RESEARCH PAPER

A Comparative Study Between N-Butyl-2-Cyanoacrylate Skin Adhesive Glue Versus Standard Ethilon Suture for Skin Closure of Clean Wounds in a Tertiary Care Setting.

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Abstract

Introduction: Optimal closure of clean skin wounds should provide effective treatment, cosmetic benefit, and comfort to the patient. This study compared the efficacy of the tissue adhesive (N-butyl-2-cyanoacrylate) to that of standard Ethilon sutures.

Methods: A prospective, randomized comparative study was performed using an equal number of subjects (50) divided into two groups (Group A) and (Group B). All outcomes measured were based on a combination of ratings for procedure time, Visual Analog Scale (VAS) for pain reported by the patient, healing of wounds at three months through the Vancouver Scar Scale (VSS) rating system, complication rates, and satisfaction ratings.

Results: Results showed that the amount of time needed to complete the procedure was significantly less for the adhesive group (3.8 ± 1.1 minutes) than for the Ethilon suture group (12.5 ± 2.9 minutes) with a P-value of less than 0.001; the amount of pain experienced immediately after the procedure was less for the adhesive group (VAS score of 1.6 ± 0.8) than for the Ethilon suture group (VAS score of 3.4 ± 1.2) with a P-value of less than 0.001; and that the rate of complications (8% for the adhesive group versus 16% for the Ethilon suture group, P-value = 0.387) and three-month VSS scores (2.6 ± 1.8 for the adhesive group versus 3.3 ± 2.1 for the Ethilon suture group, P-value = 0.191) were similar across the two groups.

Conclusion: Patient satisfaction was higher in the adhesive group than in the Ethilon suture group with 72% of patients reporting that they were "very satisfied" with the adhesive and only 40% reporting that they were "very satisfied" with the Ethilon suture method; the P-value was equal to 0.038.

Keywords: N-butyl-2-cyanoacrylate, Tissue adhesive, Ethilon suture, Wound closure, Cosmetic outcome, Patient satisfaction, Randomized controlled trial.

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Introduction

Skin texture plays an important role in how your skin appears in general and directly affects how much healing takes place following a surgical procedure. Historically, the gold standard for primary closure has been to close the wound with non-absorbable sutures (Ethilon, nylon, etc.) that maintain their tensile strength for an extended period of time and allow the surgeon to accurately approximate the wound edges as closely together as possible [1]. Suturing technique is extremely difficult, which contributes to longer surgical durations and necessitates suture removal for additional discomfort and anxiety for the patient.

Over the last several years, the development of tissue adhesives has been studied to see if tissue adhesives can replace suturing techniques. An example of a promising tissue adhesive is N-butyl-2-cyanoacrylate (NBCA), which forms a waterproof bond when polymerized by contact with moisture and does not require the use of needles, nor does it require removal [2]. Studies have shown that when tissue adhesive is used as a method of closure for wounds, it results in shorter surgical procedures, provides greater comfort to the patient, and produces cosmetic results similar to those of sutures in certain types of wounds [3]. In contrast, tissue adhesive may be more applicable for closure of clean, non-tensioned wounds while suturing remains the optimal method of closure for high-tension anatomical structures as well as contaminated wounds [4].

As physicians are becoming increasingly interested in using tissue adhesives for closure of wounds, there has

been a lack of comparative data available between NBCA tissue adhesives and Ethilon sutures with regards to effectiveness, satisfaction, and complication rates for closure of clean skin wounds when assessed across different patient populations. Therefore this prospective study is designed to address this deficiency by comparing the two techniques in a controlled clinical environment.

This study will establish evidence-based guidelines for the selection of closure techniques for skin wounds. Comparisons of the duration of each procedure, pain scores, wound healing, cosmetic outcomes, and complication rates will assist physicians in the selection of closure methods for their patients based on a combination of the characteristics of the patients and their individual preferences. Clinical findings from this study may allow for improved patient recovery following surgery, higher patient satisfaction, and improved efficiency and use of surgical resources.

