



## **A Comparative Study between Conventional Sutures, Staples and Adhesive Glue for Clean Elective Surgical Skin Closure**

**Kiran Mastud<sup>1\*</sup>, Y. R. Lamture<sup>1</sup> and Meenakshi Yeola(Pate)<sup>1</sup>**

<sup>1</sup>*Department of General Surgery, Jawaharlal Nehru Medical College, Datta Meghe Institute of Medical Sciences, Maharashtra, India.*

### **Authors' contributions**

*This work was carried out in collaboration among all authors. Author KM designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors YRL and Author MY managed the analyses of the study. Author MY managed the literature searches. All authors read and approved the final manuscript.*

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## **ABSTRACT**

**Background:** A surgeon's signature is 'scar' [1]. On a regular basis, surgeons face various kinds of wounds which must be healed. The healing process and cosmetic result can be influenced by wound and incision closure techniques.

**The Goal of this Research is to Compare 3 Skin Closure Techniques:** conventional skin sutures, adhesive glue, surgical stapler. These methods will be used to determine which of them is superior in terms of wound healing and cosmetic outcome in clean elective surgeries.

#### **Objectives:**

- To compare duration between closure by 3 methods.
- To compare prices amongst the 3 methods.
- A comparison of the cosmetic appearances of the skin after closure.
- A comparison of post-operative pain between the 3 methods.
- To assess surgical site infections after closure with these 3 methods

\*Corresponding author: E-mail: [kiranmastud94@gmail.com](mailto:kiranmastud94@gmail.com);

**Methodology:** 90 patients, undergoing clean elective surgeries, will be included in this study. 30 patients will be included in every group. Hospitalised under Department of General Surgery in Datta Meghe Institute Of Medical Sciences, Wardha. The study will be conducted between October 2020 to October 2022.

**Results:** The result would be undertaken in SPSS software.

**Conclusion:** Conclusion will be based on findings of study protocol.

*Keywords: Skin sutures; adhesive glue; staples; scar; incisions wound.*

## 1. INTRODUCTION

A surgeon's signature is 'scar' [1]. On a regular basis, surgeons face various kinds of wounds which must be healed. Wound can be described as the severance or break in the continuity of skin, mucous membrane or tissue due by chemical, physical or biological abuse. Whereas, a clean wound is usually an elective surgical incision which includes the following criterias [2]:

- Operative site should be uninfected
- There should be no inflammation
- No break in sterility technique
- Should be closed primarily and, or should be drained via closed drainage
- Respiratory, gastrointestinal and genitor-urinary tracts should not be breached.
- Surgical wounds made after non-penetrating blunt trauma, if the above criteria are fulfilled

Many creative and fascinating practices have said to be implemented in ancient times to hold wounds together. There have been reports from India and in South America report ants being motivated to bite across a wound secured close together, after which the body of the ants are rapidly twisted off, leaving the approximated jaws of the creature behind, thereby "stapling" the lesion closed; a pioneer of the surgical stapler used in surgeries [3]

The Masai tribe in East Africa used to place acacia thorns in the skin along the edges of a cut, before securing them together by using plaited plant fibre [4] and thereby, closing the wound.

There was a lot of trialing in the world of surgery by mid 19<sup>th</sup> century. Many different types of materials like aluminum, tendons, arteries, aluminium, silverwire, copper, flex, cotton, hair, hemp, and even catgut (made

from the submucosa of animal intestine) were being used. Sutures like polyamide (Nylon), polyglactin 910 (Vicryl), polydioxanone (PDS) were mass produced by mid-20<sup>th</sup> century that we now find in operation rooms today [5].

During Vietnam War (1955-1975) it was revealed that cyanoacrylate glue had an unusual property to grip wounds shut. It polymerized and toughened when left open to moisture. Ultimately, trauma surgeons or field surgeons began to spray it on wounds prior to transporting patients to the military hospitals and as a result, many lives were saved [1].

