Is single-layer better than double-layer interrupted intestinal anastomosis? A comparative study in pediatric patients

Mohamed R. Abdella, Mohamed Fathi, Alaa El-Sayed, Adel Shehata

Department of General Surgery, Faculty of Medicine, El-Minia University, Minia, Egypt

Correspondence to Mohamed R. Abdella, MD, Department of General Surgery, Faculty of Medicine, El-Minia University, Minia, Egypt. Tel: 00201067045041; fax: 0862296734; e-mail: mrabea177@gmail.com

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Objective
The aim of our study was to evaluate the efficacy and safety of single-layer anastomosis compared with double-layer interrupted anastomosis in pediatric patients.
Patients and methods
The study included 60 patients, and it was carried out in Pediatric Surgery Unit, El-Minia University Hospital from February 2016 to February 2017, and the patients were classified into two groups, each group comprising 30 patients. Group A was operated with single-layer interrupted intestinal anastomosis and group B was operated with double-layer interrupted intestinal anastomosis. All patients were subjected to carful preoperative assessment and preparations. Postoperatively, intravenous fluids were continued until oral fluids begin, usually on the third day postoperatively. The patients were followed up for 1 month postoperatively with special emphasis on postoperative complications.
Results
The most frequent diagnosis was intussusception; it represented 33.3 and 36% in groups A and B, respectively. The operative time and the postoperative hospital stay were less in group A, with *P* values less than 0.001 and 0.049, respectively, which is statistically significant. Intestinal leakage was reported in two (6.7%) cases in both groups, whereas postoperative distension was reported in four (13.3%) cases in group A and 13 (43%) cases in group B, with a *P*-value of 0.01, which was statistically significant. Wound infection was reported in two cases in group A and five cases in group B. Two cases needed re-exploration in group B. Postoperative vomiting was reported in five (16.7%) cases in group A and 10 (33%) cases in group B.
Conclusion
We concluded that single-layer interrupted intestinal anastomosis is effective, safe, successful, of less operative time, less hospital stay, and valuable cost-effectiveness.

Keywords:
anastomosis, double layer, intestinal, single layer

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Introduction

Gastrointestinal anastomosis is an operation frequently performed in pediatric surgery. The choice of anastomosis technique may be influenced by the diameter of bowel ends, edema, accessibility, site of anastomosis, contamination, available time, equipment, and underlying pathology [1]. In the early 19th century through the experimental work of Travers and Lembert, double-layered intestinal anastomosis was first performed. Since then the technique has remained more or less the same, except for the use of different suture materials for the inner layer [2]. The single-layered interrupted anastomosis was first described by Hautefeuille [3]. In clinical practice, the effectiveness and safety of anastomosis have been evaluated based on the incidence of surgical complications related to the procedure, especially intestinal leakage [4]. There is no general agreement about the most appropriate surgical technique [5]. Hand-sewn techniques have traditionally been used to perform intestinal anastomosis in pediatric patients in many cases. When treating intestinal atresia and stoma closure, great discrepancy between diameters of the proximal and distal intestine caused by disuse atrophy is often observed, which may cause difficulties and complications. To overcome size discrepancy, proficiency in performing anastomosis is required when using hand-sewn techniques [6]. Numerous studies in the literature comparing techniques (e.g. one layer vs. two layers, hand-sewn vs. stapled, and end-to-end vs. end-to-side) have failed to demonstrate a clear superiority of one over another [7].

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The utility of any technique for intestinal anastomosis depends mainly on its utility to heal without a leakage. This complication has catastrophic consequences on patient's health, as well as cost of care [8]. In fact, the only technique that has been unequivocally demonstrated to be unacceptable is the everted anastomosis [9]. The indications of intestinal anastomosis in children are many and may be congenital, for example, Hirschsprung's disease, intestinal atresia, malrotation, meconium ileus, may be inflammatory, for example, necrotizing enterocolitis, or may be a part of other surgical procedures [10]. Intussusception is a common cause and the patient should be managed immediately to reduce risk [11].

Hypothesis

Single-layer interrupted anastomosis will improve the general outcome of intestinal anastomosis in pediatric surgery.