Objectives

The goal of this research was to determine how effective N-butyl-2-cyanoacrylate (NBCA): Skin Adhesive Glue is in comparison with standard nylon (Ethilon) sutures for cosmetically and functionally improving patient satisfaction and improving complications rates while approximating clean linear wounds.

1. Determining the average time taken to close a wound using both methods;
2. Determining and comparing the amount of pain patients reported while undergoing the procedure, as well as after the procedure, using a VAS scale;
3. Determining and comparing when complete wound closure was clinically determined;
4. Determining and comparing the aesthetic outcome of forehead scars after three months postoperatively using validated tools;
5. Determining and comparing the number of patients that experienced postoperative complications (infection, dehiscence) or an allergic reaction.

Materials and Methods

The Department of General Surgery at Chettinad Hospital and Research Institute in Chennai conducted a prospective, randomised, comparative research design with Ethical Approval from Student Research Ethical Committee (CARE IHEC-I) for this research. The study included 50 Patients aged 18-60 with Clean Linear Wounds less than 10cm in length that required Primary Closure after minor surgical procedure causes or Traumatic Laceration Causes who fit within the inclusion and exclusion criteria for this study. Patients with Burn or Other Contaminant Wounds, or those who had injuries that were Crushed or had lost Tissue from some Other Source, or who were bleeding excessively, or who had Uncontrolled Diabetes, or were taking some kind of Immunosuppressant Drug, or were known to have Allergies to N-butyl-2-cyanoacrylate, or whose wound sites were Located on High Tension Skin (such as over Joints) were all excluded from the study.

To randomly assign eligible subjects to two evenly distributed groups (n=25 each) a Computer-generated Random Number Assignment Sequence was Utilized. The random assignment of subjects was conducted by a staff member who was not involved with either the care of the patient or the patient assessment, to assure concealment of the group assignment. Patients assigned to Group A had their Wounds Closed with the Tissue Adhesive (N-butyl-2-cyanoacrylate), while Patients Assigned to Group B received either interrupted or continuous nylon sutures (Ethilon).

All Procedures were performed while maintaining An Aseptic Environment to ensure a High Level of Safety and Effectiveness for Patients undergoing Surgery in the Future. The Wound Edges were Cleaned with either Povidone-Iodine or Normal Saline. Haemostasis was then Established.

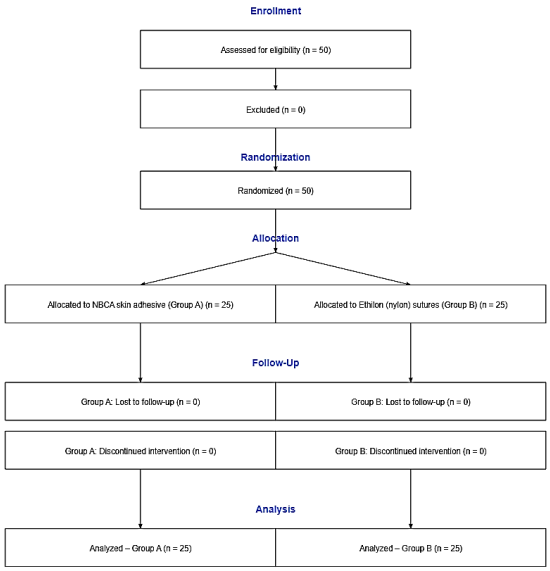
- For the NBCA Adhesive Group (Group A), the N-butyl-2-cyanoacrylate material (Histoacryl® or similar), was placed along the closable borders of the wound after it was completely dried. No extra material was permitted around the area of skin that surrounded the wound. Once placed into the wound, the adhesive material immediately began to form a strong bond.
- For the Suture Group (Group B), sterile Ethilon sutures (size 4-0 or 5-0) were used to secure the wound in an interrupted (or continuous) manner, depending on the length of the wound and tension on the wound. The sutures were tied securely to hold the apposed edges of the wound in place. A sterile dressing was placed over the sutured wounds. The sutures were removed at 7 to 10 days after completing the procedure based on the location of the wound.

Data Collection/Outcome Measures: An independent observer who was not aware of the closure technique collected all data.

