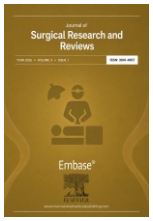
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Research Article

Section: General Surgery

Comparative Evaluation of Single-Layer Versus Double-Layer Small Bowel Anastomosis: A Prospective Comparative Study

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HIGHLIGHTS

- Reduced anastomosis time.
- Shorter operative duration.
- Earlier bowel function recovery.
- Comparable postoperative complications.
- Safe alternative to double-layer repair.

Key Words:
Single-layer anastomosis
Double-layer anastomosis
Small bowel
Anastomotic leak
Operative time
Intestinal surgery

ABSTRACT

Introduction: Single-layer intestinal anastomosis may reduce operative time and tissue handling while maintaining safety comparable to the conventional double-layer technique. **Aim & Objective:** To compare operative efficiency, postoperative recovery and complications between single-layer and double-layer small-bowel anastomosis. **Materials & Methods:** This prospective comparative study included 80 adults undergoing small-bowel resection and primary end-to-end anastomosis at Rajkiya Medical College, Jalaun, Orai. Patients were equally allocated to single-layer (n=40) and double-layer (n=40) groups. Anastomosis time, total operative time, bowel function recovery, hospital stay and postoperative complications were assessed using appropriate statistical tests. A p-value <0.05 was considered statistically significant. **Results:** Baseline characteristics were comparable between groups. Mean anastomosis time was significantly shorter in the single-layer group than in the double-layer group (17.6±3.8 vs 29.4±5.1 minutes; p<0.001). Total operative time was also significantly reduced (92.8±19.6 vs 105.6±21.4 minutes; p=0.007). Return of bowel sounds occurred earlier with single-layer anastomosis (2.4±0.8 vs 2.8±0.9 days; p=0.039). Anastomotic leakage occurred in 1 (2.5%) and 2 (5.0%) patients, respectively, without a significant difference. Overall postoperative complications, reoperation rates and hospital stay were comparable between groups. **Conclusion:** Single-layer small-bowel anastomosis significantly reduces anastomosis and total operative time and facilitates earlier recovery of bowel sounds without increasing short-term postoperative complications. It represents an efficient alternative to conventional double-layer anastomosis, although larger studies with longer follow-up are warranted to establish its long-term safety.

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INTRODUCTION

Intestinal anastomosis is one of the fundamental procedures performed in general surgery and is required following bowel resection for a wide spectrum of elective and emergency conditions. The essential principles of a successful anastomosis include adequate vascularity, absence of tension, accurate tissue apposition, preservation of the bowel lumen and meticulous surgical technique. Despite improvements in perioperative management, anastomotic failure remains an important cause of postoperative morbidity and mortality, making selection of an appropriate technique clinically relevant [1]. The method chosen depends on the anatomical site, bowel condition, underlying pathology, degree of contamination, general status of the patient and the surgeon's experience [2].

Healing of an intestinal anastomosis is largely dependent upon the submucosal layer, which provides most of the tensile strength of the bowel wall. Preservation of the submucosal vascular plexus and avoidance of excessive tissue handling are therefore important determinants of satisfactory healing [3]. Historically, several techniques have been described, evolving from early experimental observations on intestinal repair to contemporary hand-sewn and stapled methods [4].

