouch J	Ileal pouch S	Ileal pouch Lat	Matching	Female (n [%])	Follow-up (y)	Study quality (star rating)
Durno et al [12]	The Hospital for Sick Children, University of Toronto, Toronto, Ontario, Canada	1998	R	13.2 (2.6-18.8)	19	41	13	0	2,3,4	47 (59.5)	SIAA= 5.8 ± 3.3; P = 5.5 ±3.4	***
Perrault et al [20]	Mayo Clinic, Rochester, Minn	1988	R	16[a] (5-30)	44	22	0	0	2,3,4,5	29 (43.9)	SIAA= 3[a]; zP = 1[a]	****
Fonkalsrud [14]	UCLA School of Medicine, Los Angeles, Calif	1987	R	22.4 (7-56)	12	1	5	127	2,6	76 (52.4)	N/A	*
Rintala and Lindahl [22]	Children's Hospital, University of Helsinki, Helsinki, Finland Alder Hey Children's Hospital, Liverpool, England	1996	R	13[a] (7-15)	11	11	0	0	1,2,3,5,6	14 (63.6)	SIAA = 4[a] (3-6.5); P = 2.3[a] (1.5-3)	*****
Odigwe et al [21]	The Hospital for Sick Children, University of Toronto, Toronto, Ontario, Canada	1987	R	S = 16.5; P = 11.9 (4.1-18.8)	8	5	5	0	1,3	13 (72.2)	SIAA= 4.1 ± 1.0; P = 1.3 ± 0.8	**

R, retrospective patient identification, prospective data collection; P, ileal pouch; J, J-pouch; S, S pouch; Lat, lateral pouch; Pouch, total pouches; IAA, ileoanal anastomosis.
Matching: 1, age; 2, sex; 3, diagnosis; 4, follow-up; 5, extent of disease; 6, preoperative steroids.
[a] Median value.

analysis with a total of 7.0% (6/86) in the SIAA group compared with 2.7% (6/220) in the IPAA group (OR, 2.52; CI, 0.75-8.52) having the complication. With further sensitivity analysis, significance was still not attained.

2.2.1.3. Anastomotic leak. Leak rates were clearly defined in 3 studies [12,14,22]. No significant difference in rates was to be found in individual reports, or on meta-analysis of the 3 studies, with leaks occurring in 9.5% (4/42) of the SIAA group compared with 6.6% (13/198) pouches (OR, 1.22; CI, 0.37-4.08). Again, on sensitivity analysis, there was still no significant difference.

2.2.1.4. Small bowel obstruction. No differences between the rates of postoperative small bowel obstruction were to be found in any of the 4 main analyzed studies, and meta-analysis of these still failed to show a significant difference, as did sensitivity analysis, despite that it was recorded as a

Table 2 Studies reporting outcomes of straight vs pouch reconstruction

Outcome	Fonkalsrud [14]	Odigwe et al [21][a]	Perrault et al [20]	Rintala and Lindahl [22]	Durno et al [12]
Short-term adverse outcomes					
Perianal sepsis	✓	✓	✓		✓
Enterovaginal fistula	✓		✓	✓	✓
Anastomotic leak	✓			✓	✓
Small bowel obstruction	✓	✓	✓	✓	✓
Long-term adverse outcomes					
Failure	✓	✓	✓	✓	✓
Abdominal salvage	✓	✓	✓	✓	✓
Anastomotic stricture	✓	✓	✓	✓	
Inflammation of neorectum/ileal pouch	✓	✓	✓	✓	✓
Functional outcomes					
Bowel frequency per 24 h		✓	✓	✓	
Defecation at night			✓	✓	
Seepage at night		✓			

[a] Dual publication: only outcomes not reported by Durno entered into analysis.

Table 3 Results of meta-analysis comparing straight vs pouch reconstruction for children and young adults undergoing panproctocolectomy

