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# Comparison of N-butyl 2-cyanoacrylate glue fixation versus conventional suture fixation of polypropylene mesh for postoperative groin pain in patients undergoing Lichtenstein repair for inguinal hernia: A randomized clinical trial

**Syed Arif, Rubik Ray, Tridip Dutta Baruah, Dharmendra Dugar**

## Abstract

**INTRODUCTION**: A significant complication of inguinal hernia repair is chronic postoperative groin pain, which may be influenced by the method of mesh fixation. This randomized controlled trial was conducted with the objective of comparing the efficacy of N-butyl-2-cyanoacrylate (NBCA) glue fixation with conventional suture fixation of polypropylene mesh in Lichtenstein repairs.

**MATERIALS AND METHODS**: This clinical trial enrolled 60 patients with unilateral, uncomplicated inguinal hernias. Participants were randomly allocated to either the suture fixation group (Group A) or the glue fixation group (Group B). The primary outcome, which included postoperative pain, was recorded at 24 h and at 7 days, 15 days, 30 days, and 90 days. The secondary outcomes included mesh fixation time, postoperative complications, and short-term recurrence.

**RESULTS**: The mean mesh fixation time was significantly shorter in the glue group, at 4.5 min, than 13.63 min in the suture group ($P < 0.0001$). Postoperative pain scores were consistently and statistically lower in the glue group. Logistic regression showed that glue fixation was associated with a statistically significant reduction in the odds of developing chronic pain at 90 days ($P = 0.0025$). No statistically significant differences were observed between the two groups in postoperative complications, including hernia recurrence.

**CONCLUSION**: NBCA glue fixation constitutes a safe and effective alternative to conventional suture fixation for polypropylene mesh in Lichtenstein hernia repair. This method demonstrably reduces both postoperative pain and operative time without elevating the risk of complications or early recurrence. Consequently, this patient-friendly advancement merits serious consideration for broader clinical adoption.

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**Keywords:**

Cyanoacrylate, glue, hernia, Lichtenstein

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## Introduction

Inguinal hernia, characterized by the protrusion of intra-abdominal contents through a weakened area in the lower abdominal wall, affects millions of people globally. It is the most common type of abdominal wall hernia, with a lifetime risk of

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27% in males.[1] Surgical repair is the standard treatment, and the Lichtenstein tension-free mesh repair has become the gold standard due to its effectiveness in reducing recurrence rates.[2]

Despite its success, the Lichtenstein repair is associated with potential complications, notably postoperative pain, which can become chronic (inguinodynia) and affect up to 30% of patients.[1] Chronic pain can result from nerve entrapment, tissue trauma, and the foreign body sensation caused by conventional suture fixation of the mesh.[3-5]

To address these issues, alternative, less traumatic mesh fixation methods have been explored. N-butyl-2-cyanoacrylate (NBCA) is a synthetic surgical adhesive that polymerizes rapidly on contact with tissues, providing secure fixation with minimal trauma and nerve damage.[6] Previous studies and meta-analyses have shown that glue fixation can reduce operative time and early postoperative pain compared to sutures.[7,8,9] However, high-quality evidence remains sparse.

This randomized controlled trial was designed to evaluate whether NBCA glue fixation for polypropylene mesh provides superior outcomes in terms of postoperative pain, operative efficiency, and complication rates compared with conventional suture fixation in patients undergoing Lichtenstein repair for uncomplicated inguinal hernia.

## Materials and Methods

### Study design and setting

This was a single-blind, randomized clinical trial conducted at the Department of General Surgery at the Institute of Medical Sciences (AIIMS), a tertiary care teaching hospital. The study duration was 15 months, including a 3-month follow-up period for each patient. Patients over 18 years of age scheduled for elective, open Lichtenstein repair of a single, uncomplicated inguinal hernia were included. Recurrent hernias and hernias with any other simultaneous procedures were excluded. The procedures followed were in accordance with the ethical standards of the Helsinki Declaration. The study received approval from the Institutional Ethics Committee of AIIMS (Date: 19.12.2023, AIIMSRPR/IEC/2023/152). Written informed consent was obtained from all subjects.