The conventional double-layer technique generally consists of a full-thickness or transmural inner layer combined with an outer seromuscular layer. Although widely practiced, it requires additional suturing, increases operative time and may cause greater tissue inversion and compromise of the local microcirculation. In contrast, a single-layer technique aims to approximate the bowel edges with fewer sutures while incorporating the strong submucosal layer. This may reduce tissue ischemia, foreign-body load, luminal narrowing and the time required to complete the anastomosis. Evidence accumulated over several decades suggests that a second suture layer may not provide additional protection against leakage. Shikata et al., in a meta-analysis of randomized trials, found no significant reduction in postoperative anastomotic leakage with two-layer anastomosis compared with single-layer repair [5]. A Cochrane review similarly found no convincing superiority of the double-layer technique and highlighted the potential advantages of a simpler single-layer approach [6]. More recently, Modi et al. reported significantly reduced operative time with single-layer small-bowel anastomosis without an increase in postoperative complications [7]. Kar et al. also demonstrated shorter anastomosis time and earlier postoperative recovery with single-layer anastomosis while maintaining comparable safety [8]. **Figure 1.** Comparative illustration of single-layer and double-layer intestinal anastomosis, demonstrating suture techniques, intestinal wall layers, preservation of submucosal vascularity, operative efficiency, bowel function recovery and postoperative outcomes. Considering the importance of minimizing operative duration, particularly during emergency procedures, and the continuing variation in surgical practice, the present study was undertaken at Rajkiya Medical College, Jalaun, Orai, to compare the efficacy and safety of single-layer versus double-layer small-bowel anastomosis, with particular emphasis on the time required for anastomosis, total operative duration, postoperative return of bowel function, length of hospital stay, anastomotic leak, and other postoperative complications.

MATERIALS & METHODS

This prospective comparative study was conducted in the Department of General Surgery, Rajkiya Medical College, Jalaun, Orai, Uttar Pradesh. A total of 80 adult patients requiring small-bowel resection followed by end-to-end anastomosis during elective or emergency surgery were included. Patients were allocated in a 1:1 ratio into Group A: single-layer anastomosis (n=40) and Group B: double-layer anastomosis (n=40). Adult patients aged ≥18 years in whom primary small-

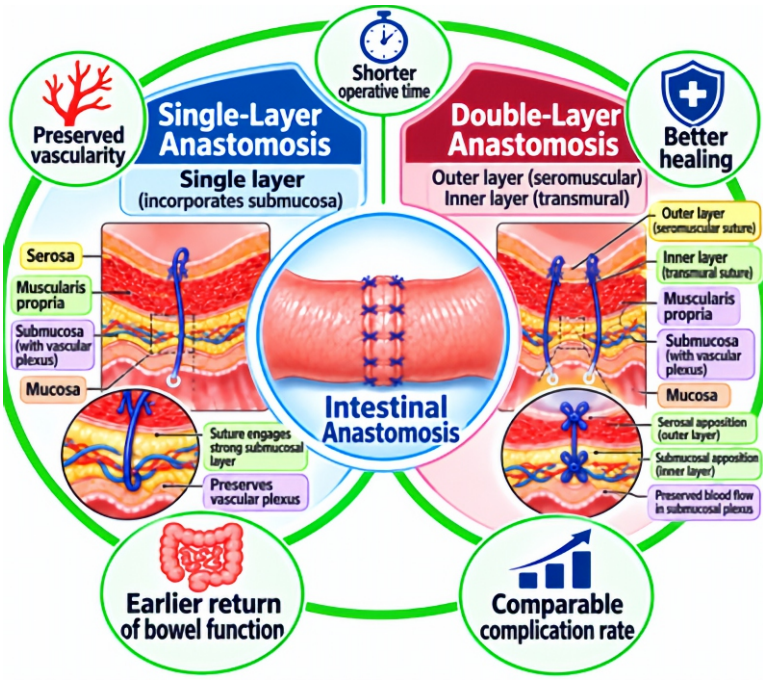


Figure 1: Comparison of single-layer and double-layer intestinal anastomosis techniques and outcomes.

bowel anastomosis was considered appropriate were eligible. Patients requiring proximal diversion/stoma formation, those with non-viable bowel extending beyond the planned resection margins, severe uncontrolled sepsis or haemodynamic instability precluding primary anastomosis were excluded.

In Group A, the bowel ends were approximated using a single-layer extramucosal/serosubmucosal technique. In Group B, a conventional double-layer anastomosis comprising an inner full-thickness/Connell layer and an outer seromuscular layer was performed. Standard principles regarding bowel viability, ade-quate blood supply, tension-free approximation and mesenteric defect closure were followed. Anastomosis time was measured from placement of the first anastomotic stitch until completion of the anastomosis. Postoperatively, patients were assessed for return of bowel function, oral intake, wound infection, ileus, leak, reoperation, stricture, mortality and hospital stay.