Eventually the Food and Drug Administration granted approval for the usage of adhesive glue in the United States for medical use. Even with various skin closures techniques, the basic doctrine of skin closure technique has not changed. That is to bring together the edges of skin in an everted position and thereby lessening the tension on the wound. The means of wound closure should ideally be cheap, quick, painless, simple, safe, if possible bactericidal, and should be able to produce the optimal cosmetic result. Closure materials for wounds are categorized into 3 main categories: sutures, surgical staples and adhesive skin glue. Even though the usage of conventional skin sutures is a gold standard practice for wound closure from several years, surgical staples and adhesive tissue glues have shown to be useful as well, in the clinical practice more recently. The conventional skin suturing is lucrative but time taking. Staplers reduced this time length by a huge margin. Modern staplers are either disposable, that is they're made of plastic or they are made of stainless steel which make them reusable. Surgical Staples carry certain reward of speedy closure, reduced chances of infectivity, better wound eversion with no tissue strangulation, almost zero cross-hatch scarring and reduced foreign

body reaction. It excludes the risk of needlestick injury for doctors and other health care providers when the patient's history is unknown [6].

2-octyl cyanoacrylate has been approved by the FDA i.e. the Food and Drug Association for closure of skin incisions.

The cyanoacrylates originally gained fame in 1958s, for being marketed as a very strong and a quick drying glue. The widely used skin adhesives come in form of alkyl cyanoacrylates. Octyl-2-cyanoacrylate is now being used in hospitals across the world, mostly for minor surface wound repairs and in places where the use of sutures would demonstrate to be unreasonable or tricky [6]. Adhesive tissue glue based on cyanoacrylate have been linked with usage problems and histotoxic reaction in earlier attempts [7].

Now, adhesive glue suits the standard, it supplies a quick, trouble-free, water resistant sealed needle free skin closure which is also cosmetic. It also has anti-microbial properties and hence, requires no added antiseptic bandaging. Reduced pain was noted in post-op period. Patients are able to bathe. The wound disappears naturally, leaving no incision mark and no suture or stapler removal is required. Probability of infection of wound with adhesive glue, are less. It also has appropriate features for closure of the wound such as adequate power, barrier proficiency in tissues, and potential to bind in clammy environment [8]. Numerous studies have shown correspondence of cyanoacrylate to 5-0 sutures in facial surgeries and traumatic facial lesion repair [9]. As the pliability of octylcyanoacrylate is superior than old-fashioned cyanoacrylate, it can be used on uneven surfaces [10]. Octyl-2-cyanoacrylate use has been linked with a reduced rate of wound infectivity and has been thought to act as an obstacle for bacteria infecting the wound, especially the Gram-positive bacteria [11]. However, there are certain downsides of cyanoacrylates, like their lesser amount of tensile strength and probability of adhesive discharge if the ends aren't adequately approximated.

In May 1997, Quinn J et al. [12] did the first study of comparing octyl-2-cyanoacrylate to

sutures by using a prospective, randomized controlled trial which included 130 patients with 136 lacerations (mainly facial). Patients were then put in randomized groups and skin closure was done with either monofilament sutures or octyl-2-cyanoacrylate glue. It was found that closure with adhesive skin glue was faster (an average of 3.6 mins for skin glue and 12.4 mins for sutures), and less painful (using 100mm visual analogue pain scale, glue: 7mm, sutures: 18mm,  $p < 0.001$ ).

The second study published in 1998 by Toriumi DM et al. [13] with a single surgeon performing elective facial surgeries in 111 randomized patients. The patients were indiscriminately subjected to closure either by interrupted mattress sutures (with 5-0 / 6-0 Nylon), or cyanoacrylate glue. Momentum of wound closure, cosmesis and complication of wound of 100 patients was assessed at the end of 1 year. It was again shown that time taken for closure of wound was quicker with skin glue (55 secs) in comparison to that of mattress sutures which took an average of 3 mins and 57 secs to close. ( $p < 0.0001$ ). There was no infection or wound dehiscence after accessing at 5-7 days.