Objective

The aim of our study was to evaluate the efficacy and safety of single-layer anastomosis compared with double-layer interrupted anastomosis in pediatric patients.

Design

This is a prospective single-blinded comparative study.

Setting

This study was conducted in El-Minia University Hospital, El-Minia, Egypt.

Patients and methods

The study included 60 patients, and it was carried out in Pediatric Surgery Unit, El-Minia University Hospital from February 2016 to February 2017, and the patients were classified into two groups, each group comprising 30 patients. The study protocol was approved by the Local Ethical Committee. Group A was operated with single-layer interrupted intestinal anastomosis, and group B was operated with double-layer interrupted intestinal anastomosis. The patients were assigned to either single or double technique in a randomized manner. Informed consents from parents of all patients were taken before entering the study. The inclusion criteria included age more than 1 month and up to 14 years. Urgent cases, elective cases, small intestine, and large intestine anastomosis were included. The exclusion criteria included age less than 1 month and more than 14 years, peritonitis with local septic condition, poor nutritional status, doubtful bowel viability, malignancy, and diabetic patients. All patients were subjected to carful history taking, physical examination, and proper radiological and laboratory workup. Preoperative preparation included fluid resuscitation, antibiotic prophylaxis, chemical and mechanical bowel preparations before elective colorectal procedures, and nasogastric tube and urinary catheter inserted to decompress the stomach and urinary bladder before surgery. These tubes were removed after the operation once there was no distension or vomiting.

Intravenous fluids were continued until oral fluids were started, usually on the third day postoperatively. The patients were discharged after they passed stool and oral feeding was allowed, and there was no distension, vomiting, or high-grade fever. The patients were followed up in a surgical outpatient clinic for 1 month postoperatively with special emphasis on postoperative complications.

Operative technique

The method of anastomosis in our study was hand-sewn anastomosis, and absorbable suture materials (vicryl 3/0, 4/0) were used. The two cut ends of the bowel were brought in close apposition, and two stay sutures between the serosa of the proximal and distal ends of the bowel were taken, one at the mesenteric border and the other at the antimesenteric border. The posterior inner-layer anastomosis by interrupted full-thickness stitches were taken between the two stay sutures were tied sequentially, with care taken not to apply excessive tension; the knot lies inside the lumen. Next, a Connell stitch was made at both ends by passing the sutures from the outside in, then inside out, on one end. The same step is repeated on the other end in the form of a continuous U-shape. The suture is tied so that the knot is outside; the needle must be pulled through each edge separately. Trying to include both edges in one pass of the needle can prevent the surgeon from taking a full-thickness bite on both edges. It is necessary to include the submucosa carefully, because this is the strongest layer of the bowel wall and gives strength to the anastomosis.

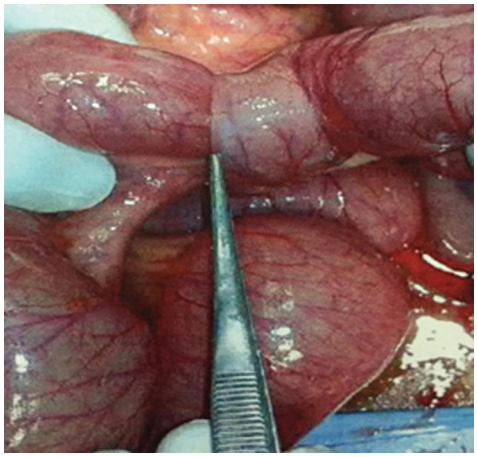
The anterior inner layer is completed in a similar manner, starting from the far end. The pouting of mucosa is prevented by taking a small amount of mucosa and a large part of the seromuscular layer, which results in inversion of the mucosa. In group B, the posterior outer layer was completed by interrupted seromuscular sutures with a 5 mm gap between each two sutures. Stitches should incorporate only the seromuscular layer, and care must be taken not to

incorporate the full thickness of the bowel wall. Sutures are tied sequentially, with care taken not to apply excessive tension so as to minimize the risk of cut-through of the seromuscular layer. The anterior outer seromuscular layer was completed in the same way. Narrowing of the lumen by including too much of the bowel into this layer should be avoided. Patency of the lumen can be confirmed by palpation acrossthe anastomosis with the tips of the thumb and the index fingers. The mesenteric defect was closed with interrupted stitches; care should be taken to avoid injuring mesenteric vessels so as to prevent ischemia of the anastomotic site. The last step was reduction of the bowel and anatomical closure. Intraperitoneal drain may or may not be inserted (Figs. 1–3).