1. The total time to complete the closure of the wound (from the beginning of preparation to the time the closure was complete) was recorded in minutes and seconds using a stopwatch.
2. The amount of pain reported by the patient immediately following the procedure was assessed on a ten point VAS (Visual Analog Scale), with "0" as no pain experienced and “10” as the worst level of pain.

3. Signs of healing, infections, erythema, discharge, and/or dehisced wounds were evaluated on the clinical evaluation form after one (1) week and again after two (2) weeks.
4. The cosmetic outcome of the scar (at the three-month follow-up period) was graded according to VSS methods, and standard photographs were taken at the same time under the same lighting conditions for the purpose of comparison between the two groups.
5. All adverse events (Infections, dehiscence, allergic contact dermatitis, and/or detachment of the adhesive material) during the duration of the study were noted.
6. Patients' overall satisfaction with the procedure and its cosmetic results was assessed on the fifth and final follow-up using a 5-point Likert scale.

Statistical Analysis: Data were analysed using SPSS (Statistical Package for the Social Sciences) version 25.0. Continuous data (e.g. procedure time, VAS Scores) were expressed as mean ± standard deviation values and compared with Student's t-test, or, where applicable, using the Mann-Whitney U Test. Categorical variables (e.g., complication rates, satisfaction scores) were defined in terms of frequency and percentage and analysed using either the Chi-square test, or Fisher's Exact test. A p-value <0.05 was deemed to indicate statistical significance.



Results

A total of 50 patients were enrolled and randomised, with 25 patients allocated to each group. All participants completed the study protocol and were available for all follow-up assessments. The baseline demographic and wound characteristics of both groups were comparable, with no statistically significant differences, ensuring homogeneity for comparative analysis (Table 1).

Table 1: Baseline Demographic and Wound Characteristics

Characteristic	Group A (NBCA Adhesive) (n=25)	Group B (Ethilon Suture) (n=25)	p-value
Age (years), Mean ± SD	38.4 ± 11.2	40.1 ± 10.8	0.584
Gender, n (%)			0.774
Male	14 (56%)	15 (60%)	
Female	11 (44%)	10 (40%)	
Wound Location, n (%)			0.652
Upper Limb	10 (40%)	12 (48%)	
Lower Limb	9 (36%)	7 (28%)	
Trunk	6 (24%)	6 (24%)	
Wound Length (cm), Mean ± SD	4.2 ± 1.5	4.5 ± 1.7	0.502
Mechanism of Injury, n (%)			0.812
Incisional (Surgical)	13 (52%)	14 (56%)	
Laceration (Traumatic)	12 (48%)	11 (44%)	

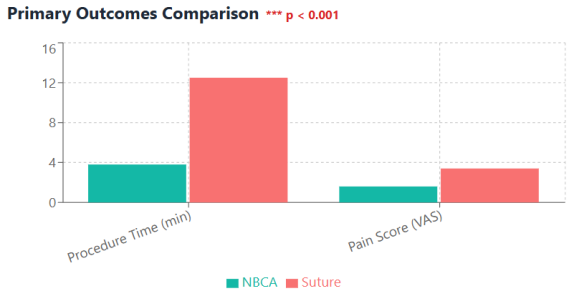
The mean time taken for wound closure was significantly shorter in the NBCA adhesive group compared to the suture group (Table 2).

Table 2: Comparison of Procedure Time and Immediate Post-Procedure Pain

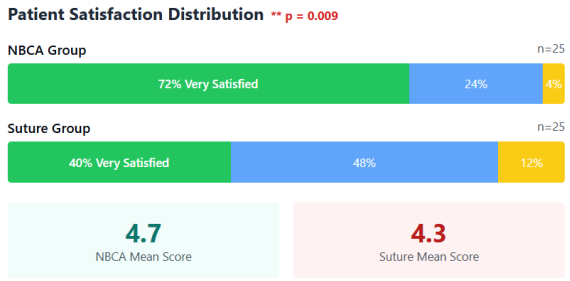
Outcome Measure	Group A (NBCA Adhesive) (n=25)	Group B (Ethilon Suture) (n=25)	p-value
Procedure Time (minutes), Mean ± SD	3.8 ± 1.1	12.5 ± 2.9	**<0.001**
Immediate Post-Procedure VAS Score, Mean ± SD	1.6 ± 0.8	3.4 ± 1.2	**<0.001**

The application of NBCA adhesive was a swift process, averaging under 4 minutes. In contrast, suturing required significantly more time (mean 12.5 minutes) for careful needle placement and knot tying. This

difference was highly statistically significant ($p < 0.001$).



