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Original Research Article

A Comparative Study in Preventing Bowel Anastomotic Leak with Versus Without Use of Cyanoacrylate

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Abstract:

Background: Anastomotic leak remains a serious complication of bowel surgery, contributing to significant morbidity and mortality despite advances in surgical techniques. Tissue adhesives such as cyanoacrylate have been proposed as adjuncts to improve anastomotic integrity.

Aim: To compare outcomes of bowel anastomosis performed with and without cyanoacrylate glue reinforcement.

Methodology: This prospective randomized controlled study was conducted at Department of General Surgery, DMCH, Laheriasarai, Darbhanga, Bihar, India for 15 months. Eighty adult patients undergoing intestinal resection with primary anastomosis were randomized into two groups: control (no glue, n=40) and intervention (cyanoacrylate reinforcement, n=40). The primary outcome was anastomotic leak, while secondary outcomes included postoperative complications and drain characteristics.

Results: Anastomotic leaks occurred in 15% of patients in the no-glue group compared to 5% in the glue group. Postoperative fever, tachycardia, and abnormal drain outputs were less frequent in the cyanoacrylate group. Although the reduction in leak rate was not statistically significant, a clear clinical trend favoring glue use was observed.

Conclusion: Cyanoacrylate glue reinforcement appears to reduce anastomotic leaks and postoperative complications and may be a useful adjunct in bowel surgery, particularly in high-risk settings.

Keywords: Bowel anastomosis, Anastomotic leak, Cyanoacrylate glue, Gastrointestinal surgery, Surgical outcomes.

Introduction

Bowel anastomosis is a fundamental component of gastrointestinal surgery and is routinely performed in procedures involving resection of the small or large intestine for benign and malignant conditions [1]. Despite advances in surgical techniques, perioperative care, and stapling devices, anastomotic leak remains one of the most feared and serious postoperative complications. An anastomotic leak is defined as a defect in the integrity of the intestinal anastomosis, resulting in leakage of luminal contents into the peritoneal cavity or surrounding tissues. The incidence of bowel anastomotic leak varies widely in the literature, ranging from 3% to 15%, depending on the site of anastomosis, underlying pathology, patient-related risk factors, and surgical expertise [2]. This complication is associated with significant morbidity and mortality, prolonged hospital stay, increased healthcare costs, and adverse oncological outcomes, particularly in patients undergoing colorectal cancer surgery.

The pathophysiology of anastomotic leakage is multifactorial and complex. Adequate tissue perfusion, minimal tension at the anastomotic site, precise surgical technique, and an optimal healing response are essential prerequisites for successful anastomotic healing. Factors such as poor nutritional status, anemia, hypoalbuminemia, diabetes mellitus, steroid use, smoking, sepsis, and preoperative radiotherapy are known to impair wound healing and increase the risk of leakage. Intraoperative factors, including excessive tissue handling, ischemia, technical errors in suturing or stapling, and contamination, further contribute to anastomotic failure. Consequently, numerous strategies have been explored to reduce the incidence of anastomotic leak, including refinement of suturing techniques, use of stapled anastomoses,

protective stomas, reinforcement materials, sealants, and pharmacological interventions [3].

In recent years, tissue adhesives have gained increasing attention as adjuncts to conventional anastomotic techniques [4]. Among these, cyanoacrylate-based adhesives have emerged as a promising option due to their strong adhesive properties, rapid polymerization, and bacteriostatic effects. Cyanoacrylates are synthetic monomers that polymerize upon contact with moisture or tissue fluids, forming a strong bond that can provide immediate mechanical reinforcement to the anastomotic site. Originally introduced for skin closure and hemostasis, medical-grade cyanoacrylates have been increasingly investigated for internal surgical applications, including gastrointestinal anastomosis, vascular surgery, and fistula closure [5].

The potential benefits of cyanoacrylate use in bowel anastomosis include enhanced sealing of the suture or staple line, reduction of microleakage, reinforcement of mechanically weak points, and creation of a protective barrier against bacterial contamination. By providing an additional layer of support during the critical early postoperative period, cyanoacrylate may facilitate anastomotic healing and reduce the risk of leakage, especially in high-risk patients [6]. Furthermore, cyanoacrylates possess inherent antimicrobial properties, which may help limit local infection and inflammation, both of which are known contributors to anastomotic breakdown.

However, despite these theoretical advantages, concerns have been raised regarding the routine use of cyanoacrylate in bowel anastomosis. Potential drawbacks include local tissue toxicity, inflammatory reaction, foreign body response, risk of luminal narrowing, and interference with normal tissue healing [7]. The rigidity of the polymerized adhesive may also affect the compliance of the bowel wall, raising questions about its long-term safety and functional outcomes. Additionally, variations in application techniques, types of cyanoacrylate formulations, and differences in patient populations have led to inconsistent results across experimental and clinical studies.

