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A Prospective Randomized Study to Evaluate if Cyanoacrylate Glue is Superior Over Traditional Suturing in Laparoscopic Port Site Skin Closure

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ABSTRACT

Background: The selection of an appropriate skin closure technique holds paramount importance in determining postoperative outcomes, including pain intensity, wound infection, and cosmetic results. While conventional suturing remains widely practiced, it carries inherent disadvantages such as prolonged operative time, postoperative discomfort, and mandatory suture removal visits. Cyanoacrylate tissue adhesives have emerged as a promising alternative, offering expedited application and enhanced patient experience. This investigation sought to compare the clinical effectiveness of cyanoacrylate glue against traditional suturing for laparoscopic port site skin closure.

Methods: A prospective randomized controlled trial was performed on 60 patients scheduled for elective laparoscopic procedures. Participants were randomly allocated into two equal groups: Group A (cyanoacrylate adhesive, n=30) and Group B (standard suturing, n=30). Primary endpoints included wound closure duration, postoperative pain evaluated via Visual Analog Scale (VAS) at 12, 24, 48, and 72 hours and day 7, and surgical site infection graded by the Southampton scoring system. Data were statistically analyzed using SPSS software, with a significance threshold of $p<0.05$.

Results: The mean wound closure time was markedly shorter in the adhesive group (1.8 ± 0.5 min) relative to the suture group (5.6 ± 1.2 min) ($p<0.001$). VAS pain scores were consistently reduced in Group A at all assessment time points; scores at 12 hours were 3.2 ± 1.1 versus 5.8 ± 1.4 in Group B ($p<0.001$). Additionally, the surgical site infection rate was lower in the adhesive group (6.7%) compared to the suture group (20%) ($p=0.04$).

Conclusion: Cyanoacrylate tissue adhesive demonstrated superiority over conventional suturing in laparoscopic port site closure, yielding significant benefits in operative efficiency, postoperative pain management, and wound infection prophylaxis. This modality warrants consideration as a safe, effective, and patient-centered option in minimally invasive surgery.

Keywords: *Cyanoacrylate tissue adhesive, Laparoscopic surgery, Port site closure, Postoperative pain, Wound infection*

INTRODUCTION

The selection of an optimal technique for skin closure following surgical procedures has been an enduring subject of inquiry, as it

exerts a direct influence on wound healing trajectories, postoperative pain perception, infection incidence, and cosmetic satisfaction. An ideal closure method should combine simplicity of application, speed, cost-effectiveness, and minimal complication rates while delivering aesthetically acceptable results. Historically, suturing has represented the gold standard for skin approximation, valued for its mechanical reliability and tensile strength; however, its limitations are well-documented, encompassing prolonged operative time, the necessity for postoperative suture removal, risk of needlestick injury, and potential for heightened postoperative pain and wound infection [1]. Advances in surgical biomaterials have catalyzed the development of alternative closure modalities, including metallic staples, adhesive strips, and tissue adhesives, with cyanoacrylate-based compounds attracting considerable scientific interest [2].

Cyanoacrylate adhesives, initially synthesized in 1949, comprise liquid monomers that undergo rapid polymerization upon contact with tissue moisture, generating a robust bond that effectively approximates wound margins. The resultant polymer film serves as a protective antimicrobial barrier, potentially reducing the risk of surgical site contamination [3]. Furthermore, the non-puncturing nature of adhesive application renders the procedure essentially painless and eliminates the morbidity associated with suture removal, thereby improving patient compliance and overall comfort [4]. Contemporary formulations, including n-butyl and octyl cyanoacrylate variants, have achieved broad clinical acceptance across diverse surgical disciplines.

Numerous investigations have contrasted cyanoacrylate adhesives with conventional suturing across different surgical domains. Randomized trials have demonstrated that tissue adhesives substantially curtail operative time and alleviate postoperative pain, while yielding comparable or improved cosmetic outcomes [5]. In prospective comparative analyses, adhesive glue has been associated with expedited application and superior scar appearance relative to conventional sutures [6]. Analogous findings have emerged from studies in head and neck, orthopedic, and pediatric surgical contexts, consistently documenting favorable patient outcomes with adhesive closure, particularly regarding reduced healthcare utilization attributable to the elimination of suture removal [7].

