ORIGINAL ARTICLE

Comparison of the outcome after the anastomosis of intestine with mechanical stapler versus hand suturing – A Prospective Observational Study

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ABSTRACT

Introduction: Intestinal anastomosis connects bowel segments with good blood supply. Techniques include end-to-end, end-to-side, side-to-end, and side-to-side, using hand-sewn or stapled methods. This study compares outcomes of hand suturing versus mechanical stapling.

Methods: We conducted a prospective observational study comparing hand-sutured and stapled bowel anastomosis outcomes from September 2020 to February 2022 in our Hospital, surgery department. Eighty ethically-approved patients were divided into two groups, and data were analyzed using SPSS version 23 with Chi-square and t-tests.

Results: The study involved 80 patients, divided equally between hand suturing and stapler groups. The mean age was 49.5 ± 16.5 years for hand suturing and 50.6 ± 14.4 years for staplers. Hand suturing took an average of 42.00 ± 8.7 minutes, and stapling took 14.13 ± 4.5 minutes. Surgery duration was 2.72 ± 0.95 hours for hand suturing and 2.15 ± 0.62 hours for staplers. Anastomotic leakage occurred in 11.3% of hand-sutured cases and 3.8% of stapled cases. SSI rates were 18.8% for hand suturing and 5.0% for staplers. Hospital stay averaged 12.28 ± 5.3 days for hand suturing and 9.23 ± 3.03 days for staplers. The cost was 23.22 ± 6.45 thousand for hand suturing and 46.42 ± 15.74 thousand for staplers.

Conclusion: Intestinal anastomosis with a stapler is quicker and leads to shorter hospital stays, while hand suturing takes longer and extends hospital stays. Both methods have similar leakage and mortality rates. Hand suturing requires skilled operators and has a steep learning curve, unlike the stapler technique.

INTRODUCTION

Intestinal anastomosis denotes the approximation of two bowels which should be without tension and have a good blood supply. These are common procedures done in elective and emergency abdominal surgery.[1] Bowel anastomosis was started in the 19th century.[2] The anastomosis can be done in end-to-end, end-to-side, side-to-end, and side-to-side fashion.[2,3] The anastomotic technique may be done with hand-sewn or stapled methods.[4,5] In the era of Sushruta, "The Great Indian Surgeon," the use of black ants during intestinal suturing was described.6,7 Antoine Lembert described the seromuscular suturing procedure for intestinal anastomosis in 1826.[6,8,9] Probably the most common type of intestinal suture technique was described by O'Connell in 1892, in which the inner row was sutured continuously in an inverted fashion and the outer with interrupted seromuscular sutures.[6,8]

Mechanical stapling devices were first used successfully by Humer Hultl

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in Hungary in 1908 to close the stomach after resection.[3,9-11] The main principle of these staplers is theuse of fine metal staples, placement of a double row of staples on each side, and closureof staples in the B configuration, which is much cheaper than modern stapling devices but equally effective, and comparing the frequency of anastomotic leakage with handsewn technique of bowel anastomosis. The rationale to carry out this study is that if this study concludes in favor of stapled technique over conventional hand sewn technique patients would not only benefit in terms of safer reversal, but also would be benefited from shorter duration of operation. Moreover the local surgeons would gain confidence in adopting recent advancements in gut anastomosis. Methodology: All procedures were done by skilled forth year surgical trainees under consultant's supervision. Ileostomy reversals was done via stapling or suturing technique according to patient's randomization. The patients were then evaluated for signs of anastomotic leakage by consultants at the day of discharge (5th post-operative day,[9-11] The main principle of these staplers is the use of fine metal staples, placement of a double row of staples on each side, and closure of staples in the B configuration, which is still the principle of today's instruments.[11,12] Russian-invented instruments that approximated, stapled, and cut the bowel; these are the precursors of the current GIA stapler and linear cutter stapler.[11-13]

The key to successful anastomosis is the accurate union of two viable bowel ends without any tension over the bowels.[14] The anastomotic technique selection depends on the site of anastomosis, bowel caliber, bowel quality, and the underlying disease process. The main complications of intestinal anastomosis include anastomotic leakage and dehiscence. Reported anastomosis failure rates range from 1.5% to 2.2%, depending on the type of anastomosis and whether the surgery was elective or emergency.[2] Overall, patients with anastomotic leaks after colorectal surgery have significantly greater chances of morbidity (56%) and mortality rates of up to 32%.[15]

As a clear consensus about the superiority between these two procedures has not been reached, this study was designed to compare the outcomes of two techniques, that is, hand suturing and mechanical stapling, used for intestinal anastomosis.