Given these contrasting perspectives, there is ongoing debate regarding the effectiveness and safety of cyanoacrylate as an adjunct in preventing bowel anastomotic leak. While several experimental studies and limited clinical trials have reported reduced leak rates and improved anastomotic strength with cyanoacrylate reinforcement, other studies have failed to demonstrate a significant benefit or have highlighted potential complications [8]. The lack of standardized protocols and robust comparative clinical data further underscores the need for well-designed studies to clarify the role of cyanoacrylate in gastrointestinal surgery.

In this context, a comparative study evaluating bowel anastomoses performed with and without the use of cyanoacrylate is of considerable clinical relevance. Such a study aims to assess whether the adjunctive application of cyanoacrylate can significantly reduce the incidence of anastomotic leak without increasing postoperative complications. By systematically comparing clinical outcomes, including leak rates, surgical site infections, postoperative morbidity, and hospital stay, this research seeks to provide evidence-based guidance on the utility of cyanoacrylate in routine surgical practice. Ultimately, identifying effective strategies to prevent bowel anastomotic leak has the potential to improve patient outcomes, reduce healthcare burden, and enhance the overall quality of gastrointestinal surgical care.

Methodology

Study Setting: The present study was conducted in the Department of Surgery, Darbhanga Medical College and Hospital (DMCH), Laheriasarai, Bihar, India

Study Duration: The study was carried out over a period of 15 months, from March 2024 to June 2025.

Study Design: This study was designed as a prospective, randomized controlled trial to compare the outcomes of bowel anastomosis performed with and without reinforcement using cyanoacrylate glue.

Study Population: The study population comprised adult patients undergoing intestinal resection with primary anastomosis for various gastrointestinal conditions in the Department of Surgery, DMCH, during the study period. Patients were selected after applying predefined inclusion and exclusion criteria.

Sample Size and Group Allocation: A total of 80 patients were included in the study and were equally divided into two groups:

- **Group A (Control Group):** Patients undergoing standard intestinal resection and anastomosis without cyanoacrylate reinforcement (n = 40).
- **Group B (Intervention Group):** Patients undergoing standard intestinal resection and anastomosis with cyanoacrylate glue reinforcement (n = 40).

Sampling Method: Simple randomization was employed using a computer-generated randomization table to allocate patients into either Group A or Group B, ensuring unbiased group distribution.

Inclusion Criteria

- Patients aged between 18 and 80 years
- Patients undergoing intestinal resection with primary anastomosis
- Patients willing to provide written informed consent

- Patients not enrolled in any other concurrent clinical study

Exclusion Criteria

- HIV-positive patients
- Patients receiving chemotherapy or radiotherapy
- Patients on chronic steroid therapy or other immunosuppressive drugs
- Diagnosed cases of intestinal tuberculosis
- Patients unwilling to provide informed consent

Ethical Clearance: Prior to initiation, the study protocol was reviewed and approved by the Institutional Ethics Committee (IEC) of DMCH, Laheriasarai. Written informed consent was obtained from all participants before enrollment.

Intervention Details

- **Group A (Control):** Patients underwent conventional hand-sewn intestinal anastomosis without glue reinforcement.
- **Group B (Cyanoacrylate Group):** Patients underwent a similar anastomotic procedure, with additional external reinforcement of the anastomotic site using n-butyl-2-cyanoacrylate glue applied as a thin film after completion of suturing.

Surgical Technique: All surgeries were performed under general anesthesia using standardized surgical protocols. Anastomosis was performed using either a single-layer or double-layer technique based on intraoperative assessment.

- Single-layer anastomosis: Performed using interrupted polyglactin 910 (2-0 or 3-0) sutures.
- **Double-layer anastomosis:** The first layer was completed using continuous polyglactin 910 sutures with proper counselling, followed by a second outer Lembert layer using interrupted polyglactin 910 sutures.
- Abdominal drainage was placed in all patients using a standard abdominal drainage kit.

In Group B, after completion of the hand-sewn anastomosis, the anastomotic site was mopped dry and isolated. A thin film of cyanoacrylate glue, prepared in a dextrose-flushed hypodermic syringe, was applied externally over the suture line and allowed to polymerize for 30–40 seconds. A thin layer of absorbable gelatin was then placed over the glued site before returning the bowel to the peritoneal cavity. The abdomen was subsequently closed in layers.