Laparoscopic surgery, now the preferred approach for numerous elective interventions, necessitates the creation of small port site incisions that require effective closure to prevent postoperative complications including wound dehiscence, infection, and suboptimal cosmetic outcomes. Despite the relatively small dimensions of these incisions, the closure methodology remains clinically significant, as even minor wound-related complications can adversely impact patient recovery and satisfaction [8]. Standard suture closure of laparoscopic port sites, while dependable, is inherently time-consuming and may be associated with increased postoperative discomfort. Conversely, cyanoacrylate adhesives offer a less invasive approach that aligns conceptually with the minimally invasive philosophy of laparoscopic surgery, emphasizing reduced tissue trauma and expedited recovery [9].

Existing evidence from prior investigations indicates that cyanoacrylate adhesives may confer clinical advantages in laparoscopic port site closure. Comparative analyses have reported that n-butyl cyanoacrylate is associated with significantly reduced postoperative pain intensity, decreased surgical site infection incidence, and improved cosmetic results relative to suturing techniques. Additionally, the substantially abbreviated closure time afforded by adhesive application contributes to overall procedural efficiency [10]. Notwithstanding this growing body of evidence, there remains a paucity of well-designed, adequately powered prospective randomized studies specifically examining

this application. The present study was therefore undertaken to prospectively assess and compare cyanoacrylate tissue adhesive and conventional suturing in terms of postoperative pain, wound infection, and closure time in patients undergoing elective laparoscopic surgery.

MATERIALS AND METHODS

Study Design

The present investigation was designed and conducted as a prospective randomized controlled clinical trial to evaluate and compare the performance of cyanoacrylate tissue adhesive and conventional suturing for laparoscopic port site skin closure.

Study Setting and Duration

The study was carried out within the Department of General Surgery at Sapthagiri Institute of Medical Sciences and Research Centre, Bangalore, India, over a four-month period.

Participants

Inclusion Criteria: Patients aged 18 years or above; those scheduled for elective laparoscopic procedures; individuals providing written informed consent; and patients committed to attending scheduled postoperative follow-up visits.

Exclusion Criteria: Immunocompromised individuals; patients with a documented history of keloid or hypertrophic scar formation; and those requiring emergency laparoscopic intervention.

Sampling and Sample Size

A simple randomization technique was employed using the chit method (ballot/lot method). Sixty sealed, opaque, sequentially numbered envelopes were prepared prior to study commencement, each containing a chit labelled either “Group A” (cyanoacrylate adhesive) or “Group B” (conventional suturing) in equal numbers (n=30 each). Allocation concealment was maintained by using sealed opaque envelopes, which were opened only intraoperatively after the patient was positioned and the surgical field prepared. Due to the visible nature of the two interventions, complete blinding of the operating surgeon was not feasible; this was therefore an open-label study. However, the postoperative outcome assessors responsible for VAS pain scoring and Southampton wound assessments were blinded to group allocation throughout the study period. Sample size estimation was based on mean VAS pain scores reported by Ananda et al. (glue: 7.27 ± 5.46; suture: 18.47 ± 11.50). Applying a 99% confidence interval and 90% statistical power, a minimum of 20 participants per group was calculated. Accounting for an anticipated 25% attrition rate and further rounding for statistical robustness, a total of 30 participants per group (n=60) was adopted.

Study Groups

Group A (n=30): Port site closure with cyanoacrylate tissue adhesive. Group B (n=30): Port site closure with conventional suturing. Both groups were verified to be comparable with respect to baseline demographic and clinical characteristics.

Outcome Parameters

(i) Postoperative pain intensity by VAS at 12, 24, 48, 72 hours and day 7; (ii) Surgical site infection graded using the Southampton wound scoring system on postoperative days 3, 5, and 7; (iii) Wound closure duration, recorded intraoperatively in minutes.