Ridgway et al. [14] published a study in 2007 wherein 30 patients who underwent parathyroid and thyroid surgeries were randomized to skin closure using adhesive glue or surgical skin staples. The time required for wound closure was considerably abridged with the use of staples. Skin stapler took an average of 67s +/- 42s less time compared to adhesive glue. According to Chibbaro et al. [15], there wasn't any noteworthy difference between skin staples and adhesive glue when used for closing of scalp incisions in neurosurgery.

In the study comparing conventional sutures and staples by Ranaboldo et al. [16], the speed of closure for the wound was eight secs/cm with skin stapler and 12.7 secs/cm with conventional sutures.

Medina dos Santos et al. [17] found less time in staples than suture closure, in his prospective trial. The standard mean time for closure of wound was 5 minutes with skin staples and with nylon sutures it, it took 25 minutes.

There was not much difference between the 2 groups in indications for caesarean deliveries or number of previous caesarean deliveries. The rate of complications of wound in the group of was 5.3% and 3.4% in the NBCA group. NBCA maybe useful for closure of skin of Pfannenstiel incisions [18]

All the above mentioned techniques of skin closure vary from each other with own merit and demerits.

Hence, this study will be planned towards aiming to compare these three skin closure modalities after a clean elective surgery, with skin incisions of varying lengths and widths in terms of their potency, cosmesis and cost-effectiveness.

## 2. OBJECTIVES

- a. To compare duration between closure by 3 methods.
- b. To compare prices amongst the 3 methods.
- c. Comparison of cosmetic appearances of skin after closure by any of the 3 methods.
- d. Comparison of post-operative pain between the 3 methods.
- e. To assess surgical site infections after closure with these 3 methods

## 3. INTERVENTIONS

### 3.1 Materials and Methods

90 patients, undergoing clean elective surgeries, will be included in this comparative prospective study. 30 participants included in every group. Hospitalised under Department of General Surgery in Datta Meghe Institute Of Medical Sciences, Wardha. The study will be conducted between October 2021 to October 2023.

Clean surgical wounds will be given single dose of antibiotic at the time of induction of anesthesia.

**Study design:** Prospective interventional study as the objectives of the study will directly evaluate impacts of treatment

**Study Setting:** In this comparative prospective study 90 patients will be included wherein, 30 in

each group undergoing surgery. Admitted in the Department of General Surgery in Datta Meghe Institute Of Medical Sciences, Wardha. The study will be conducted between October 2021 to October 2023.

### Groups:

**Group A:** Incisions will be secured with glue (octyl-2- cyanoacrylate).

**Group B:** Incisions will be secured with non-absorbable surgical skin staples.

**Group C:** Incisions will be secured with non-absorbable conventional nylon sutures. (ethilon 3-0).

Sample Size: 90

**Group A: 30**

**Group B: 30**

**Group C: 30**

## 3.2 Study Participants

### 3.2.1 Inclusion criteria

- Patients willing to provide informed consent for proposed technique of wound closure, before surgery.
- Patients undergoing skin closure with conventional suturing or surgical stapler or skin glue after undergoing clean elective surgical procedures.
- Incisions ranging between 1-10 cms in cases undergoing clean elective procedures.

### 3.2.2 Exclusion criteria

- Patients not willing to provide informed consent for proposed technique of wound closure.
- Patients with Hb <10 gm %.
- Skin incisions <1cm or >10 cm.
- Critical cases in need of damage control surgery.
- Patients for whom stomas are needed.
- Patients who won't be able to come for follow-up on 7<sup>th</sup> or 15<sup>th</sup> post-operative days.
- Facial wounds or wounds over bony prominences and highly mobile areas for surgical stapler closure.