Data were analysed using appropriate descriptive and inferential statistics. Continuous variables were expressed as mean±standard deviation and compared using the independent-samples Student's t test. Categorical variables were expressed as frequency and percentage & analysed using the chi-square test or Fisher's exact test where expected cell frequencies were small. Effect estimates were expressed as mean difference or risk ratio with 95% confidence intervals where appropriate. A two-sided $p<0.05$ was considered statistically significant.

RESULTS

A total of 80 patients were analysed, with 40 patients each in the single-layer and double-layer groups. The two groups were comparable with respect to age, sex, operative setting and anatomical site of anastomosis. The major difference observed was in operative efficiency: mean anastomosis time and total operative duration were significantly shorter in the single-layer group. Postoperative bowel recovery also tended to occur earlier following single-layer repair. Anastomotic leak and overall postoperative complication rates were low in both groups and did not differ significantly. No significant difference was observed in length of hospitalization, reoperation or mortality, suggesting that reduction in suturing time with the single-layer technique was achieved without evidence of compromised short-term safety.

Table 1 demonstrates that the two study groups were well balanced with respect to major baseline characteristics. The mean age was 38.6±14.2 years in the single-layer group and 40.1±13.8 years in the double-layer group, with no statistically significant difference (p=0.633). Males constituted 60.0% and 57.5% of the two groups, respectively. Emergency surgery accounted for more than three-fourths of procedures in both groups, being required in 77.5% of single-layer and 80.0% of double-layer cases (p=0.785). Ileo-ileal anastomosis was the most frequent anatomical configuration in both groups, followed by jejuno-jejunal anastomosis. The overall distribution of anatomical sites was nearly identical (p=0.984). Thus, there was no evidence of clinically important baseline imbalance capable of independently explaining subsequent differences in operative or postoperative outcomes. The principal intraoperative findings are presented in **Table 2** and summarized graphically in **Figure 2**. The mean time required to complete the bowel anastomosis was 17.6±3.8 minutes in the single-layer group compared with 29.4±5.1 minutes in the double-layer group, representing a mean reduction of 11.8 minutes ($p<0.001$). Total operative duration was also shorter with single-layer repair (92.8±19.6 vs 105.6±21.4 minutes; mean difference 12.8 minutes; p=0.007). In addition, 95.0% of single-layer anastomoses were completed within 25 minutes compared with only 20.0% of double-layer anastomoses ($p<0.001$). Estimated blood loss was similar between groups (83.5±29.4 vs 88.2±34.1 mL; p=0.510). As illustrated in Figure 1, the greatest proportional advantage of the single-layer technique was seen in anastomosis-specific time, confirming a clear operative time-saving benefit without increased blood loss.

Postoperative recovery characteristics are summarized in **Table 3** and **Figure 3**. Return of bowel sounds occurred at a mean of 2.4±0.8 days after single-layer anastomosis compared with 2.8±0.9 days after double-layer repair, a statistically significant difference (p=0.039). First passage of flatus occurred after 2.8±0.9 and 3.2±1.0 days, respectively (p=0.064), while oral intake was commenced at 3.2±0.9 and 3.6±1.0 days (p=0.064). Mean hospital stay was 7.1±2.1 days in the single-layer group and 7.8±2.4 days in the double-layer group (p=0.169). Figure 2 shows the same consistent direction of effect across all recovery measures, with numerically earlier recovery after single-layer repair; however, apart from return of bowel sounds, the differences did not reach statistical significance.