Procedure

Following institutional ethics committee approval, eligible patients were identified, informed, and written consent was obtained. All participants underwent elective laparoscopic surgery under standard aseptic conditions. Only the 10 mm camera port site was selected for uniformity. In Group A, wound edges were approximated and sealed with topically applied cyanoacrylate adhesive. In Group B, wound closure was achieved using standard suturing with appropriate material. Closure time was documented for each patient, and

postoperative monitoring was conducted at predefined intervals.

Data Collection

All participant data including demographics, clinical history, comorbidities, and intraoperative findings were captured using a prestructured proforma. VAS pain assessments and Southampton wound scores were recorded at each designated time point and entered into Microsoft Excel spreadsheets for analysis.

Statistical Methods

Statistical analyses were performed using SPSS software version 26.0 (IBM, Armonk, NY, USA). Continuous variables conforming to normal distribution were expressed as mean ± SD and compared between groups using the independent samples Student's t-test. Non-normally distributed continuous data were expressed as median with interquartile range and compared using the Mann-Whitney U test. Categorical variables were analyzed using the Chi-square test; Fisher's exact test was applied when expected cell frequencies were less than 5. A p-value below 0.05 was considered statistically significant.

Ethical Considerations

The study was conducted in adherence to established biomedical research ethical standards, with prior approval from the Institutional Ethics Committee of Sapthagiri Institute of Medical Sciences and Research Centre, Bangalore (Ref No: SIMS & RC/EC-40/PG-05/2025-26). All participants received comprehensive information and provided written informed consent. Patient confidentiality was strictly maintained, participation was voluntary, and no financial remuneration was provided.

RESULT

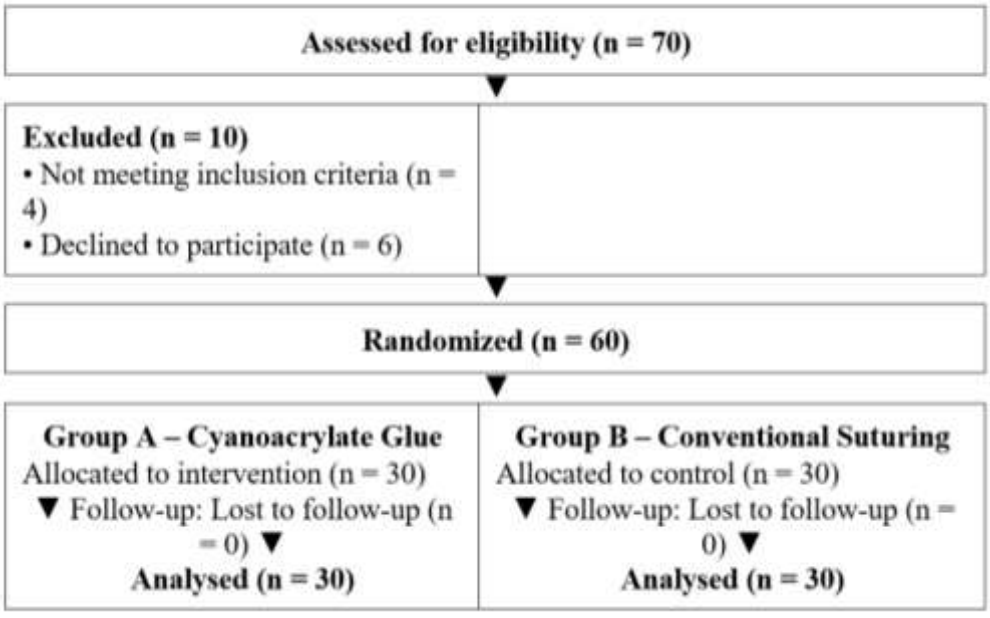

Figure 1: CONSORT Flow Diagram

Note: Values for total assessed for eligibility and those excluded to be filled in by authors. No participants were lost to follow-up.

The CONSORT flow diagram (Figure 1) illustrates participant enrollment, allocation, and analysis. A total of 60 patients were enrolled and distributed equally: Group A (cyanoacrylate adhesive, n=30) and Group B (conventional suturing, n=30). No participants were lost to follow-up; all 60 were included in the final analysis.