Outcome Measures

Primary Outcome:

- Incidence of anastomotic leak, diagnosed clinically and/or radiologically based on standard criteria such as feculent drain output, abdominal distension, peritonitis, or imaging-confirmed leakage.

Secondary Outcomes:

- Drain output (volume and character)
- Postoperative fever and tachycardia
- Total leukocyte counts and hemoglobin levels
- Surgical site infection
- Need for reoperation
- Duration of hospital stay
- Post-discharge complaints including abdominal pain and wound-related issues

Data Collection and Documentation: Data were collected using a structured case record proforma documenting demographic details, diagnosis, operative findings, postoperative vitals, laboratory parameters, complications, and outcomes. Data were anonymized, coded, and compiled in a master Excel sheet for analysis.

Follow-Up: All patients were monitored throughout their hospital stay and followed up in the surgical outpatient department for 30 days post-discharge. Any delayed complications were recorded.

Statistical Analysis: Data were analyzed using Microsoft Excel and SPSS software (27.0V). Categorical variables were analyzed using the Chi-square test or Fisher's exact test, while continuous variables were analyzed using the student's t-test or Mann–Whitney U test depending on data distribution. A p-value < 0.05 was considered statistically significant.

Result

Table 4.1 presents the age distribution of the study participants across different age groups. The highest proportion of participants belonged to the 71–80 years age group (15), followed by the 21–30 years group (14) and the 41–50 and 61–70 years groups (12 each), indicating a fairly wide age representation. Participants aged 51–60 years accounted for 11, while those in the 31–40 years group comprised 10 participants. The lowest representation was observed in the 11–20 years age group, with only 6 participants. Overall, the table demonstrates that the study population was predominantly composed of adults and elderly individuals, with relatively fewer younger participants.

Table 1: Age Distribution of Study Participants	
Age Group (years)	**Frequency**
11–20	6
21–30	14
31–40	10
41–50	12
51–60	11
61–70	12
71–80	15

Table 2 shows the sex distribution of the 80 study participants, indicating a nearly equal representation of both sexes in the study population. Females constituted a slightly higher proportion with 42 participants (52.5%), while males accounted for 38 participants (47.5%). This balanced distribution suggests minimal gender bias in the sample, allowing for a more reliable comparison of outcomes without significant influence from sex-based disparities.

Table 2: Sex Distribution of Study Participants		
Sex	**Number of Patients (n=80)**	**Percentage (%)**
Female	42	52.50%
Male	38	47.50%

Table 3 shows the distribution of co-morbidities among the 80 study participants, indicating that the majority of patients did not have any associated co-morbid conditions. Co-morbidities were present in 13 patients, accounting for 16.20% of the study population, while 67 patients (83.80%) were free from any co-morbid illnesses. This finding suggests that most participants were relatively healthy with respect to pre-existing medical conditions, thereby minimizing the potential confounding effect of co-morbidities on the study outcomes.

Table 3: Distribution of Co-morbidities Among Study Participants		
Co-morbidity Status	**Number of Patients (n=80)**	**Percentage (%)**
Present	13	16.20%
Absent	67	83.80%

Table 4 depicts the distribution of pre-operative diagnoses among the study participants. Intestinal obstruction was the most common indication for surgery, accounting for 29 cases, followed by perforation peritonitis in 19 patients, highlighting these as the leading causes requiring operative intervention. Gangrenous bowel and traumatic perforation were observed in 8 cases each, reflecting a significant proportion of patients presenting with advanced or acute abdominal pathology. Follow-up cases of loop ileostomy constituted 7 patients, while obstructed inguinal hernia was noted in 5 cases. Malignant obstruction was relatively uncommon, seen in only 3 patients. Follow-up of end ileostomy was the least frequent diagnosis, with a single case, indicating a lower representation of this condition in the study population.

Table 4: Pre-operative Diagnosis Distribution	
Pre-operative Diagnosis	**Frequency**
Intestinal Obstruction	29
Perforation Peritonitis	19
Gangrenous Bowel	8
Traumatic perforation	8
F/U/C/O - Loop Ileostomy	7
Obstructed Inguinal Hernia	5
Malignant Obstruction	3
F/U/C/O - End Ileostomy	1

Table 5 depicts the distribution of surgical procedures performed among the study participants. End-to-end resection anastomosis of the ileum was the most frequently performed procedure, accounting for 36 cases, indicating its common applicability in the studied clinical conditions. This was followed by side-to-side resection anastomosis of the ileum in 17 cases. Ileo-transverse colon anastomosis (side-to-side) and anastomosis of the ileal loop during loop reversal were each performed in 7 patients,

reflecting their moderate utilization. Primary repair of perforation was carried out in 6 cases, while end-to-end resection anastomosis of the jejunum was performed in 5 cases. Less commonly performed procedures included ileo-jejunal end-to-end anastomosis and resection anastomosis of the ileal loop with excision of Meckel's diverticulum, each noted in one case, highlighting their relatively rare indications in the study population.