As shown in **Table 4** and **Figure 4**, postoperative complications were uncommon in both groups and none differed significantly between the techniques. Anastomotic leak occurred in one patient (2.5%) following single-layer repair and two patients (5.0%) following double-layer anastomosis (p=1.000). Surgical-site infection occurred in 7.5% and 10.0% of patients, respectively, while prolonged ileus occurred in 5.0% and 7.5%. Intra-abdominal collection was observed in 2.5% versus 5.0%. Two cases of anastomotic stricture occurred in the double-layer group compared with none in the single-layer group (p=0.494). Reoperation was required in one patient in each group, and mortality occurred in one patient in the double-layer group only. **Figure 3** demonstrates that complication percentages were numerically lower after single-layer repair across the displayed outcomes, but the small number of events precluded statistical significance. Overall, both techniques showed comparable short-term safety. **Table 5** summarizes the clinically most important effect estimates. Single-layer anastomosis reduced mean anastomosis time by 11.8 minutes compared with double-layer repair, with a 95% confidence interval of approximately −13.8 to −9.8 minutes ($p<0.001$). Total operative time was similarly reduced by an estimated 12.8 minutes (95% CI −21.9 to −3.7; p=0.007). The relative risk of anastomotic leakage was 0.50 for single-layer compared with double-layer repair, although the

wide confidence interval and nonsignificant p value reflect the small number of leak events. Any postoperative complication wide confidence interval and nonsignificant p value reflect the small number of leak events. Any postoperative complication occurred in 15.0% versus 22.5% of patients, yielding an RR of 0.67 but without statistical significance. Mean hospital stay was0.7 day shorter following single-layer anastomosis. Thus, the most robust advantage demonstrated was reduced operative time rather than a difference in postoperative morbidity.

Table 2. Comparison of intraoperative parameters

Parameter	Single layer, n=40	Double layer, n=40	Mean difference	p value
Anastomosis time, min	17.6±3.8	29.4±5.1	-11.8	<0.001
Total operative time, min	92.8±19.6	105.6±21.4	-12.8	0.007
Estimated blood loss, mL	83.5±29.4	88.2±34.1	-4.7	0.510
Anastomosis completed <25 min	38 (95.0%)	8 (20.0%)	-	<0.001

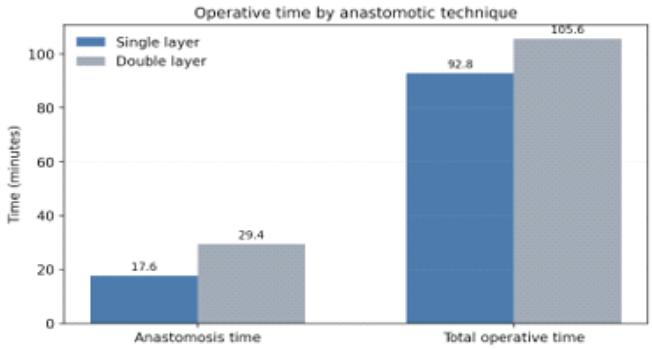


Figure 2. Comparison of mean anastomosis time and total operative duration between single-layer and double-layer bowel anastomosis.

Table 3. Postoperative recovery parameters

Parameter	Single layer, n=40	Double layer, n=40	p value
Return of bowel sounds, days	2.4±0.8	2.8±0.9	0.039
First passage of flatus, days	2.8±0.9	3.2±1.0	0.064
Oral intake started, days	3.2±0.9	3.6±1.0	0.064
Hospital stay, days	7.1±2.1	7.8±2.4	0.169

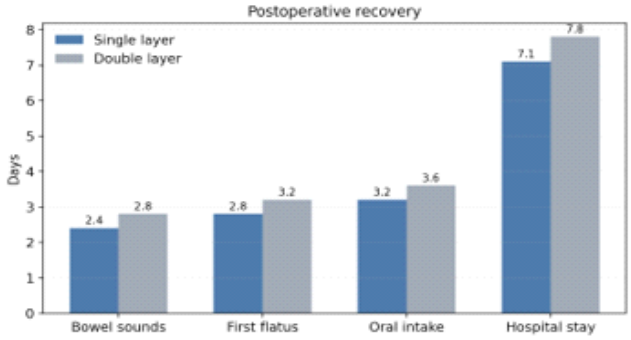


Figure 3. Comparison of postoperative return of bowel function, oral intake and hospital stay following single-layer and double-layer anastomosis.