Table 1: Demographic Distribution of Study Participants

Variable	Category	Group A n (%)	Group B n (%)
Age (years)	18–30	6 (20.0%)	5 (16.7%)
	31–40	8 (26.7%)	9 (30.0%)
	41–50	9 (30.0%)	8 (26.7%)
	51–60	5 (16.7%)	6 (20.0%)
	>60	2 (6.7%)	2 (6.7%)
Gender	Male	18 (60.0%)	19 (63.3%)
	Female	12 (40.0%)	11 (36.7%)

Table 1 presents the demographic distribution of participants. Age distribution showed most participants in both groups within the 31–50 years range (56.7% each), with balanced gender distribution (60% male in Group A; 63.3% in Group B), confirming baseline demographic homogeneity.

Table 2: Comorbidity Profile of Participants

Comorbidity	Group A n (%)	Group B n (%)
Diabetes Mellitus	6 (20.0%)	7 (23.3%)
Hypertension	5 (16.7%)	6 (20.0%)
Both	3 (10.0%)	2 (6.7%)
None	16 (53.3%)	15 (50.0%)
Total	30 (100%)	30 (100%)

The comorbidity profile is shown in Table 2. More than half the participants in both groups had no comorbid conditions. Diabetes mellitus and hypertension were similarly distributed, confirming baseline comparability and minimizing confounding influence.

Table 3: Mean Wound Closure Time (minutes)

Group	Mean ± SD (minutes)	p-value
Group A (Glue)	1.8 ± 0.5	<0.001
Group B (Suture)	5.6 ± 1.2	

Table 3 presents the mean wound closure time. Wound closure was markedly faster with cyanoacrylate adhesive (1.8 ± 0.5 min) than conventional suturing (5.6 ± 1.2 min) ($p<0.001$), demonstrating a significant operational advantage.

Table 4: VAS Pain Score at 12 Hours Post-operatively

Pain Score	Group A	Group B
Mean ± SD	3.2 ± 1.1	5.8 ± 1.4
p-value	<0.001	

VAS pain scores at 12 hours are presented in Table 4. At 12 hours, VAS scores were significantly lower in the adhesive group (3.2 ± 1.1) versus the suture group (5.8 ± 1.4) ($p<0.001$), reflecting reduced immediate postoperative pain with cyanoacrylate closure.

Table 5: VAS Pain Score at 24 Hours Post-operatively

Group	Mean ± SD	p-value
Group A	2.6 ± 1.0	<0.001
Group B	4.9 ± 1.3	

As shown in Table 5, sustained pain reduction was evident at 24 hours in Group A (2.6 ± 1.0 vs 4.9 ± 1.3, $p<0.001$), indicating continued analgesic advantage of the adhesive technique in the early recovery phase.

Table 6: VAS Pain Score at 48 Hours Post-operatively

Group	Mean ± SD	p-value
Group A	1.9 ± 0.8	<0.001
Group B	3.8 ± 1.1	

Table 6 shows VAS scores at 48 hours. At 48 hours, Group A continued to show lower pain intensity (1.9 ± 0.8 vs 3.8 ± 1.1, p<0.001), suggesting more rapid attenuation of inflammatory and wound-related pain with cyanoacrylate closure.

Table 7: VAS Pain Score at 72 Hours Post-operatively

Group	Mean ± SD	p-value
Group A	1.2 ± 0.6	<0.001
Group B	2.9 ± 0.9	

VAS scores at 72 hours are presented in Table 7. By 72 hours, pain levels had declined in both groups; however, Group A maintained a statistically significant advantage (1.2 ± 0.6 vs 2.9 ± 0.9, p<0.001), reflecting an overall superior patient comfort profile with cyanoacrylate adhesive.