A total of 60 patients were included in this study. Sample size was calculated based on the assumption that patients in the comparator group will have 20% more analgesic requirement in the first 24 h in conventional fixation compared to the cyanoacrylate glue fixation.[10] Participants were randomly allocated to one of two groups: Group A (suture fixation) or Group B (glue fixation). The randomization sequence was computer-generated with blocks of four. The allocation concealment was done using the "Sequentially Numbered, Opaque, Sealed Envelopes" technique. Patients were blinded to their group allocation, but the surgical team could not be blinded due to the nature of the interventions.[11]

### Surgical procedure

All procedures were performed under regional anesthesia and standard aseptic conditions. The procedures were performed by surgeons with adequate experience in open inguinal hernia repair (y). After a standard inguinal incision and dissection of the hernia sac, a 15 cm × 7.5 cm polypropylene mesh (pore size: < 1 $mm^2$ and weight: > 95 $g/m^2$) was placed to reinforce the posterior wall of the inguinal canal. An attempt was made to preserve all the major nerves traversing the inguinal region whenever identified.

- **Group A (suture fixation):** The mesh was secured to the pubic tubercle, inguinal ligament, and conjoint tendon using a nonabsorbable polypropylene 2-0 suture.
- **Group B (glue fixation)** [Figure 1]: The mesh was fixed using NBCA glue (ENDOCRYL® , Samarth Life Sciences Pvt Ltd, Mumbai, India). The glue (0.5 mL) was applied with a syringe dropwise to key points: the pubic tubercle, the inguinal ligament, the junction of the mesh limbs near the deep inguinal ring, and the portion of the mesh over the conjoint tendon.

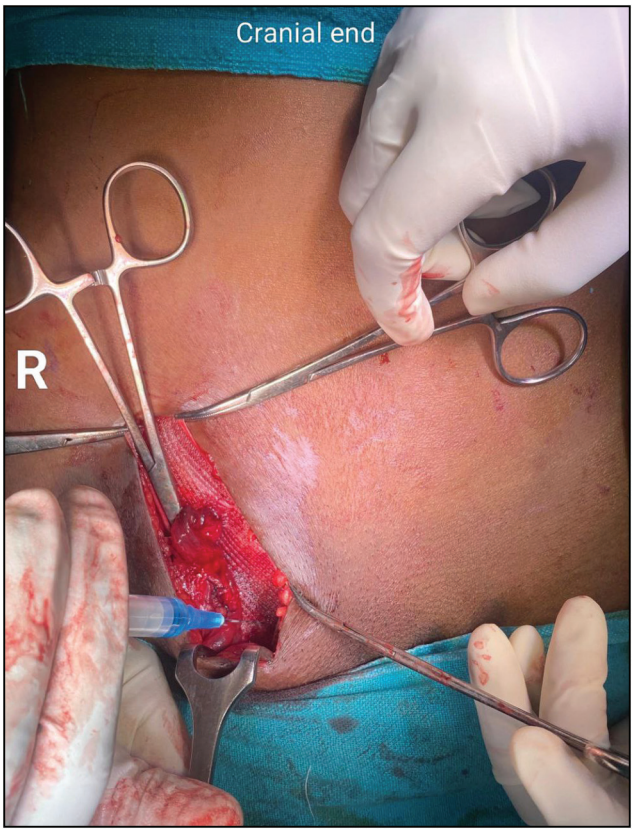



**Figure 1:** Method of glue fixation of mesh

The primary outcome was postoperative pain, assessed using the visual analog scale (VAS) at 24 h, 7 days, 15 days, 30 days, and 90 days postoperatively. A VAS score of 3 or higher was considered significant discomfort.

The secondary outcomes included mesh fixation time and postoperative complications such as hematoma, seroma, surgical site infection (SSI), scrotal edema, foreign body sensation, and early recurrence. Data were analyzed using Microsoft Excel and Statistical Package for the Social Sciences, version 28 statistical software (IBM Corp., Armonk, NY, USA). Appropriate statistical tests, including the Mann–Whitney *U* test, chi-square test, repeated-measures analysis of variance (ANOVA), and logistic regression, were used to compare the groups. A *P* value of <0.05 was considered statistically significant.

## Results

This study included a total of 60 patients, with 30 participants in each group. The groups were well-matched in terms of demographics and hernia characteristics, confirming successful randomization. Data from all patients were analyzed [Table 1].