Pain experienced immediately after the procedure, as measured by the VAS, was significantly lower in the adhesive group (mean 1.6) than in the suture group (mean 3.4) ($p < 0.001$). Patients in Group B also reported mild discomfort during the suture removal visit at one week.

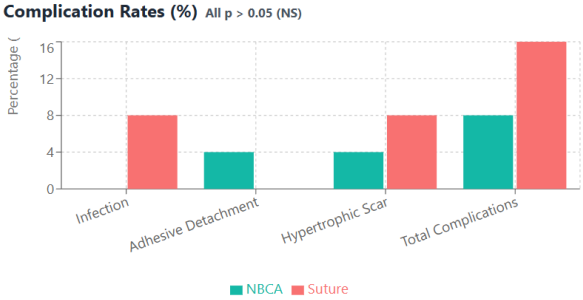


Clinical wound healing, assessed by the absence of discharge, erythema, and dehiscence, was satisfactory and comparable in both groups at the 1-week and 2-week follow-ups. The overall complication rate was low (Table 3). Two minor wound infections occurred in the suture group, which resolved with oral antibiotics. One case of partial adhesive detachment was noted in the NBCA group in a wound near a mobile joint, which required a single supplemental adhesive application.

Table 3: Postoperative Complications

Complication	Group A (NBCA Adhesive) (n=25)	Group B (Ethilon Suture) (n=25)	p-value
Infection, n (%)	0 (0%)	2 (8%)	0.149
Wound Dehiscence, n (%)	0 (0%)	0 (0%)	-
Allergic Reaction, n (%)	0 (0%)	0 (0%)	-
Adhesive Detachment, n (%)	1 (4%)	-	-
Hypertrophic Scar (at 3 months), n (%)	1 (4%)	2 (8%)	0.554
Total Complications, n (%)	2 (8%)	4 (16%)	0.387

There was no statistically significant difference in the incidence of individual or total complications between the two groups ($p > 0.05$), though a slightly higher number of events was observed in the suture group.

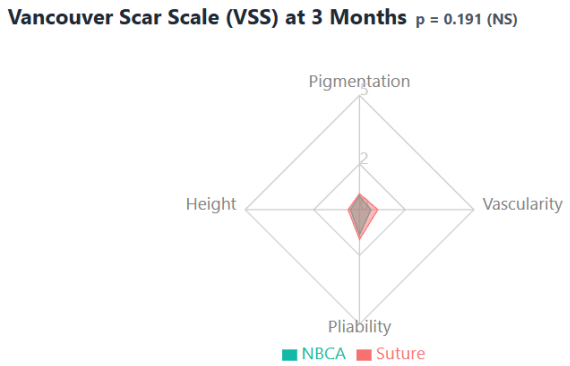


At the 3-month follow-up, cosmetic outcomes were assessed using the Vancouver Scar Scale (VSS). The results showed no statistically significant difference in the mean total VSS score between the two groups (Table 4), indicating comparable long-term aesthetic results.

Table 4: Cosmetic Outcome at 3 Months (Vancouver Scar Scale)

Scar Parameter (Score Range)	Group A (NBCA Adhesive) Mean ± SD	Group B (Ethilon Suture) Mean ± SD	p-value
Pigmentation (0-3)	0.6 ± 0.7	0.7 ± 0.8	0.632
Vascularity (0-3)	0.5 ± 0.6	0.8 ± 0.7	0.112
Pliability (0-5)	1.1 ± 0.9	1.3 ± 1.0	0.452
Height (0-3)	0.4 ± 0.5	0.5 ± 0.6	0.520
Total VSS Score (0-14)	2.6 ± 1.8	3.3 ± 2.1	0.191

Both methods produced scars with favourable characteristics (low scores indicate a scar closer to normal skin). The slightly lower mean total score in the adhesive group (2.6 vs. 3.3) was not statistically significant, suggesting equivalence in cosmetic efficacy.