Table 5: Surgical Procedures Performed	
Surgical Procedure	**Frequency**
End to End Resection Anastomosis of ileum	36
Side to Side Resection Anastomosis of ileum	17
Ileo-Transverse Colon Anastomosis (Side to Side)	7
Anastomosis of Ileal Loop (Loop Reversal)	7
Primary Repair of Perforation	6
End to End Resection Anastomosis of jejunum	5
Ileo-jejunal End to End anastomosis	1
Resection anastomosis End to End of ileal loop with meckel's diverticulum excision	1

Table 6 shows the distribution of anastomotic leaks between the two study groups. In the no-glue group, 34 out of 40 patients did not develop an anastomotic leak, while 6 patients experienced a leak, resulting in a leak rate of 15%. In contrast, in the group where cyanoacrylate glue was used, 38 patients had no leak and only 2 patients developed a leak, corresponding to a significantly lower leak rate of 5%. Overall, the findings indicate a reduced incidence of anastomotic leak in patients receiving cyanoacrylate glue compared to those without glue, suggesting a protective effect of glue application on bowel anastomotic integrity.

Table 6: Anastomotic Leak Distribution Between Groups				
Group	**No Leak (n)**	**Leak (n)**	**Total**	**Leak Rate (%)**
No Glue	34	6	40	15.00%
Glue Used	38	2	40	5.00%

Table 7 presents the statistical comparison of anastomotic leak rates between the no-glue group and the glue group using Fisher's exact test. Out of 40 patients in each group, anastomotic leaks were observed in 6 patients in the no-glue group compared to 2 patients in the glue group, indicating a lower absolute incidence of leaks with the use of cyanoacrylate. The calculated odds ratio of 3.35 suggests that patients in the no-glue group had more than three times higher odds of developing a leak compared to those in the glue group. However, this difference did not reach statistical significance, as reflected by a p-value of 0.263. These findings indicate a trend toward reduced leak rates with glue application, although the observed difference may be attributable to chance and requires confirmation in studies with a larger sample size.

Table 7: Statistical Comparison of Leak Rates Using Fisher's Exact Test				
Comparison	**No Glue Group**	**Glue Group**	**Odds Ratio**	**p-Value**
Patients with Leak	6	2	3.35	0.263
Patients without Leak	34	38		
Total Patients	40	40		

Table 4.11 presents a comparative summary of postoperative outcomes between patients in whom cyanoacrylate glue was used and those in whom it was not used during bowel anastomosis. The incidence of anastomotic leaks was notably lower in the glue group (2 cases) compared to the no-glue group (6 cases), suggesting a protective effect of glue application. Postoperative fever was also less frequent among patients receiving glue (2 vs. 9 cases). Tachycardia occurred in both groups but was slightly lower in the glue group (7 vs. 9 cases). Indicators of severe infective complications, such as feculent drain output and purulent discharge, were observed less commonly in the glue group (1 case each) compared to the no-glue group (4 and 2 cases, respectively). Overall, the findings indicate better postoperative outcomes and reduced complication rates in patients where cyanoacrylate glue was used.

Table 4.8: Group-wise Summary of Postoperative Outcomes		
Outcome Parameter	**Glue Used (n = 40)**	**No Glue (n = 40)**
Anastomotic Leaks	2	6
Fever	2	9
Tachycardia	7	9
Feculent Drain Output	1	4
Purulent (Pus) Output	1	2

Discussion

Anastomotic leakage remains one of the most serious complications following bowel surgery and is associated with increased morbidity, prolonged hospital stays, and mortality, particularly in emergency abdominal procedures. The present prospective randomized comparative study evaluated the effectiveness of cyanoacrylate glue as an adjunct to conventional hand-sewn intestinal anastomosis in preventing postoperative anastomotic leaks. The findings demonstrated a lower leak rate in the cyanoacrylate group (5%) compared to the non-glue group (15%), indicating a relative reduction of 66.7% in leak incidence. Although statistical significance was not achieved, the observed difference is clinically relevant, especially in emergency surgical settings where unfavorable physiological and local tissue conditions prevail.