**Table 1: Baseline characteristics and demographics of study participants**

| Characteristics | Group A (suture fixation; *n* = 30) | Group B (glue fixation; *n* = 30) | *P* value |
|---|---|---|---|
| Age mean ± standard deviation (years) | 47.1 ± 13.2 | 45.2 ± 12.7 | 0.58 |
| BMI category | | | 0.67 |
| Normal (*n*) | 28 | 26 | |
| Overweight (*n*) | 2 | 4 | |
| Side of the hernia | | | 0.376 |
| Right (*n*) | 13 | 16 | |
| Left (*n*) | 10 | 11 | |
| Bilateral (*n*) | 7 | 3 | |
| Type of hernia | | | 0.904 |
| Indirect (*n*) | 18 | 18 | |
| Direct (*n*) | 9 | 8 | |
| Both (pantaloons) (*n*) | 3 | 4 | |
| Comorbidities (*n*) | | | |
| Hypertension | 8 | 2 | 0.088 |
| COPD | 2 | 0 | 0.494 |
| Benign prostatic hyperplasia | 2 | 2 | 1.0 |
| Hypothyroidism | 2 | 2 | 1.0 |

BMI: body mass index; COPD: chronic obstructive pulmonary disease

### Primary outcome: Postoperative pain

Postoperative pain, as measured by the VAS, was consistently and significantly lower in the glue fixation group (Group B) at all follow-up time points. For instance, at 24 h, the median VAS score for Group B was 3 compared with 5 for Group A. This difference was statistically significant [Table 2]. A repeated-measures ANOVA demonstrated a highly significant interaction between time and group ($P < 0.0001$), indicating that the pattern of pain reduction over time was different between the two groups, with the glue group experiencing a more rapid decline in pain scores [Figure 2].

### Secondary outcomes

The secondary outcomes were as follows:

- **Mesh fixation time:** The mean mesh fixation time was significantly shorter in the glue group (4.5 min) than in the suture group (13.63 min; $P < 0.0001$) [Table 3]. A correlation analysis revealed a moderate to strong positive correlation ($r = 0.666$) between fixation time and VAS pain scores at 24 h.
- **Complications:** No statistically significant differences were observed in the incidence of seroma, hematoma, or SSI between the two groups. However, patients in the glue group reported a significantly lower incidence of foreign body sensation than in the suture group at all time points ($P < 0.001$) [Table 4].
- **Recurrence:** No recurrences were observed in either group during the 90-day follow-up period.
- **Logistic regression analysis:** The analysis revealed that the glue group had significantly lower odds of developing chronic pain at 90 days ($P = 0.0025$). Furthermore, a longer mesh fixation time was a strong predictor of an increased risk of chronic pain ($P = 0.0019$) [Figure 3].

**Table 2: Comparison of postoperative pain between the two groups**

| Time points | Group A (suture fixation *n* = 31) median (min–max) | Group B (glue fixation *n* = 29) median (min–max) | Mann–Whitney *U* test | *P* value |
|---|---|---|---|---|
| 24 h | 5 (4–6) | 3 (2–5) | 825.5 | < 0.001 |
| 7 days | 3 (2–4) | 1 (0–3) | 811.0 | < 0.001 |
| 15 days | 2 (0–3) | 0 (0–2) | 827.0 | < 0.001 |
| 30 days | 1 (0–2) | 0 (0–2) | 704.5 | < 0.001 |
| 90 days | 0 (0–2) | 0 (0–1) | 624.5 | 0.0008 |

**Table 3: Comparison of mesh fixation time between the two groups**

| Groups | *n* | Time range (min) | Mean ± standard deviation (min) | *P* value |
|---|---|---|---|---|
| Group A (suture fixation) | 31 | 3–25 | 13.63 ± 4.67 | < 0.0001 |
| Group B (glue fixation) | 29 | 1–9 | 4.5 ± 1.63 | |