- Wounds over mucocutaneous junctions like lips or sites with high friction like hands and feet, for adhesive glue application.
- Wounds over anogenital regions.
- Patients with history of DM, scars or keloid formation, immunosuppression and malignancy

### 3.2.3 Sample size calculation:

Sample size formula for difference between two means:

$$n = \frac{(Z\alpha + Z\beta)^2(\delta_1^2 + \delta_2^2/\kappa)}{\Delta^2}$$

Where,

Z $\alpha$  is the level of significance at 5 % i.e 95%

Confidence interval = 1.96

Z $\beta$  is the power of test = 80% = 0.84

$\delta_1$  = SD of length of stay in glue group = 0.97

$\delta_2$  = SD of length of stay in staple group = 4.65

$\kappa$  = 1

$\Delta$  = 5.93 – 3.47 = 2.46

$$n = (1.96 + 0.84)^2 \left( 0.97^2 + 4.65^2 \frac{1}{1} \right) 2.46 = 29.23$$

n = 30 patient needed in each group

90 healthy patients undergoing lipoma excisions, umbilical hernioplasties, vascular surgeries, open inguinal hernioplasty, splenectomy, thyroidectomy, spine surgeries, c-section will be chosen for the study. After subcutaneous approximation to shut dead space and apposing the edges of the wound, patients will be randomly chosen into 3 groups.

In group A, incision line will be secured with cyanoacrylate tissue glue using prophen. Adhesive glue will be applied using prophen, in a slim layer over the whole wound with extension of 5-10mm beyond wound edge. The wound will be permitted to dry for 15-20 secs and then 2<sup>nd</sup> and 3<sup>rd</sup> layer will be applied. No additional dressing will be done. In group B, the incision line will be approximated with non-absorbable surgical skin staples. It will be applied in one single layer while holding and therefore approximating the margins of the wound together with forceps.

In group C, lesions will be sutured using ethilon 3-0 that is, non-absorbable nylon suture. After thoroughly examining the patient and taking detailed history, routine blood investigations like complete haemogram, Bleeding time, Clotting Time, blood sugar level, blood urea, serum creatinine, HIV and HBsAg (other investigations if required) will be sent. Injection cefotaxime 1gm will be given intravenously at the time of induction of anaesthesia.

Time taken to close the wound in all three groups, using a particular method will be noted and compared using a stopwatch timer. The post-operative pain will be gauged using a Visual Analog Scale of 1-10. It will be assessed at 12h, 48h, 72h and 7<sup>th</sup> day. 1 being no pain and 10 is worst pain possible. It will be rated by patient themselves. The outcome of wound will be assessed ranging from 0-10 using the standard wound assessment scoring system. It will be assessed on 3<sup>rd</sup>, 5<sup>th</sup>, 7<sup>th</sup> post-operative day (POD).

The cosmetic appearance of the wound will be judged using modified Hollander cosmesis scale of 1-6 on POD 7. A score of 6 will be considered as optimal while 5 or less will be considered suboptimal.

(0 for yes, 1 for no)

- Step off the borders
- Contour irregularities - puckering
- Wound margin separation
- Wound edge inversion
- Excessive wound distortion
- appearance overall (0 - poor, 1- acceptable)

Post-operative wound infection can be explained as surgical site infection within 0-30 days after surgery, or infection at surgical site till 1 year in cases of implants like mesh, vascular grafts and prosthesis.

Southampton wound grading system will be used to grade the severity of post-operative wound infection, which goes as follows:

## SOUTHAMPTON WOUND - GRADING SYSTEM

(Bailey and love 25<sup>th</sup> edition)

Grade	Appearance	
0	Normal healing	
I	Normal healing with mild bruising or erythema	
	Ia	Some bruising
	Ib	Considerable bruising
	Ic	Mild erythema
II	Erythema plus other signs of inflammation	
	IIa	At one point
	IIb	Around sutures
	IIc	Along wound
	IId	Around wound
III	Clear or haemoserous discharge	
	IIIa	At one point only ( $\leq$ 2cm)
	IIIb	Along wound (>2 cm)
	IIIc	Large volume
	IIId	Prolonged (> 3 days)
IV	Pus	
	Iva	At one point only ( $\leq$ 2cm)
	IVb	Along wound (>2 cm)
V	Deep or severe wound infection with or without tissue breakdown; hematoma requiring aspiration	

### 4. RESULTS

**Expected Results:** The comparison between three methods of closure will be monitored for short term and long term outcomes. Comparative evaluation will be done.