METHODS

After obtaining ethical approval from the Institutional Review Board (IRB) of our hospital, a comparative prospective observational study was conducted at our hospital. Informed written consent was obtained from all patients.

The inclusion criteria included all patients requiring gastrointestinal surgeries who needed intestinal anastomosis, irrespective of elective or emergency surgery, and who were more than or equal to 15 years of age. The exclusion criteria included patients who were less than 15 years of age, did not provide written informed consent, were not fit for anesthesia, had severe sepsis, hemodynamic instability, or contraindications for intestinal anastomosis.

Patients were allocated into two groups: those undergoing intestinal anastomosis with hand-sewn and mechanical stapler techniques. A total of 80 patients were included in the study: 40 in the hand-sewn group and 40 in the stapler group. Convenient sampling was performed to allocate patients to each arm.

Each case was analyzed concerning the duration required to perform intestinal anastomosis alone, total operative time, and postoperative complications such as anastomotic leak, SSI, mortality, and prolonged hospital stay. Anastomotic leak was confirmed by either the development of an enterocutaneous fistula or the appearance of bowel contents from drains, systemic sepsis in association with peritonitis, or confirmation by reoperation. Other postoperative complications were noted and resolved. All patients were observed until their complete postoperative hospital stay and were followed up for one month by contacting the patients.

RESULTS

This clinical study was conducted in 80 patients over the age of 15 years, of either sex, admitted for gastrointestinal surgery requiring intestinal anastomosis who met the inclusion criteria. The study was undertaken at our hospital over 6 months. After approval from the Institutional Review Board (IRB) of our hospital, a comparative study was carried out on 80 patients, of which 40 patients underwent intestinal anastomosis with hand suturing and 40 with a mechanical stapler. There was a higher incidence of intestinal anastomosis in the 40-59 age group, with 17 patients (42.5%) in the mechanical stapler group and 14 patients (35%) in the hand suturing group. Additionally, the data showed a predominance of male patients in both groups: 25 (62.5%) in the hand-suturing group and 23 (57.5%) in the stapler group. (Table 1)

Table 1: Age and Sex distribution of Intestinal Anastomosis

Parameter		Hand Suturing	Mechanical stapler	p-value
Age	15-39	11 (27.5%)	10 (25%)	0.764[I]
	40-59	14 (35%)	17(42.5%)	
	≥60	15 (37.5%)	13 (32.5%)	
	(mean ± SD)	49.5±16.5	50.6±14.4	
Sex	Male	25 (62.5 %)	23 (57.5 %)	0.648[C]
	Female	15 (37.5 %)	17 (42.5 %)	

[I]Independent sample t-test, [C]chi square test

Among the 80 patients undergoing bowel anastomosis, 34 (42.5%) had comorbid conditions such as diabetes mellitus (DM), hypertension (HTN), or thyroid disorders, while 46 (57.5%) had no comorbid conditions. (Table 2.)

Table 2: Incidence of intestinal Anastomosis in patients with comorbid conditions

Technique	Comorbid conditions Number (%)	Non comorbid conditions Number (%)	p-value
Hand suturing	16 (40%)	24 (60%)	0.651[C]
Mechanical stapler	18 (45%)	22 (55%)	
Total	34 (42.5%)	46 (57.5%)	

[C]chi square test

The postoperative complications between the two techniques are shown in Table 3. Anastomotic leakage occurred in 9 patients (11.3%) in the hand suturing group and 3 patients (3.8%) in the mechanical stapler group. Surgical site infections (SSI) were noted in 15 patients (18.8%) in the hand suturing group and 4 patients (5.0%) in the stapler group. Mortality rates were identical across both groups, with one patient dying in each. SSI rates were significantly different between the groups, while anastomotic leakage and mortality did not show a statistically significant difference. (Table 3)

Table 3: Comparison of postoperative complications:

Parameter	Hand suturing group Number (%)	Mechanical stapler group Number (%)	p value
Anastomotic leak	9 (11.3 %)	3(3.8 %)	0.060 [C]
SSI	15 (18.8 %)	4 (5.0 %)	0.004 [C]
Mortality	1 (1.3 %)	1(1.3 %)	1.00 [C]

[C]chi square test

The average time required for intestinal anastomosis alone was 42.00 ± 8.7 minutes for hand suturing and 14.13 ± 4.5 minutes for mechanical stapling. The overall operation duration was 2.72 ± 0.95 hours for hand suturing and 2.15 ± 0.62 hours for stapling, with a statistically significant difference observed in both the anastomosis and total operation times. (Table 4)

Table 4: Comparison of time taken for anastomosis of bowel only and total duration of the whole operation:

Parameter	Hand Suturing (mean±SD)	Mechanical Stapler (mean±SD)	p-value
Time of Anastomosis only (minutes)	42.00 ± 8.7	14.13 ± 4.5	0.000 [I]
Time of the whole operation (hours)	2.72 ± 0.95	2.15 ± 0.62	0.002 [I]

[I]Independent sample t-test

The mean hospital stay post-anastomosis was 12.28 ± 5.3 days for the hand suturing group, compared to 9.23 ± 3.03 days for the mechanical stapler group. This difference in hospital stay duration was statistically significant. (Table 5)

Table 5: Comparison of Duration of hospital stay

Technique	Duration of hospital stay (in days) (Mean ±SD)	p-value
Hand Suturing	12.28 ± 5.3	0.003[I]
Mechanical Stapler	9.23 ± 3.03	

[I]Independent sample t-test

The mean cost of surgery for hand suturing was 23.22 ± 6.45 thousand, while for mechanical stapling, it was 46.42 ± 15.74 thousand. This represents a statistically significant cost difference between the two techniques. (Table 6)

Table 6: Comparison of cost between the hand suturing and mechanical stapler technique.

Technique	Cost of Operation (in thousand Rs.) (Mean ±SD)	p-value
Hand suturing	23.22 ± 6.45	0.000 [I]
Mechanical stapler	46.42 ± 15.74	

[I]Independent sample t-test

DISCUSSION

Various surgical conditions require the resection and anastomosis of bowel segments. These conditions include intestinal obstruction, hollow viscous perforation peritonitis, gastric outlet obstruction, and malignancy of the gastrointestinal tract. The results were analyzed and compared with those of previous institutional studies.

In this study, the mean age of patients in the hand suturing group was 49.5 ± 16.5 years, and in the mechanical stapler group, it was 50.6 ± 14.4 years, which is consistent with the study by Belbase et al.,[2]where the mean age of patients was 49.60 ± 14.69 years in the hand-sewn group and 50.40 ± 15.65 years in the stapled group. Similarly, in a study by Banurekha et al.[16], the mean age of patients with hand-sewn anastomosis was 51 years, and those who underwent stapler anastomosis was 49 years. The maximum number of intestinal anastomoses was found in the age group 40-59 in both groups, i.e., 14 (35%) in the hand suturing and 17 (42.5%) in the stapler group, suggesting that the incidence of intestinal anastomosis is higher in the age group 40-59.

In our study, a total of 48 (60%) male patients out of 80 and 32 (40%) female patients underwent bowel anastomoses. This indicates that intestinal anastomosis is more common in male patients. Liu et al.[17]conducted a study involving 499 patients, comparing handsewn and stapled anastomoses in GI tumors, while Hassanen et al.[18] in their prospective study comparing stapled and handsewn anastomoses among 39 patients with anastomosis of the large bowel due to abdominal trauma, found a predominance of male patients.

In our study, the mean time for performing intestinal anastomosis with hand suturing was 42.00 ± 8.7 minutes, while with the mechanical stapler, it was 14.13 ± 4.5 minutes, showing a statistically significant difference, indicating that the stapler procedure is significantly quicker than the hand suturing procedure. This is consistent with the study performed by Belbase et al.,[2] where the mean duration of anastomosis in the handsewn group was 32.04 ± 4.51 minutes, and in the stapled group, it was 11.00 ± 1.91 minutes, considered statistically significant ($p < 0.001$). Similarly, Hassanen et al.[18] conducted a prospective study comparing stapled and handsewn anastomosis of the large bowel due to abdominal trauma among 39 patients, in which the mean duration of hand-sewn anastomosis was 30 ± 6.3 minutes, and stapled anastomosis was 15 ± 12 minutes, with a mean difference of 15 minutes.

Similarly, in the study done by Chandramohan et al,[19]recent trials specifically designed to evaluate differences between the two in surgery time, anastomosis time, and return to bowel activity are lacking. This trial compared the outcomes of the two in subjects undergoing open gastrointestinal surgery. Adult subjects undergoing emergency or elective surgery requiring a single gastric, small, or large bowel anastomosis were enrolled into this open-label, prospective, randomized, interventional, parallel, multicenter, controlled trial. Randomization was assigned in a 1:1 ratio between the hand-sutured group (n = 138 time of anastomosis of 20.6±1.90 min for the hand-sutured group was significantly longer than 17.6±1.90 min for the stapled group (P< 0.0008). In this study, the mean time for the whole operation, performing hand suturing bowel anastomosis, was 2.72 ± 0.95 hours, and with the mechanical stapler, it was 2.15 ± 0.62 hours, showing a statistically significant difference. In a prospective comparative study by Belbase et al.,[2] the mean duration to operate was longer in the handsewn group (147.12 ± 20.91 minutes in the handsewn group and 132.52 ± 15.71 minutes in the stapled group), which is also consistent with the study performed by Damesha et al.[20] in his comparative study of 50 patients who underwent resection and anastomosis in gastrointestinal operations, finding the mean operating time to be longer in the handsewn group (145 minutes in the handsewn group and 125 minutes in the stapled group).