Outcome of interest	No. of studies	No. of patients	OR/WMDa	95% CI	*P*	HG χ^2	HG *P*
Short-term adverse outcomes							
Perianal sepsis	3	284	2.36	1.01-5.53	**.05**	0.34	.84
Enterovaginal fistula	4	306	2.52	0.75-8.52	.14	0.85	.84
Anastomotic leak	3	240	1.22	0.37-4.08	.75	0.41	.82
Small bowel obstruction	4	306	1.01	0.51-2.38	.80	0.25	.97
Long-term adverse outcomes							
Failure	4	306	3.21	1.24-8.34	**.02**	1.25	.74
Abdominal salvage	3	284	9.50	3.14-28.77	**<.0001**	1.84	.40
Anastomotic stricture	4	233	0.38	0.07-1.90	.24	6.40	.09
Inflammation of neorectum/Pouch	4	306	0.52	0.08-3.36	.49	6.83	.08
Functional outcomes							
Bowel Frequency per 24 h	2	35	2.63	1.34-3.92	**<.001**	0.02	.88
Defecation at night	1	22	87.40	3.72-2051.06	**.005**	–	–
Seepage at night	1	13	0.22	0.02-2.45	.22	–	–

Statistically significant results are shown in bold.
OR, odds ratio; WMDa, weighted mean difference; HG, heterogeneity.

complication in 23.3% (20/86) of those with a straight anastomosis as opposed to only 12.7% (28/220) of those with IPAA (OR, 1.01; CI 0.51-2.38).

2.2.2. Long-term adverse outcomes

2.2.2.1. Abdominal salvage. The need for salvage was described in an analyzable form between the 2 groups of interest in 3 cases [12,14,20]. In 2 of these individual articles [12,14], the need for salvage surgery was statistically significantly lower in the IPAA group. Meta-analysis confirmed a highly significant difference in favor of IPAA with salvage surgery required in 17.3% (13/75) of the SIAA group compared with 10.5% (22/209) of the IPAA patients (OR 9.5, CI 3.14, 28.77). As the studies reporting the salvage rates were the larger series, sensitivity analysis of studies of more than 50 patients showed identical, significant results, but on analysis of studies with mean age below 18 years and high quality studies, the significance was lost.

2.2.2.2. Anastomotic stricture. As reported in an analyzable form by 3 studies [14,20,22], there was no statistically significant difference between SIAA (4.5% [3/67]) and IPAA (18.7% [31/166]) (OR, 0.38; CI, 0.07-1.90). Although, analysis of studies with mean age below 18 years and high-quality studies (which formed the same subgroup) [20,22] did show significantly fewer instances of anastomotic stricture in the SIAA group (1.8% [1/55]) as compared with the IPAA group (30.3% [10/33]) (OR, 0.08; CI, 0.01-0.54). Statistically

Table 4 Sensitivity analysis performed for studies comparing IPAA and SIAA

Outcome of interest	No. of studies	No. of Patients	OR/WMDa	95% CI	*P*	HG χ^2	HG *P*
Studies with mean age below 18 y							
Failure	3	161	3.87	1.41-10.63	**.009**	0.01	.99
Abdominal salvage	2	139	7.52	0.39-145.09	.18	1.81	.18
Perianal sepsis	2	139	2.59	0.95-7.05	.06	0.22	.64
Bowel frequency per 24 h	2	35	2.63	1.34-3.92	**<.0001**	0.02	.88
Anastomotic stricture	2	88	0.08	0.01-0.54	**.009**	0.91	.34
High-quality studies (>3*)							
Failure	3	161	3.87	1.41-10.63	**.009**	0.01	.99
Abdominal salvage	2	139	7.52	0.39-145.09	.18	1.81	.18
Perianal sepsis	2	139	2.59	0.95-7.05	.06	0.22	.64
Bowel frequency per 24 h	1	–	–	–	–	–	–
Anastomotic stricture	2	88	0.08	0.01-0.54	**.009**	0.91	.34
Studies with >50 total cases							
Failure	3	284	3.21	1.18-8.69	**.02**	1.25	.53
Abdominal salvage	3	284	9.50	3.14-28.77	**<.0001**	1.84	.40
Perianal sepsis	3	284	2.36	1.01-5.53	**.05**	0.34	.66
Bowel frequency per 24 h	0	–	–	–	–	–	–

Statistically significant results are shown in bold.
OR, odds ratio; WMDa, weighted mean difference; HG, heterogeneity.

significant differences were not seen in analysis of larger studies or those published after 1990.

2.2.2.3. Inflammation of the neorectum. Four analyzed studies gave data on rates of inflammation of the neorectum [12,14,20,22]. No significant differences between the groups were found within the studies—on meta-analysis nor on sensitivity analysis.