Statistical analysis

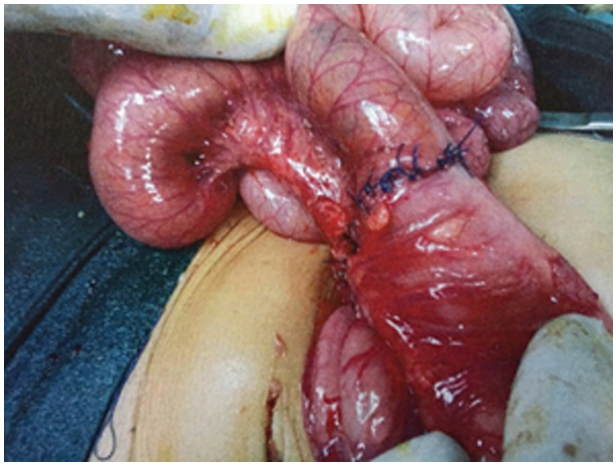
Obtained data were presented as mean±SD, ranges, numbers, and ratios. Results were analyzed using one-way analysis of variance with post-hoc Tukey's honest significant difference test and χ^2-test. Statistical analysis was conducted using the SPSS (IBM Corporation, California, USA) (version 15, 2006) for Windows statistical package. *P*-value less than 0.05 was considered statistically significant.

Figure 1



Intussusception failed simple reduction.

Figure 2



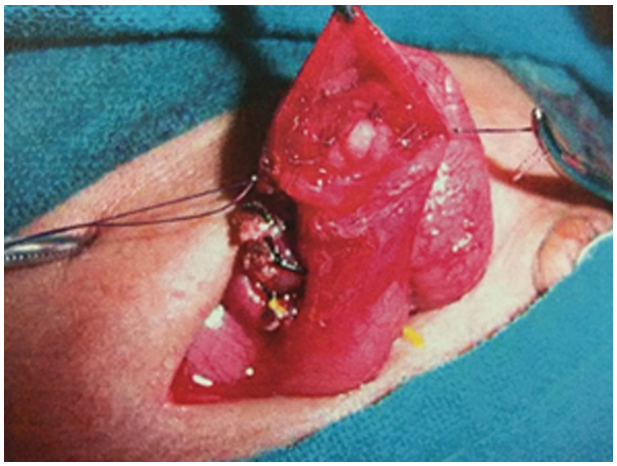
Single-layer interrupted anastomosis.

Results

Sixty cases of intestinal anastomosis were included in the study: 30 were operated by single interrupted layer (group A) and 30 were operated by double interrupted layer (group B). The age ranged between 3 months and 8 years (mean=2.08 years) in group A and 4 months and 12 years (mean=2.5 years) in group B. Fifteen cases were male and 15 cases were female in group A, whereas in group B, 21 cases were male and nine cases were female (Tables 1 and 2, Figs. 4 and 5).

Intussusception was the most common cause of anastomosis in both groups: 10 (33.3%) cases in group

Figure 3



Posterior wall anastomosis.

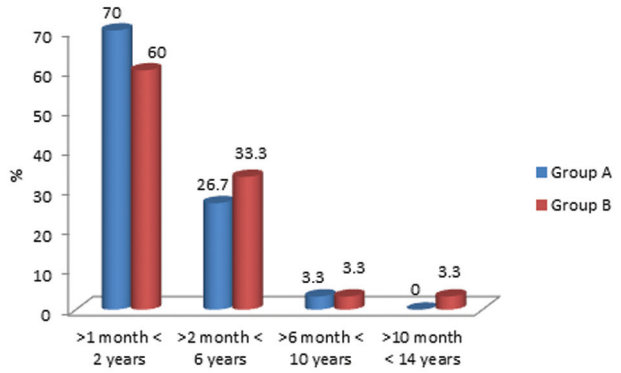
Table 1 Age distribution in both groups

	Group A (*n*=30) [*n* (%)]	Group B (*n*=30) [*n* (%)]	*P*-value
Age group			
>1 month ≤2 years	21 (70)	18 (60)	0.693
>2 months ≤6 years	8 (26.7)	10 (33.3)	
>6 months ≤10 years	1 (3.3)	1 (3.3)	
>10 months ≤14 years	0 (0)	1 (3.3)	
Age (months)			
Range	3–96	4–144	
Mean±SD	24.9±22.5	30.2±29.1	
Age (years)			
Range	0.25–8	0.29–12	
Mean±SD	2.08±1.8	2.5±1.6	