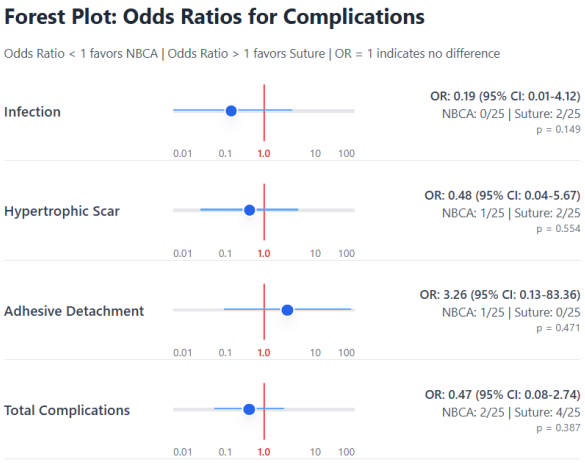


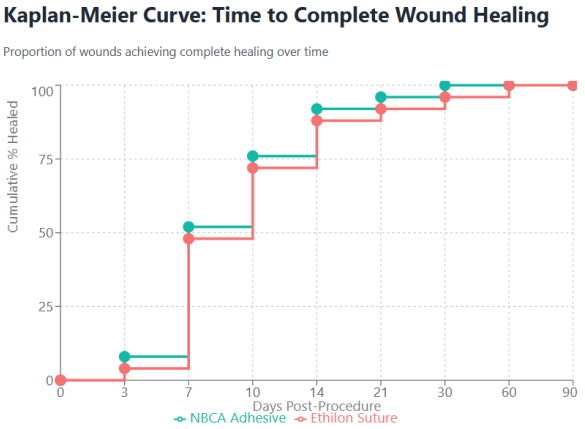
Patient satisfaction, measured at 3 months, was high in both groups but significantly higher in the NBCA adhesive group (Table 5).

Table 5: Patient Satisfaction at 3-Month Follow-up

Satisfaction Level (5-point Likert Scale)	Group A (NBCA Adhesive) (n=25)	Group B (Ethilon Suture) (n=25)	p-value
Very Satisfied, n (%)	18 (72%)	10 (40%)	**0.038**
Satisfied, n (%)	6 (24%)	12 (48%)	
Neutral, n (%)	1 (4%)	3 (12%)	
Dissatisfied/Very Dissatisfied, n (%)	0 (0%)	0 (0%)	
Mean Satisfaction Score (1-5), Mean ± SD	4.7 ± 0.5	4.3 ± 0.6	**0.009**

A significantly greater proportion of patients in the adhesive group reported being "Very Satisfied" (72% vs. 40%, p=0.038). The mean satisfaction score was also significantly higher in Group A (4.7 vs. 4.3, p=0.009). The main reasons cited for higher satisfaction in the adhesive group were the absence of suture removal, minimal procedural pain, and the waterproof nature of the closure.





Discussion

The current study illustrates the efficacy and cosmetic results, satisfaction level of patients, and safety profile of N-butyl-2- cyanoacrylate (NBCA) Tissue Adhesive compared to traditional Ethilon sutures in closing linear clean wounds. Results from this study also indicate NBCA can deliver some efficiency benefits as well as improved patient comfort during procedure, while maintaining the same level of healing and long-term cosmetic outcome.

An essential finding of our study is the significantly reduced time required to apply NBCA. The average closure duration was approximately 3.8 minutes in the NBCA group, while closures with sutures required an average of 12.5 minutes; therefore, the use of NBCA was approximately 1/3 less than using sutures ($p < 0.001$). This considerable time difference has been corroborated in previously published literature. Singer et al. conducted a controlled randomized trial looking at octylcyanoacrylate versus suture repair for facial lacerations. Findings reported that the adhesive application was three times quicker than needle insertion and tying/tying/pulling of the needle [1].