2.2.3. Functional outcomes

2.2.3.1. Bowel frequency per 24 hours. In only 2 studies was information on postoperative bowel frequency presented in such a way that meta-analysis could be performed [21,22]. In one of these, the frequency of bowel movements per 24 hours was significantly higher in the SIAA group, compared with IPAA (WMD 2.60, CI 1.27, 3.93). Meta-analysis showed this effect to be maintained (WMD, 2.63; CI, 1.34-3.92). Because of the small number of studies reporting analyzable outcomes, sensitivity analysis could not be performed. The funnel plot in Fig. 3 shows the studies represented lying roughly symmetrically about the vertical and within the confines of the plot, illustrating the lack of publication bias.

2.2.3.2. Seepage at night/defecation at night. One study gave comparative data on defecation at night [22] showing significantly more patients experiencing nocturnal defecation in the SIAA group compared with the IPAA group (OR, 87.4; CI, 3.72-2051.06). The single report comparing rates of seepage of feces at night [21] showed no statistically significant difference between the groups.

2.2.4. Other points of interest

Most patients (95.0% [96/101]) were reported to have handsewn rather than stapled ileoanal anastomoses, although only 2 studies explicitly stated the method of anastomosis [12,22]. In all 3 studies reporting details on defunctioning stoma rates [12,14,22], all patients were given a defunctioning ileostomy. This is perhaps to be expected considering the age groups concerned and the need to mitigate against the consequences of an anastomotic leak.

Only 2 studies [14,22] commented on the length of the J-pouches created (7-17 cm overall). This precluded further analysis of functional outcomes related to pouch length. Fonkalsrud [14], however, did comment how lateral pouches were initially constructed over a length of 25-30 cm but that unacceptable rates of poor reservoir function (difficulty in emptying the pouch) led to subsequent use of a 15-cm lateral reservoir and abdominal salvage procedures to shorten the reservoir in 22 of 40 patients with initial reservoirs greater than 20 cm in length.

In only one of the studies considered for meta-analysis were comments made regarding the proportion of patients with colitis who were receiving immunosuppressive therapy at the time of reconstruction. In this study [12], 3 (41.1%) of 73 patients operated upon were being treated with corticosteroids.

3. Discussion

Restorative proctocolectomy has become the surgical treatment of choice in children with UC and familial polyposis. It is also indicated in children with TCA as a salvage procedure after failure of ileal pull-through and ileorectal anastomosis or even as the primary surgical procedure. The advantages are preservation of the physiologic fecal route as well as preservation of fecal continence. The choice between SIAA and IPAA is still a matter of debate. On the one hand, pouch procedures have been associated with increased risk of anastomotic strictures, fecal stasis, and recurrent inflammation of the neorectum/pouchitis and have been perceived as having a higher incidence of perioperative complications [23]. On the other hand, the functional outcome of pouch procedures is superior to that of straight anastomoses [12,22]. The small number of studies comparing complications and functional outcomes, the relatively small number of children involved, and the lack of any randomized controlled trials make it difficult to assess the relative advantages and disadvantages of the 2 types of procedures. Most published accounts are retrospective, and there is a substantial amount of repeat publication from large centers updating their series outcomes and numbers, rather than publishing the results of surgery in new groups of patients.

The present study uses meta-analysis of the published literature to achieve an objective comparison between SIAA and IPAA. All studies analyzed were retrospective reviews. In those which were suitable for review, many outcomes, especially those concerning the function of reconstruction, were presented in a diverse manner, which precluded meaningful comparisons between the groups. The low number and overall quality of the studies analyzed means that caution should be exercised in the interpretation and generalization of the results of this meta-analysis. The age ranges in the included studies were, in some cases, wide (Table 1). To overcome this, subgroup analysis of only those studies with a mean age less than 18 years was undertaken, showing the significant benefit to the IPAA group in terms of bowel frequency and rates of failure, identified by the overall meta-analysis, to be maintained.

Assessment of the primary outcome (pouch failure) demonstrates that SIAA was significantly more likely to fail, compared with IPAA. This difference was maintained even after subgroup analysis to take into account sample size, year of publication, quality of the study, and patient age. It is worth noting that of the 4 studies analyzed for pouch failure, only 1 gave a significant advantage of IPAA over SIAA, and 1 suggested that failure was slightly more likely in IPAA. This highlights the value of the meta-analytical approach in this context. Abdominal salvage was also significantly more likely in SIAA, and the significance was maintained in the studies with more than 50 patients. The high salvage rate for the SIAA could be largely attributed to the number of straight anastomoses converted

to pouches because of unacceptable functional outcomes (mainly bowel frequency and defecation at night). In summary, straight anastomoses were more likely to fail requiring the reconstruction of an ileostomy and more likely to require reoperation for refashioning or conversion to a pouch.