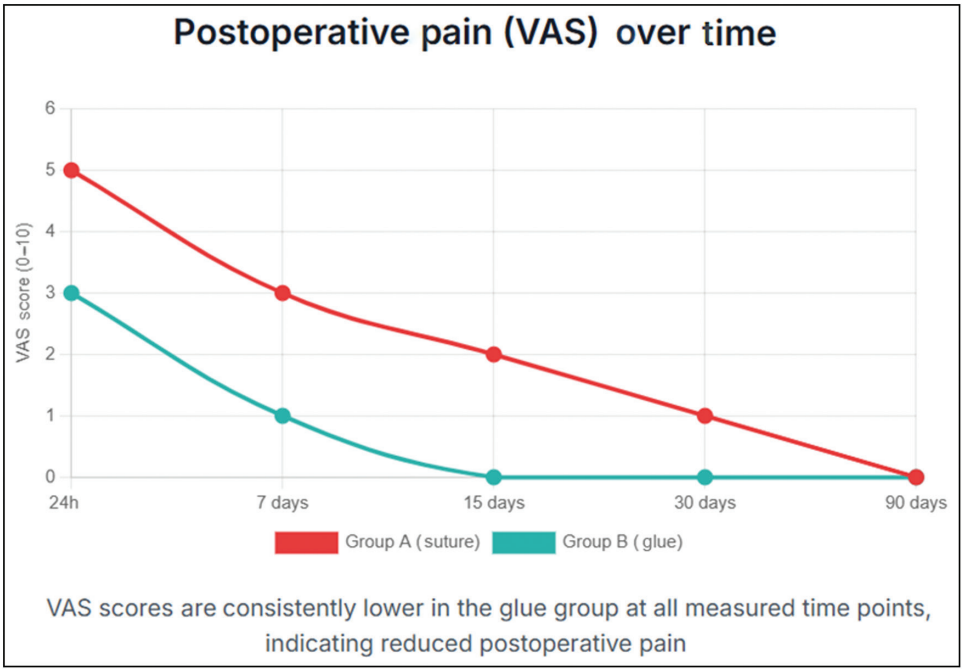



**Figure 2:** Comparison of postoperative pain between the two groups

**Table 4: Comparison of postoperative complications between the two groups**

| Complications | Group A (yes/total) | Group A (%) | Group B (yes/total) | Group B (%) | *P* value |
|---|---|---|---|---|---|
| Surgical site infection (SSI) | 0/30 | 0.0 | 1/29 | 3.4 | 0.07 |
| Hematoma/ seroma | 1/30 | 3.3 | 2/30 | 6.7 | 0.62 |
| Scrotal edema | 7/30 | 23.3 | 1/30 | 3.3 | 0.07 |
| Foreign body sensation | 9/30 | 30.0 | 0/30 | 0.0 | < 0.001 |

## Discussion

This randomized controlled trial provides compelling evidence that NBCA glue fixation offers tangible advantages over conventional suture fixation in open Lichtenstein hernia repair, particularly in reducing postoperative pain and operative time. Our findings directly align with the primary hypothesis, demonstrating that glue fixation yields significantly lower VAS scores across all follow-up periods, a result attributed primarily to the atraumatic, nonpenetrating nature of the adhesive technique.[3,6] This difference is further substantiated by the significantly reduced incidence of foreign body sensation in the glue group, suggesting minimized nerve irritation and tissue response at the fixation points.

### Efficiency and cost-effectiveness

The most marked objective difference observed was the nearly tenfold reduction in mean mesh fixation time in the glue group (4.5 min vs. 13.63 min; $P < 0.0001$). This enhanced surgical efficiency, as confirmed by our correlation analysis linking longer fixation time to increased early pain, is a critical finding for high-volume settings.[12] While the immediate material cost of NBCA glue (approximately 400–500 Indian Rupees per ampoule in the commercial market) is higher than that of standard polypropylene suture, the economic viability must be assessed holistically. The potential cost savings from reduced operating room time, decreased analgesic requirements, and faster patient mobilization/return to work must be factored into a comprehensive cost-effectiveness analysis. Previous studies support the notion that the overall economic benefit of a faster and less painful procedure may outweigh the initial material cost.[8]

### Clinical relevance to laparoscopic surgery

The principle of atraumatic mesh fixation extends significantly to laparoscopic repair techniques, such as transabdominal preperitoneal and total extraperitoneal repair. In these minimally invasive procedures, glue fixation has been widely accepted as a superior alternative to metal tacks or staples, which carry a higher risk of nerve injury and chronic pain due to blind fixation.[4,5,13] The success observed with NBCA in open Lichtenstein repair strengthens the argument for adopting nonpenetrating fixation methods across all hernia approaches. The consistency of efficacy between open and laparoscopic settings validates the fundamental benefit of the glue's action, irrespective of the surgical plane.[13]