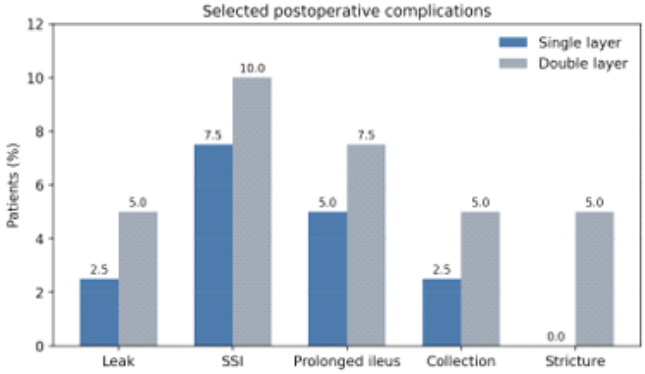


Figure 4. Percentage distribution of major postoperative complications according to single-layer and double-layer intestinal anastomotic technique.

Table 4. Postoperative complications

Complication	Single layer, n=40	Double layer, n=40	p value*
Anastomotic leak	1 (2.5%)	2 (5.0%)	1.000
Surgical-site infection	3 (7.5%)	4 (10.0%)	1.000
Prolonged ileus	2 (5.0%)	3 (7.5%)	1.000
Intra -abdominal collection	1 (2.5%)	2 (5.0%)	1.000
Anastomotic stricture	0	2 (5.0%)	0.494
Reoperation	1 (2.5%)	1 (2.5%)	1.000
Mortality	0	1 (2.5%)	1.000

**Fisher's exact test used where appropriate.*

Table 5. Summary of principal comparative outcomes

Outcome	Single layer	Double layer	Effect estimate	95% CI	p value
Anastomosis time, min	17.6±3.8	29.4±5.1	Mean difference -11.8 min	-13.8 to -9.8	<0.001
Total operative time, min	92.8±19.6	105.6±21.4	Mean difference -12.8 min	-21.9 to -3.7	0.007
Anastomotic leak	2.5%	5.0%	RR 0.50	0.05-5.30	1.000
Any postoperative complication†	15.0%	22.5%	RR 0.67	0.26-1.73	0.576
Hospital stay, days	7.1±2.1	7.8±2.4	Mean difference -0.7 day	-1.7 to 0.3	0.169

†Patients with one or more postoperative complication counted once.

DISCUSSION

The present study compared single-layer and double-layer small-bowel anastomosis in 80 patients and demonstrated that single-layer repair substantially reduced the time required for anastomotic construction and overall operative duration, while postoperative complication rates remained comparable. These findings are relevant because anastomotic safety is determined primarily by adequate vascularity, tension-free tissue approximation and preservation of the submucosal layer rather than simply by the number of suture layers.

The marked reduction in anastomosis time observed in the present study is consistent with previous evidence. Burch et al. reported that single-layer continuous anastomosis could be performed more rapidly than conventional two-layer interrupted repair without compromising clinical safety [9]. Garude et al. similarly described single-layer intestinal anastomosis as a safe and economical technique and reported a shorter construction time [10]. Khan et al. also found an operative advantage with single-layer repair in their comparative evaluation of safety and morbidity [11]. This reduction in time may be particularly valuable during emergency laparotomy, in physiologically compromised patients and whenever prolonged anaesthesia is undesirable.

The absence of a significant difference in anastomotic leakage between the study groups is consistent with the broader literature. Max et al., in a large experience with single-layer continuous polypropylene anastomoses, demonstrated a low incidence of major anastomotic complications [12]. Hyman et al. emphasized that intestinal leakage remains multifactorial and can occur later in the postoperative period, highlighting the importance of appropriate clinical surveillance irrespective of the suturing method [13]. Ceraldi et al. found no significant disadvantage of single-layer repair compared with double-layer or stapled techniques in elective bowel resections [14]. Likewise, Leslie et al. reported favorable results with serosubmucosal anastomosis, supporting the importance of accurate incorporation of the strong submucosal layer [15]. The numerically greater frequency of stricture in the double-layer group may be biologically plausible. Askarpour et al. discussed the possibility that greater inversion additional sutures in double-layer repair could contribute to luminal narrowing and local vascular compromise [16]. Nevertheless, the low number of events in the present study precludes a definitive conclusion. Slieker et al., in a systematic review of anastomotic technique, similarly emphasized that technical details, perfusion and tissue handling influence anastomotic outcome beyond the simple choice of one versus two layers [17].