Table 2 Sex distribution in both groups

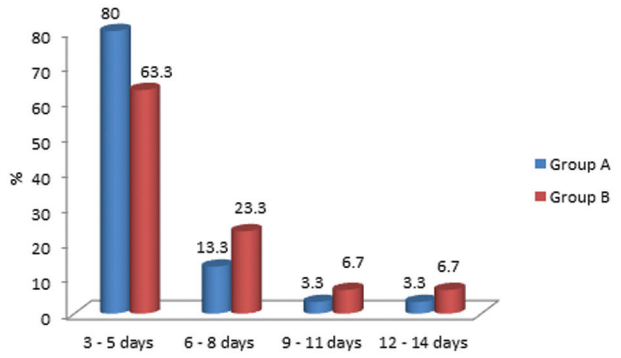
	Group A (*n*=30) [*n* (%)]	Group B (*n*=30) [*n* (%)]	*P*-value
Sex			
Male	15 (50)	21 (70)	0.114
Female	15 (50)	9 (30)	

Figure 4



Comparisons of age distribution in both groups.

Figure 5



Sex distribution in both groups.

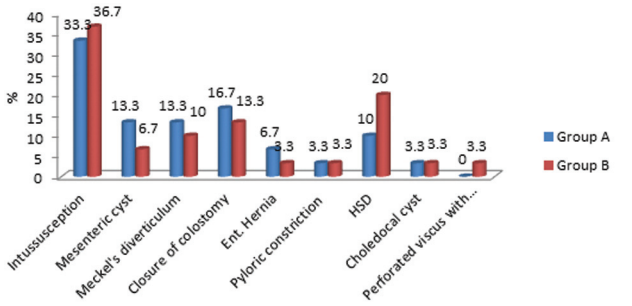
A and 11 (36.7%) cases in group B. Five (16.7%) cases and four (13.3%) cases were due to closure of colostomy in groups A and B, respectively. Four (13.3%) cases and two (6.7%) cases were mesenteric cysts in groups A and B, respectively. Cases of Hirschsprung's disease represented 10% in group A and 20% in group B, whereas cases of internal hernia represented 6.7 and 3.3% in groups A and B, respectively. Four (13.3%) cases were Meckel's diverticulum in group A, whereas it was three (10%) cases in group B. Other causes of anastomosis in our study included pyloric constriction, choledocal cyst, and perforated viscus with ischemic line (Table 3 and Fig. 6).

The operative time ranged between 50 and 155 min (mean=73.8 min) and 75 and 240 min (mean=110.8 min) in groups A and B, respectively, with *P*-value less than 0.001, which is statistically

Table 3 Diagnosis of causes of intestinal anastomosis

	Group A (*n*=30) [*n* (%)]	Group B (*n*=30) [*n* (%)]	*P*-value
Intussusception	10 (33.3)	11 (36.7)	0.914
Mesenteric cyst	4 (13.3)	2 (6.7)	
Meckel's diverticulum	4 (13.3)	3 (10)	
Closure of colostomy	5 (16.7)	4 (13.3)	
Internal hernia	2 (6.7)	1 (3.3)	
Pyloric constriction	1 (3.3)	1 (3.3)	
Hirschsprung's disease	3 (10)	6 (20)	
Choledocal cyst	1 (3.3)	1 (3.3)	
Perforated viscus with ischemic line	0 (0)	1 (3.3)	

Figure 6



Diagnosis of cause of intestinal anastomosis. HSD, Hirschsprung's disease.