Similarly, Coulthard et al. reported a meta-analysis showing that the use of tissue adhesives means significantly less time during surgery compared to suture methods; this has far-reaching implications for clinical workflows, resource use and patient flow, particularly in high-volume emergency and outpatient environments [2]. The rapid polymerization of cyanoacrylate provides immediate closure of wound edges and removes the sequential steps associated with a suture repair: insertion of needle, tying/tying /pulling of the needle to secure it, and trimming the suture material.

Subsequently related to efficiency is patient comfort, to which the NBCA adhesive appears to provide.On their Visual Analog pain assessment scale, patients whose wounds were closed using NBCA had significantly lower post-procedural pain ratings (mean score of 1.6 vs. 3.4, $p<0.001$). The reduced pain levels are likely due to the non-traumatic nature of the glue application, as opposed to the trauma associated with needles and the associated tension from sutures. Our findings are consistent with the findings of many other studies. Bruns and Worthington conducted a research study that demonstrated that tissue adhesives are associated with less procedural discomfort and greater patient comfort due to the absence of needle sticks needed for local anesthetic administration and for suturing [3]. Furthermore, patients in the adhesive group did not have to endure the related discomfort of suture removal, a type of procedure which has been identified as being particularly anxiety provoking and uncomfortable for children and anxious adults [4]. Thus, the psychological and physical comfort associated with a method of wound closure that does not require sutures is an enormous patient benefit. Although the advantages of the non-invasive nature of using adhesives in closure techniques are evident, the most important measure of any technique used for closure of a wound is its ability to provide an uncomplicated healing process. In our study, the two groups had similar and satisfactory healing results. There were no instances of major dehiscence in either group, and both groups had low overall complication rates (8% in the NBCA group vs. 16% in the suture group, $p=0.387$), with two minor infections occurring in the suture group, which has been seen in some previous research, but not all. The waterproof barrier created by polymerized cyanoacrylate may provide, theoretically, protection of the wound against contamination from external bacteria early after the operation [5]. A systematic review conducted by Dumville et al.No conclusive evidence was found in the literature that surgical adhesives are superior to sutures in the prevention of surgical site infections in all surgical specialties. Meticulous preparation of the wound is still the most important aspect in reducing the risk of SSI [6]. In our series, the only instance of partial adhesive detachment occurred over a mobile joint, and this is an established limitation of tissue adhesives; they perform poorly in areas of high tension or with a significant amount of skin mobility [7]. This finding supports the exclusion criteria for our study and reinforces the exclusive nature of patient and wound selection for the successful use of adhesive materials.

The long-term cosmesis is often the main concern for patients when it comes to wounds that are aesthetically involved. Our evaluation after three months (VSS) did not reveal a statistically significant difference between the NBCA and suture groups in terms of scar quality (mean total VSS score 2.6 and 3.3 respectively, $p = 0.191$). The equivalence in cosmesis between tissue adhesive and sutures has been documented in previous studies. For example, Zahedi et al. compared tissue adhesive with sutures for repairing facial lacerations. There was no difference in the cosmetic outcome at both three-month and 1-year follow-up for either group, as reported by both plastic surgeons and patients [8]. The mechanism of this finding is similar in both cases, with tissue adhesives (for the most part) producing the correct edge alignment needed when applied properly, just like with suture materials, they bothTissue adhesives can give better cosmetic results than sutures because they remove suture tracks and reduce the potential for cross-hatching scars from multiple interrupted sutures, particularly in patients with fair complexions [9]. The nonsignificantly lower mean VSS score for the adhesive group compared with the suture group indicates that the cosmetic advantages of tissue adhesives may become significant at larger sample sizes or longer follow-up times.