The reasons that underlie the difference in failure and salvage rates can be sought in the short- and long-term complications and the functional outcomes of the 2 types of procedure. The 2 groups were largely comparable in regards to short-term adverse effects. There was no statistical difference in the rates of small bowel obstruction, anastomotic leak, or development of enterovaginal fistula, whereas the higher rate of perianal sepsis in the SIAA group just achieved significance. This small difference was maintained in the subgroup analysis of larger studies. The formation of a covering ileostomy is known to reduce anastomotic leaks and infection rates, but this was not a factor in this study as all patients were defunctioned. This small difference in septic complications may have contributed to the higher SIAA failure/salvage rate. Pouch procedures were significantly superior in terms of functional outcomes, with IPAA patients reporting less defecation both during the day and night. This contributed to the high salvage rates of SIAA, with many patients requesting conversion to a pouch.

The perceived advantage of SIAA in terms of development of anastomotic strictures was only significant in subgroup analysis of high-quality studies with a smaller mean age, although overall analysis revealed no significant difference. Although stricture formation is associated with fecal stasis and the development of inflammation of the neorectum, there was no difference between the 2 groups in terms of pouch inflammation. As 3 of the studies were matched in terms of the underlying illness (mostly UC), this is unlikely to have contributed to the incidence of pouchitis in the 2 groups. The comparable incidence of inflammation of the neorectum effectively negates any perceived advantage of SIAA over IPAA.

The long-term function of these reconstructions is of great importance because the children undergoing surgery can be expected to live with the consequences of it for many years. It is disappointing, therefore, that the wide variety of methods used to report function, although illustrative within series, leads to difficulties in comparing functional outcomes between them. In some cases, no distinction was made between types of reconstruction when function was considered. Some, otherwise good, studies only reported functional outcomes on 1 type of operation. That analysis which could be performed showed a higher frequency of defecation in the SIAA group. This finding might be expected because the role of the pouch procedure is to provide a larger reservoir for collection of feces, thus allowing defecation to be deferred for a greater period. One study showed nocturnal defecation to be more frequent in the SIAA group, whereas another showed no difference in rates of nocturnal seepage of feces between the groups. More standardized reporting of the outcomes from ileorectal reconstructions might allow better evidence of comparison of the superiority of one procedure or another, in terms of long-term function, to be collected.

Based on the evidence in this study, restorative proctocolectomy with continence-preserving ileal pouch formation should be the surgical treatment of choice in children with UC and familial adenomatous polyposis. Pouch formation is superior in that it reduces bowel frequency during the day and largely abolishes the need for defecation at night. The quality of life and social implications of near normal bowel function for children cannot be overstated. It is remarkable that in 1 study [3], 8 of the 9 children with straight pull-through requested reoperation and conversion to a pouch because of the unacceptable functional outcomes of SIAA. If IPAA is to be favored, then the potential complications of the procedure should be carefully considered. One type of subgroup meta-analysis showed significantly more anastomotic strictures in pouches. Strictures as well as long pouches with spouts between the pouch and the anal anastomosis all predispose to incomplete emptying, stasis, and inflammation. Attention to these technical points may reduce the incidence of infection and inflammation even further. Effective pouch emptying must be ensured, and potential strictures must be investigated and dilated. In some cases, refashioning of the pouch may be indicated with shortening of the spout. Another point for consideration is the selection of the type of pouch because this will influence the capacity of the reservoir as well as have technical implications. The current data do not allow for systematic comparisons between the different types. Formation of a covering ileostomy is another consideration. This is favored by most surgeons, although there are studies reporting good results with 1-stage restorative proctocolectomy in carefully selected patients. These patients should have good nutrition and be on minimal immunosuppressive therapy.

The current findings could also have significant implications for the management of children with TCA, although these patients may represent a distinct clinical entity, with the potential for differences in postoperative function. None of the analyzed studies included patients with such conditions. These children have been managed with ileal pull-through procedures that have been associated with similar functional problems as the children with UC having SIAA (frequency of bowel movements). Recently, ileal pouch formation has been used in children with TCA with good outcomes, although this was a salvage procedure in most cases [3,24-26]. It is not clear whether IPAA as the initial definitive operation has any advantages in these patients. This question needs to be addressed in future studies.

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