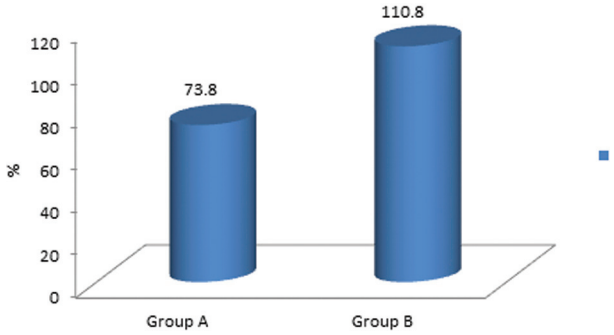
significant. As regards postoperative hospital stay, it ranged between 3 and 12 days (mean=5 days) in group A and 4 and 12 days (mean=6.1 days) in group B, with a *P*-value of 0.049, which is statistically significant (Tables 4 and 5, Fig. 7).

Fifteen (50%) patients in group A and 17 (56.7%) in group B had postoperative fever, whereas two (6.7%) cases in group A and five (16.7%) cases in group B had wound infection. In group A, we reported two (6.7%) cases of intestinal leakage and five (16.7%) cases of vomiting, whereas in group B it was two (6.7%) cases and 10 (33.3%) cases, respectively. We reported significant results as regards postoperative distention, as it was four (13.3%) cases in group A and 13 (43.3%) cases in group B, with *P*-value equal to 0.01. None of the cases required re-exploration in group A, whereas two (6.7%) cases required re-exploration in group B (Table 6 and Fig. 8).

Discussion

Intestinal anastomosis in pediatric surgery is a relevant matter because of the frequency of the procedure [12]. The two-layer interrupted anastomosis has its origins in the early 19th century, whereas the single-layer interrupted anastomosis was first described by Hautefeuille [3]. Ischemia, tension on the anastomosis,

Figure 7



Operative time in minutes.

Table 4 Operative time

	Group A (*n*=30)	Group B (*n*=30)	*P*-value
Operative time (min)			
Range	50–155	75–240	<0.001
Mean±SD	73.8±26.9	110.8±45.4	

Table 5 Postoperative hospital stay

Hospital stay (days)	Group A (*n*=30) [*n* (%)]	Group B (*n*=30) [*n* (%)]	*P*-value
3–5	24 (80)	19 (63.3)	0.914
6–8	4 (13.3)	7 (23.3)	
9–11	1 (3.3)	2 (6.7)	
12–14	1 (3.3	2 (6.7)	
Postoperative hospital stay (days)			
Range	3–12	4–12	
Mean±SD	5±2	6.1±2.2	

and poor technique are clearly the most important factors responsible for anastomotic failure [2,13].

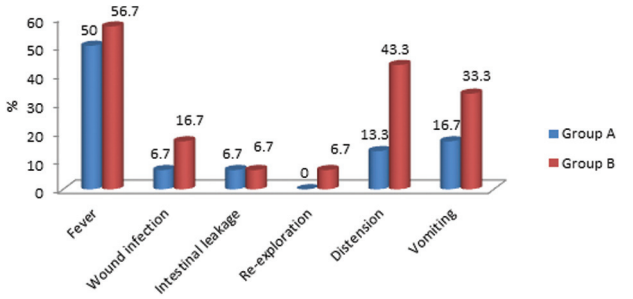
The present study assessed the efficacy and safety of the single-layer interrupted against the double-layered anastomosis in pediatric age, comparing between them mainly in operative time, postoperative complications, and postoperative hospital stay.

In our study, the mean age was 2.08 years in group A and 2.5 years in group B, whereas in the study conducted by Ordorica-Flores *et al.* [12] the mean age was 3.7 years in both groups [12] and in the study conducted by Ross *et al.* [14] the mean age was 6 months in the single-layer group [12,14].

In the present study, intussusception was the most frequent diagnosis in both groups: 10 and 11 cases in groups A and B, respectively.

In the study conducted by Ordorica-Flores *et al.* [12], the most frequent diagnosis was closure of

Figure 8



Postoperative complications.