### 5. DISCUSSION

For decades, man has looked for a flawless way to close a wound. Man has left no stone unturned in trying out different ways for closure. War and trauma have provided a continuous supply of wounds, but it is only recently that

surgical incisions have become of importance. Hence, there is a need to find the most appropriate method of closure.

Sources like honey, which are natural were used as antibacterial agents in the pre-historic era. Such old school techniques are still used in modern day managing of the wound.

Ideally, as soon as a wound is closed, it should be strong just like a normal tissue.

However, Douglas and Forester concluded that the maximum strength a tissue can regain after

closure of wound is 80% even after follow up of a year.

Gennari et al. [19] conducted a randomized study which was prospective, in 2004, to explore the usage of skin glue in breast surgeries for superficial wound closure. 133 patients were randomized into 2 groups of skin glue closure (69 patients) or monofilament suture closure (64 patients). The groups were coordinated for age, incision length, type of procedure and length of hospital stay. The results acquired included assessment by blinding the plastic surgeons as well as the patients. The cosmetic appearance was rated after an interval of 6 months – 1 year. A scale of 1-10 was used, with ten being congruous with optimal cosmetic appearance. Early follow-up was carried out at 5-10 days to gauge erythema of wounds. Economic outcome was also compared. During follow up, it was evaluated that wounds closed with adhesive glue showed significantly less inflammation and erythema. While assessing patient satisfaction score (on a scale of 1-10, with 10 being optimal), the group where adhesive glue was used appeared to be more satisfied than the group where conventional sutures were used. (9.5 vs. 7.45,  $p < 0.001$ ). The authors deduced that there wasn't much to choose between methods of closure based on outcome. Although, economically glue had an upper hand over sutures.

Krishnamoorthy et al. [20], investigated the use of cyanoacrylate glue v/s subcuticular sutures in the closing of bridged saphenous vein harvest incisions, for its use in coronary artery bypass grafting, in 2009. 106 patients were enlisted on the trial and 53 patients were randomized to every group. HWES was used to evaluate the wounds on day 7. Vancouver scar scale was used to evaluate the length of the scar, scar pigmentation and vascularity and pliability at the end of 6 weeks. The vein harvest closure time and total time taken for operation was noted too. The time for vein harvest wound closure lessened significantly, but total time of operation was not greatly lessened. The cosmetic outcome was assessed using Hollander's scale. The Vancouver scar scale also showed much better results for groups wherein incisions were approximated using glue with regard to scar appearance. ( $p = 0.001$ ). Patients were significantly more satisfied with their glued group ( $p < 0.001$ ).

Knott et al. [21] did a study comparing adhesive glue to conventional sutures for patients undergoing cleft lip, palate correction. The study proved that skin adhesives containing cyanoacrylate can be used on the red zone of the lip which is partially keratinized. It gave results similar to that with sutures. Skin adhesive glue was not recommended for internal mucosal closure, as it requires moisture to harden. If glue is used on the internal 'wet' surface, it would result in an ineffective join due to premature hardening.

## 6. CONCLUSION

The expected conclusion will be to find out which skin closure modality is better after a clean elective surgery, with skin incisions of varying lengths and widths in terms of their potency, cosmesis and cost-effectiveness.

## CONSENT

As per international standard or university standard, patients' written consent will be taken by the author(s).

## ETHICAL APPROVAL

As per international standard or university standard written ethical approval will be taken by the author(s).

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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