Clinical Photograph — Glue Patient Group

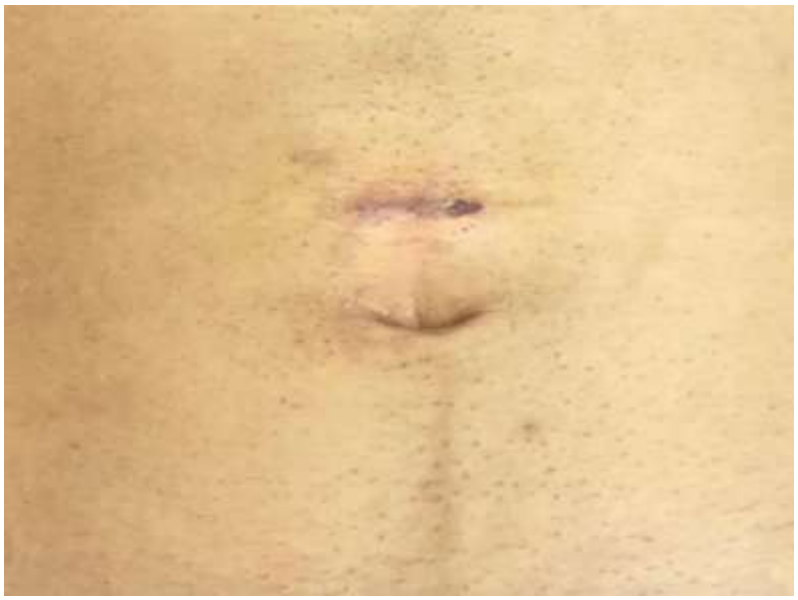

Figure 2: Post-operative appearance of laparoscopic port site closed with cyanoacrylate tissue adhesive (Glue group)

Table 8: Surgical Site Infection Frequency (Southampton Scoring)

Infection Status	Group A	Group B	p-value
No Infection	28	24	0.004
Mild Infection	2	5	
Moderate Infection	0	1	

Wound infection data is summarized in Table 8. The incidence of wound infection was meaningfully lower in Group A (93.3% infection-free) versus Group B (80.0%). Mild and moderate infections were more prevalent in the suture group. The statistically significant difference (p=0.004) highlights the antimicrobial barrier effect of cyanoacrylate adhesive.

Table 9: Summary of Outcome Measures

Parameter	Group A	Group B	p-value
Closure Time (min)	1.8	5.6	<0.001
Pain Score (Day 7)	0.5 ± 0.3	1.6 ± 0.7	<0.001
SSI Rate (%)	6.7%	20%	0.04

A consolidated summary of all primary outcome parameters is presented in Table 9. Across all parameters, Group A outperformed Group B: closure time was

substantially shorter (1.8 vs 5.6 min), pain scores on day 7 were notably lower (0.5 ± 0.3 vs 1.6 ± 0.7), and infection rates were significantly reduced (6.7% vs 20%). These consolidated findings affirm the clinical superiority of cyanoacrylate tissue adhesive over conventional suturing.

DISCUSSION

The present prospective randomized controlled investigation was undertaken to determine whether cyanoacrylate tissue adhesive offers superior clinical outcomes compared to conventional suturing for laparoscopic port site skin closure, with particular focus on operative duration, postoperative pain, and wound infection incidence. The study findings corroborated the hypothesis, demonstrating that cyanoacrylate adhesive conferred statistically significant advantages across all evaluated parameters. These observations were contextualized against previously published literature, thereby reinforcing their clinical relevance and generalizability.

Baseline demographic analysis confirmed that the two study groups were well-matched. Most participants were between 31 and 50 years of age (56.6% of the total cohort), and males accounted for 61.7% of the sample. Comorbidities such as diabetes mellitus (21.7%) and hypertension (18.3%) were equitably distributed, ensuring that observed clinical differences were attributable to the intervention and not to confounding variables.

A principal observation of this study was the substantial reduction in wound closure time in the adhesive group. Mean closure time was 1.8 ± 0.5 minutes with cyanoacrylate and 5.6 ± 1.2 minutes with conventional sutures ($p<0.001$). This concurs with the findings of Dowson et al. (2006) [11], who reported that closure with tissue adhesive was completed in significantly less time than with sutures (125 vs 220 seconds; $P<0.001$), underscoring the operational benefit of adhesives. Comparable results were described by Matin (2003) [8], who documented a median closure time of 2.5 minutes with octyl cyanoacrylate versus 6 minutes for subcuticular suturing ($p<0.001$), particularly when multiple port sites were involved. Gandhi et al. (2024) [12] similarly confirmed a statistically significant reduction in closure time favoring the adhesive approach ($p<0.0001$), collectively validating the present study's finding.