Table 6 Presence of postoperative complications

Postoperative complications	Group A (*n*=30) [*n* (%)]	Group B (*n*=30) [*n* (%)]	*P*-value
Fever	15 (50)	17 (56.7)	0.605
Wound infection	2 (6.7)	5 (16.7)	0.228
Intestinal leakage	2 (6.7)	2 (6.7)	1
Re-exploration	0 (0)	2 (6.7)	0.150
Distension	4 (13.3)	13 (43.3)	0.01
Vomiting	5 (16.7)	10 (33.3)	0.136

colostomy postnecrotising enterocolitis, which was 53% in both groups [12], whereas in the study conducted by Garude *et al.* [15] the most frequent diagnosis was trauma, which represented 47.9% in the single-layer group and 47.2% in the double-layer group [15].

The mean operative time in our study was 73.8 min in the single-layer group and 110.8 min in the double-layer group. In the study conducted by Ordorica-Flores *et al.* [12], it was 26 min in the single-layer group and 43 min in the double-layer group, whereas in another study conducted by Saboo *et al.* [13] the mean operative times were 23.6 and 33.06 min in the single-layer and double-layer groups, respectively [13].

The operative time was longer in our study because it was estimated from the incision of the skin to the last skin stitch, but in other studies it was the time needed for constructing the anastomosis only.

In the present study, the mean hospital stay was 5 days in single-layer and 6.1 days in double-layer anastomosis, with statistically significant results. Ordorica-Flores *et al.* [12] reported a mean hospital stay of 10.4 days in both groups; also, Garude *et al.* [15] reported the same mean hospital stay in both groups (12 days), whereas Saboo *et al.* [13] reported 16.9 days in single-layer and 16 days in double-layer anastomosis [12,13,15].

The percentages of postoperative distension and vomiting were higher in group B in our study – 43 and 33%, respectively – whereas in group A they were 13.3 and 16.7%, respectively, with statistically significant *P*-value as regards postoperative distension. These results can be attributed to the decreased lumen of the intestine in double-layer intestinal anastomosis. The other studies were reviewed and they did not report postoperative distension or vomiting.

There was no difference between the two groups as regards postoperative intestinal leakage. It was two (6.7%) cases in each group in our study, whereas in the study conducted by Ordorica-Flores *et al.* [12] intestinal leakage was reported in 5% in single-layer and 7% in double-layer anastomosis [12]. In the study conducted by Askarpour *et al.* [16], intestinal leakage was found in 1.6% in single-layer and 6.3% in double-layer anastomosis. Saboo *et al.* [13] reported intestinal leakage in 10 and 6.66% and Garude *et al.* [15] reported it in 5.3 and 4% in single- and double-layer anastomosis, respectively [13,15].

Re-exploration due to intestinal leakage in our study was needed in two cases of group B, whereas in group A no cases re-explored. Saboo *et al.* [13] reported re-exploration in 10% in single-layer and 3.33% in double-layer anastomosis [13].

In our study, wound infection was found in two (6.7%) cases in single-layer and five (16.7%) cases in double-layer anastomosis, whereas in the study conducted by Ordorica-Flores *et al.* [12] wound infection was found in two (5%) cases in single-layer and three (7%) cases in double-layer anastomosis and in the study conducted by Askarpour *et al.* [16] wound infection was found in five (7.9%) cases in single-layer and seven (11%) cases in double-layer anastomosis [12,16]. Saboo *et al.* [13] reported wound infection in four (13.3%) cases in single-layer and six (20%) cases in double-layer anastomosis [13].

In this study, we can conclude that single-layer anastomosis is more successful and effective and this can be attributed to less damage to the blood supply because less mesentery is cleared off of the two cut edges and less damage to the submucosal vascular plexus, as in this technique sutures are taken sparing the mucosa. Also there is less inversion of tissue that can lead to narrowing of the lumen.

In our study, we did not exclude the duodenum and rectum from the inclusion criteria, whereas other studies did that. In addition, emergency cases were included in our study. The limitation of our study was that we did not conduct contrast studies to cases with distension to detect whether the cause was stricture in the anastomosis, especially in double-layer interrupted anastomosis.

Conclusion

The present study assessed the efficacy and safety of the single-layer interrupted against the double-layer interrupted anastomosis, comparing between them mainly in operative time, postoperative complications, and postoperative hospital stay. We concluded that single-layer anastomosis is effective, safe, and successful, of less operative time, less hospital stay, and valuable cost-effectiveness.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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