In this study, the postoperative complications included anastomotic leakage, SSI, and mortality. The number of anastomotic leakages found in this study was nine (11.3%) in the hand suturing group whereas in the mechanical stapler group, it was 3 (3.8%), which was statistically non-significantly different. This result is consistent with studies performed by Banurekha et al.[16] where 11 patients had an anastomotic leak, with 8 (16%) receiving hand-sewn anastomosis and 3 (6%) having stapler anastomosis with a p-value of 0.074, and Belbase et al.[2] where 8% of patients in the handsewn group and 4% in the stapled group had clinical anastomotic leakage, suggestive of statistically non-significant difference.

Fifteen (18.8%) patients in the hand suturing

group had SSI, while only 4 (5.0%) patients in the mechanical stapler group had SSI in this study, which was significantly different between the two groups. Similarly, in the study by Belbase et al.[3], 16% of patients in the handsewn group and 12% in the stapled group had SSI, which was not statistically significantly different, consistent with Fayek et al.'s[21]prospective study among 50 patients who underwent colorectal anastomosis using stapled versus hand-sewn techniques after low anterior resection of mid-rectal carcinoma.

In this study, there was 1 mortality in both the hand suturing and mechanical stapler groups, showing no statistically significant difference. The cause of mortality in both groups was anastomotic leakage, managed by exteriorization of the bowel (creating a stoma), but due to septic shock, both patients died. Similarly, Banurekha et al.[16] reported mortality in three (6%) patients who underwent hand-sewn anastomosis, whereas none died in the stapler anastomosis group, with no statistically significant difference between the two groups.

Belbase et al.,[2] in their prospective comparative study of 50 patients, reported that the mean duration of hospital stay in the handsewn group was 9.04±2.77 days, and in the stapled group was 8.44±2.32 days (p = 0.366). However, in the study by Banurekha et al.,[16] mean duration of hospitalization in subtotal gastrectomy and gastrojejunostomy was 10 days in hand sewn and 8 days in stapler technique with a p-value of 0.003, which is consistent with our study where the mean duration of hospital stay for patients undergoing hand suturing group was 12.28 ± 5.3 days and that of mechanical stapler group was 9.23 ± 3.03 days. This shows the stapler procedure becoming more sophisticated day by day with more advanced Instruments causing less pain and taking a short time for operation, leading to a short hospital stay nowadays.

In this study, the mean cost of the operation performed with the hand suturing method was 23.22 ± 6.45 thousand, while the cost of surgery with a mechanical stapler was 46.42 ± 15.74 thousand, indicating a statistically significant difference. The stapler is a sophisticated device, hence more expensive than the hand suturing technique. Many studies have demonstrated significant cost disparities between these two groups 22,23 For example, Mohammed et al.[24] found that stapler use (group B) was notably more costly than handsewns (group A), particularly in patients requiring multiple sites of small intestinal resection anastomosis, with a significant P-value ($P < 0.05$). However, these studies typically focused solely on surgical costs and did not include expenses related to hospital stay and readmission due to complications, which are more prevalent with the hand suturing technique. Therefore, when considering the overall costs, including postoperative care and complications, both procedures may ultimately cost a similar amount.

CONCLUSION

From this study, it can be concluded that the mechanical stapler method requires less time for intestinal anastomosis and the entire surgery. The incidence of surgical site infections (SSI) was lower in the stapler group compared to the hand-sewn group, and hospital stay duration was shorter. However, outcomes such as mortality and anastomotic leakage were similar in both groups. Hand suturing was found to be more cost-effective. Given the quicker nature of the stapler technique, it may be particularly beneficial for sick patients who cannot tolerate prolonged anesthesia and extended surgery durations. Moreover, the stapler method has demonstrated advantages in performing surgeries in challenging anatomical locations, such as pelvic and esophageal surgeries. Both techniques are operator-dependent, but hand suturing requires expertise with a steeper learning curve compared to the mechanical stapler technique.

The study's limitations include small sample size, single-center design, limiting generalizability. Selection bias, variability in surgical expertise, and lack of blinding could affect results. Additionally, as a referral center, the patient population may represent more severe cases, limiting applicability to general practice. Future research with a broader, multi-center approach and a larger, more diverse patient population would be valuable for validating and generalizing these findings.

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