Reported anastomotic leak rates in gastrointestinal surgery vary widely, ranging from 3% to 26%, depending on the site of anastomosis, urgency of surgery, and patient-related risk factors (Reischl et al., 2021) [9]. The overall leak rate of 10% in the present study falls within this range, supporting the representativeness of the study population. The higher leak rate observed in the control group (15%) is consistent with previous reports on emergency bowel surgeries, where contamination, bowel edema, compromised vascularity, and sepsis adversely affect healing (Trencheva et al., 2013) [10]. In contrast, the reduced leak rate in the glue-reinforced group suggests that cyanoacrylate provides additional mechanical and biological support to the anastomotic site.

The findings of this study are in agreement with earlier clinical studies evaluating cyanoacrylate reinforcement. Wu et al. (2011) [11] reported a reduction in colorectal anastomotic leaks from 12% in conventional sutured anastomoses to 4% when cyanoacrylate glue was applied. Similarly, García et al. (2011) [12] demonstrated significantly fewer anastomotic failures and improved early healing in patients receiving cyanoacrylate reinforcement compared with sutures alone. The reduction in leak rates from 15% to 5% in the present study closely parallels these findings, reinforcing the role of cyanoacrylate as a beneficial adjunct in bowel anastomosis.

Experimental studies further support these clinical observations. Weiss and Haj (2001) [13] demonstrated improved burst pressure and reduced leakage in intestinal anastomoses reinforced with Histoacryl glue in animal models. Ozmen et al. (2004) [14] also reported superior mechanical strength and better histological healing in cyanoacrylate-reinforced colonic anastomoses compared with sutured controls. These experimental findings provide a mechanistic explanation for the clinical benefit observed in the present study, suggesting that cyanoacrylate acts as a protective seal during the critical early phase of anastomotic healing.

Cyanoacrylate glue polymerizes rapidly upon contact with tissue moisture, forming a watertight and mechanically stable barrier over the suture line. This barrier may prevent early micro-leakage of bowel contents, reduce bacterial contamination, and minimize local inflammatory response. In the present study, no adverse tissue reactions or glue-related complications were observed, which is consistent with previous studies demonstrating good biocompatibility and safety when cyanoacrylate is applied externally to anastomotic sites (Kaul et al., 2011; Ozmen et al., 2004).

Early postoperative clinical indicators such as fever and tachycardia were more frequently observed in patients who developed anastomotic leaks. Fever was noted in 9 patients in the non-glue group compared to only 2 patients in the glue group, while tachycardia was predominantly associated with leak cases. These findings are consistent with the observations of Trencheva et al. (2013) [15], who identified systemic inflammatory signs as early predictors of anastomotic failure. The lower incidence of these signs in the glue group suggests better containment of the anastomosis and reduced inflammatory stress.

Drain output characteristics provided additional evidence supporting the protective effect of cyanoacrylate. Feculent and purulent drain outputs were observed exclusively in patients with confirmed anastomotic leaks, predominantly in the non-glue group. Similar observations have been reported in previous studies, where abnormal drain content was strongly associated with anastomotic disruption (Reischl et al., 2021). The reduced incidence of abnormal drain findings in the glue group highlights the role of cyanoacrylate in improving early anastomotic sealing.

While fibrin sealants have also been studied as adjuncts to anastomotic healing, their effectiveness has

been variable. Fernandez et al. (1996) [16] reported a modest reduction in esophagojejunal anastomotic leaks with fibrin glue; however, the benefit was limited. Compared to fibrin glue, cyanoacrylate offers stronger adhesive properties and faster polymerization, which may account for the more pronounced reduction in leak rates observed in this and other studies.

Despite the encouraging findings, the present study is limited by its relatively small sample size, which may explain the lack of statistical significance. Larger multicenter randomized trials are required to validate these results. Nevertheless, the consistent reduction in leak rates and postoperative complications strongly suggests that cyanoacrylate glue is a valuable adjunct in bowel anastomosis, particularly in emergency and high-risk surgical scenarios.

Conclusion

This prospective randomized study demonstrated that external reinforcement of bowel anastomosis with cyanoacrylate glue was associated with a clinically meaningful reduction in anastomotic leak rates compared to conventional hand-sewn anastomosis alone. Patients in the glue group showed fewer leaks and lower incidence of postoperative complications such as fever, tachycardia, and abnormal drain output, indicating improved early anastomotic integrity. Although the difference in leak rates did not achieve statistical significance, the observed trend favors the adjunctive use of cyanoacrylate, particularly in emergency and high-risk surgical settings. The technique was simple, safe, and did not result in glue-related adverse effects. These findings suggest that cyanoacrylate glue may serve as a useful adjunct to enhance anastomotic healing, warranting further validation through larger multicenter trials.

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