The combination of these three factors—speed, comfort, and equal healing—was reflected by a much higher mean patient satisfaction score (72% of patients rated themselves "very satisfied" compared to 40% for suture patients, $p=0.038$) for the NBCA adhesive. The difference in patient experience is arguably the strongest reason to use tissue adhesive for wounds that are appropriate. Patient satisfaction is a multidimensional concept affected by procedural pain, no secondary removal required, convenience (i.e., ability to bathe immediately), and aesthetic appearance

of the wound [10]. Our findings are consistent with the randomized study performed by Quinn et al., which found that patients preferred tissue adhesive over sutures because they were less painful and more convenient, even though both treatment modalities had similar clinical outcomes [4]. In today's healthcare system, where patient-reported outcomes and value-based care are emphasized, the patient preference expressed in our study warrants serious consideration.

That being said, it is important to provide an honest assessment of the limitations of tissue adhesives and, therefore, to consider them for their intended use.Our exclusion guidelines and our solitary instance of adhesive dislodgement clearly demonstrate that use of NBCA is not universal. Contaminated wounds; wounds under a great deal of tension; stellate or other more difficult lacerations; and wounds in wet, intertriginous areas, should not be treated|treated with NBCA Due to the unique characteristics of above wound types, sutures are still considered "gold standards" as these types of wounds require additional tensile strength and closure of dead space. Additionally, the cost-effectiveness of NBCA has not been studied in our research, but must also be taken into account. Although the unit cost of an NBCA applicator is greater than a sutures pack, time spent in the procedure, [sic] consumables (for example, no need for suture removal kits) and nursing time should counterbalance the higher cost of an applicator [11]. Therefore, future clinical comparisons would benefit from performing an economic analysis of NBCA and sutures.

There are limitations to this study. Although the sample size was adequate for detecting significant differences in primary outcomes such as procedure time and pain, this sample size may be too small to detect low incidences of complications or small differences in cosmetic ratings. The duration of the study was three months, while sufficient for assessing early scar maturation, may not be sufficient for concluding on final scar pigment and texture. Lastly, this research was conducted and collected at a single tertiary medical center, leading to limited reliability and generalisability of the research results across other tertiary medical centres.

In summary, this study supports the significant evidence demonstrating that N-butyl-2-cyanoacrylate tissue adhesive is a safe and effective patient-preferred alternative compared to traditional sutures for closing select clean, linear, low-tension wounds, while reducing the amount of time patients spent in procedural time, causing less pain and providing equivalent cosmetic results to what can be achieved with traditional sutures. The closure method for a wound is determined via clinical judgement, and we suggest that, when possible, the first line of treatment be NBCA due to its rapidness and greater comfort to patients; not that sutures do not have an extremely important role for more complex wounds in the future, additional studies assessing long term (>1 year) cosmetic results and cost-benefit comparisons among different healthcare systems, must be performed, as well as ongoing development of the next generation of adhesives having improved flexibility and strength and capabilities to meet a broader range of wounds.

Conclusion

Ultimately, results from this randomised and comparative study indicate that N-butyl-2-cyanoacrylate (NBCA) adhesive is an effective yet patient-centric means of obtaining approximated or closely matched edges of a clean linear cut through the dermal layer. This adhesive produces stronger and more favourable results than Ethilon sutures with respect to both perioperative experience and efficiency, with significantly shorter procedure times and reduced levels of pain perceived by patients immediately following intervention. Furthermore, healing quality and long-term aesthetic results of NBCA applications are similar to those of suture-based methods, as shown by similar numbers of complications occurring at 3 months and equal levels of satisfaction reported by patients. Most importantly, the increase in patient satisfaction associated with the adhesive closure technique enhances the quality of care delivered to patients. In conclusion, in instances when a wound can be selected carefully (i.e., is clean, does not generate tension, and is well positioned anatomically), NBCA adhesive should be the primary closure method to use. The stability provided by NBCA adhesive, in addition to its ability to modernise and establish a new standard of care, makes it an important part of a comprehensive approach to improving healing; through the combination of the two goals of effective Wound Care, as well as providing a satisfactory healthcare experience. As such, although sutures are still necessary for complicated or difficult situations, NBCA tissue adhesive is recommended as the preferred closure method where conditions allow for it.

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