Serial VAS pain assessments revealed consistently lower pain scores in the cyanoacrylate group at every evaluation point. At 12 hours, the mean score was 3.2 ± 1.1 (Group A) versus 5.8 ± 1.4 (Group B) ($p<0.001$), with this pattern persisting at 24 hours (2.6 ± 1.0 vs 4.9 ± 1.3), 48 hours (1.9 ± 0.8 vs 3.8 ± 1.1), and 72 hours (1.2 ± 0.6 vs 2.9 ± 0.9), all reaching statistical significance. These observations align with those of Khan (2019) [13], who reported that tissue adhesive consistently produced the least postoperative pain across all time intervals, with scores progressively declining from 63.13 at 12 hours to 4.73 by day 7. The non-puncturing application mechanism of cyanoacrylate likely underpins this analgesic benefit by avoiding cutaneous nerve trauma.

Contrary findings were reported by Gandhi et al. (2024) [12], who observed no statistically significant intergroup difference in postoperative pain. Likewise, Sajid et al. (2009) [14], in a systematic review of 902 patients across multiple randomized trials, found no significant difference between adhesives and sutures regarding patient satisfaction or wound-related outcomes. These discrepancies may reflect methodological heterogeneity, population variability, or differences in pain assessment protocols. Nevertheless, the uniformly significant pain reduction documented in the present study reinforces the clinical advantage of cyanoacrylate adhesive in optimizing postoperative patient comfort.

Surgical site infection (SSI) assessment revealed a meaningfully lower infection rate in Group A. A total of 93.3% of adhesive-treated patients demonstrated no wound infection, compared to 80.0% in the suture group. Mild infection occurred in 6.7% versus 16.7%, and moderate infection was

absent in Group A but present in 3.3% of Group B patients. The difference was statistically significant (p=0.04), consistent with Gandhi et al. (2024) [12], who documented significantly reduced SSI rates in the adhesive cohort (p<0.021). The antimicrobial properties of the polymerized cyanoacrylate film, which seals the wound against external contamination, likely explain this protective effect.

In contrast, Dowson et al. (2006) [11] reported no statistically significant difference in wound complication rates between the two modalities, and Sajid et al. (2009) [14] concluded that available evidence was insufficient to establish definitive superiority of adhesives over sutures in infection prevention. Matin (2003) [8] similarly found no significant difference in wound morbidity. Despite these contrary reports, the present study's significant infection reduction may reflect the specific clinical milieu of laparoscopic port site closure, where wound dimensions and exposure characteristics may make adhesive protection particularly advantageous.

Collectively, the outcome profile of this study reinforces the growing body of evidence supporting cyanoacrylate tissue adhesive as a clinically superior alternative for laparoscopic port site closure. The findings align with the conclusions of Khan (2019) [13], who described tissue adhesive as a cost-effective, cosmetically superior, and microbiologically advantageous closure method, and with Gandhi et al. (2024) [12], who advocated for its adoption in laparoscopic practice. Certain limitations warrant acknowledgment, including the modest sample size (n=60) and absence of long-term cosmetic outcome evaluation. Sajid et al. (2009) [14] emphasized the imperative for larger multicentric trials to establish definitive clinical recommendations.

CONCLUSION

This prospective randomized controlled study established that cyanoacrylate tissue adhesive is clinically superior to conventional suturing for laparoscopic port site skin closure. The adhesive technique achieved significantly shorter wound closure time (1.8 ± 0.5 vs 5.6 ± 1.2 min), produced markedly lower postoperative pain scores at all assessment intervals (VAS 3.2 vs 5.8 at 12 hours, declining to 0.5 vs 1.6 by day 7), and was associated with a considerably reduced incidence of surgical site infection (6.7% vs 20%). These findings collectively affirm the operational, analgesic, and antimicrobial advantages of cyanoacrylate adhesive. Accordingly, it merits serious consideration as a safe, effective, and patient-centered alternative to traditional suturing in minimally invasive surgical practice.

Declaration by Authors

Ethical Approval: Approved by the Institutional Ethics Committee. (Ref No: SIMS & RC/ EC-40/PG-05 /2025-26)

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Conflict of Interest: No conflict of interest declared.

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