Postoperative bowel recovery was somewhat earlier after single-layer repair. This observation agrees with Maurya et al. and Chittmittrapap et al., who reported favorable postoperative recovery following one-layer techniques [18,19]. In contrast, Saboo et al. observed broadly comparable postoperative outcomes between single- and double-layer repair, indicating that differences in bowel recovery may not be consistent across populations [20].

The study has certain limitations. It represents a single-centre experience with a relatively modest sample size, limiting statistical power for uncommon outcomes such as leakage, stricture and mortality. Variability in underlying pathology and emergency presentation may also influence recovery. In addition, long-term evaluation of anastomotic narrowing was limited. Larger multicentre randomized studies with standardized techniques and longer follow-up would provide stronger evidence.

CONCLUSION

Both single-layer and double-layer small-bowel anastomoses were associated with comparable short-term postoperative safety. Single-layer anastomosis, however, required significantly less time for construction and resulted in a shorter total operative duration without a significant increase in anastomotic leak, wound infection, reoperation or other postoperative complications. Postoperative bowel recovery also showed a modest trend in favour of the single-layer technique. Therefore, when performed with appropriate attention to bowel viability, vascularity and tension-free tissue approximation, single-layer anastomosis represents a safe, efficient and time-saving alternative to conventional double-layer anastomosis, particularly in emergency surgical settings.

LIMITATIONS & FUTURE PERSPECTIVES

The study's limitations include a single-centre setting, a relatively small sample size, and a short study duration, which may limit the broader applicability of the results. Future studies should incorporate multi-centre designs with larger populations to enhance validity, assess long-term outcomes, & investigate advanced diagnostic & management approaches. Such efforts will improve overall patient care & help minimize complications.

CLINICAL SIGNIFICANCE

The clinical significance of this study lies in its potential to bridge the gap between research findings and practical health-care, diagnosis, and treatment outcomes. By highlighting real-care applications. It emphasizes the importance of translating scientific observations into meaningful improvements in patient world relevance, the study contributes to evidence based medical practice and supports informed clinical decision making. Ultimately, the findings aim to enhance patient quality of life, optimize therapeutic strategies, and promote better disease management in clinical settings.

ABBREVIATIONS

SD: Standard Deviation
SPSS: Statistical Package for the Social Sciences
p: Probability Value
n - Sample Size

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AUTHOR CONTRIBUTIONS

All authors significantly contributed to the study conception and design, data acquisition, or data analysis and interpretation. They participated in drafting the manuscript or critically revising it for important intellectual content, consented to its submission to the current journal, provided final approval for the version to be published, and accepted responsibility for all aspects of the work. Additionally, all authors meet the authorship criteria outlined by the International Committee of Medical Journal Editors (ICMJE) guidelines.

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CONFLICT OF INTEREST

Authors declared that there is no conflict of interest.

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None

ETHICAL APPROVAL & CONSENT TO PARTICIPATE

All necessary consent & approval was obtained by authors.

CONSENT FOR PUBLICATION

All necessary consent for publication was obtained by authors.

DATA AVAILABILITY

All data generated and analyzed are included within this research article. The datasets utilized and/or analyzed in this study can be obtained from the corresponding author upon a reasonable request.

USE OF ARTIFICIAL INTELLIGENCE (AI) & LARGE LANGUAGE MODEL (LLM)

The authors confirm that no AI & LLM tools were used in the writing or editing of the manuscript, and no images were altered or manipulated using AI & LLM.

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