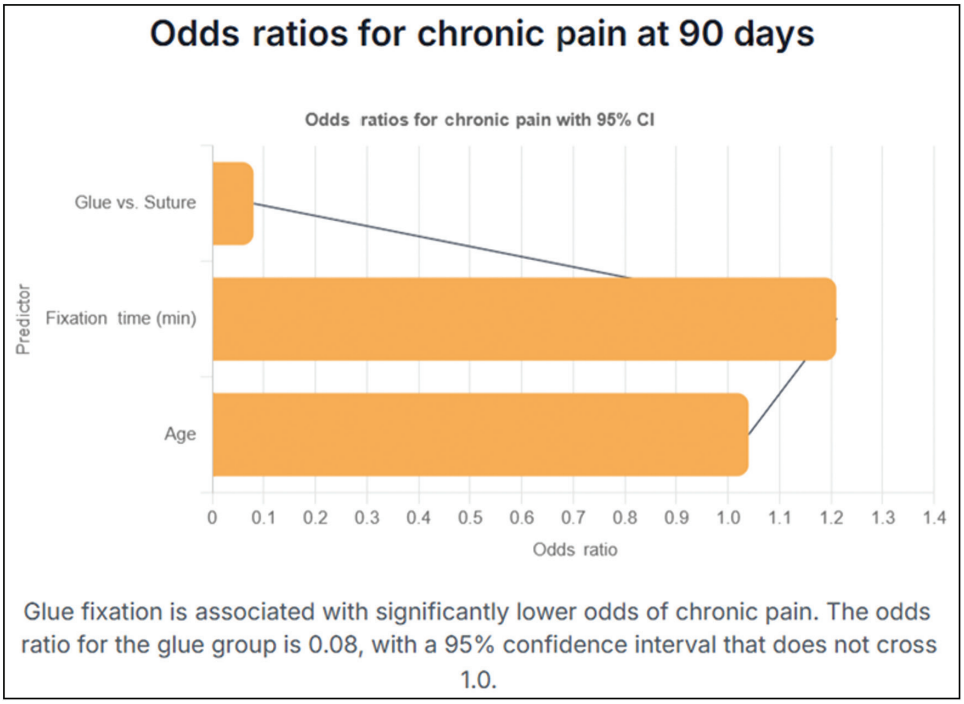



**Figure 3 :** Comparison of chronic pain between the two groups

## Biocompatibility and adverse effects

NBCA is a well-established medical adhesive. Its polymerization on contact with tissue fluid provides a strong bond and exhibits bacteriostatic properties, potentially offering an ancillary benefit against SSI.[4,5] The chemical is ultimately degraded and absorbed by the body over time. Importantly, our complication data confirms the safety profile, showing comparable rates of seroma, hematoma, and infection in both groups. While cyanoacrylates are generally biocompatible, the potential for local inflammatory reactions or rare allergic responses exists, as with any foreign material. However, these negative effects are seldom reported in hernia literature, and no such complications were encountered in this trial.[14,15,16]

## Broader surgical applications

The use of cyanoacrylate glue is not confined to hernia surgery. Its properties—rapid polymerization, high tensile strength, and bacteriostatic action—have made it invaluable across multiple surgical specialties. The adhesive is commonly utilized for vessel embolization in neuro- and interventional radiology, skin closure in place of sutures or staples, fistula treatment in gastroenterology, and in ophthalmology for corneal perforations. This extensive history of use in varied, often sensitive, anatomical locations underscores the material's general safety and clinical reliability.[14,16,10]

## Limitations and future directions

While robust, this study is limited by the short 90-day follow-up period. Although the logistic regression strongly predicts a reduced risk of chronic pain, long-term recurrence, and the definitive evolution of inguinodynia often require follow-up extending beyond 1 year.[17] Furthermore, multicentric trials with longer observational periods are warranted to confirm the sustained benefit of glue fixation across diverse patient populations and to conduct formal economic evaluations weighing the glue's cost against the accumulated procedural and patient recovery savings. Studies such as that by Kalwaniya *et al.*,[10] which also compared cyanoacrylate glue with Prolene sutures in Lichtenstein hernioplasty, further support the need for broader investigation into nonsuture fixation techniques to standardize patient care and optimize outcomes.

# Conclusion

In conclusion, NBCA glue fixation for polypropylene mesh in Lichtenstein inguinal hernia repair is a safe, effective, and efficient alternative to conventional suture fixation. This technique significantly reduces postoperative pain and operative time without increasing the risk of complications or early recurrence. Our findings provide strong evidence that glue fixation is a clinically superior and patient-friendly innovation that should be considered for broader adoption in modern surgical practice. Future multicentric trials with extended follow-up are recommended to further validate these results.

## Author contributions

SA and RR conceived the study. SA, RR, and TDB designed the protocol. SA, RR, TDB, and DD recruited

patients. SA, RR, TDB, and DD were involved in performing the actual procedures and management of patients. SA and RR analyzed data. SA, RR, and DD wrote the manuscript. All authors contributed to revisions, critical interpretation, and approved the final version.

## Data availability statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

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