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The efficacy of cyanoacrylate tissue adhesive versus subcuticular suture utilized for wound closure in maxillofacial region: A prospective comparative study

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Abstract
Background: Wound closure has evolved with advancements in sutures and materials, yet no single method is ideal for all situations. Surgeons seek the fastest, easiest, and most cosmetically pleasing techniques, with cyanoacrylate tissue adhesive offering benefits like improved cosmesis, versatility, moisture resistance, better patient compliance, and ease of application. Evaluating newer methods against traditional sutures remains crucial. Study objective: To compare and evaluate cyanoacrylate tissue adhesive and subcuticular suture techniques for maxillofacial incision closure in terms of speed, early wound complications, patient cosmetic satisfaction, and scar cosmesis.
Method: In a comparative prospective randomized clinical study at Al-Imamain Al-Kadhemain Medical City, patients undergoing maxillofacial surgery were divided into two groups for skin incision closure using tissue adhesive or subcuticular sutures. Postoperative wound healing was assessed at 5 to 10 days, and scar evaluation at 4 months by a blinded plastic surgeon using the Scar Cosmesis Assessment and Rating Scale. Patients' scar satisfaction was measured with a visual analog scale, and data analysis was performed using SPSS version 25.0.
Results: 32 patients, 40 incisions, 20 per group. The tissue adhesive group had a substantially faster mean closure time (106.25±25.43 seconds) compared to the subcuticular suture group (188.40±44.11 seconds) ($p<0.05$). Early wound problems, patient scar satisfaction, and scar cosmesis at 4 months were not significantly different between the two groups.
Conclusion: Our study reveals that tissue adhesive is a dependable, effective, and safe skin closure for maxillofacial surgeries in the face and neck. It also takes less time to apply and seal the skin and offers good aesthetic outcomes. These findings need to be confirmed by bigger patient investigations.

Keywords: Efficacy, cyanoacrylate, tissue, adhesive, subcuticular, suture utilized, wound, closure, maxillofacial region

Introduction
The surgical closure of wounds has been a cornerstone of medical practice since ancient times. Effective wound closure is crucial for ensuring not only the functional integrity of the skin but also achieving an aesthetically pleasing scar, which is often considered a "surgeon's signature" [1]. Over the centuries, techniques for wound closure have evolved significantly, from the rudimentary use of natural adhesives and animal parts to sophisticated methods utilizing advanced materials like synthetic sutures and tissue adhesives [2]. The primary goal of any wound closure technique is to approximate tissue edges in a manner that promotes optimal healing and minimizes scar formation. Traditional suturing has been the mainstay of wound closure for thousands of years. However, with advancements in medical technology, alternative methods such as skin staples, adhesive tapes, and tissue adhesives have emerged [3]. Among these, cyanoacrylate tissue adhesives have gained substantial attention in recent decades due to their multifunctional properties. These adhesives not only facilitate wound closure but also act as hemostatic agents, antimicrobial barriers, and fixation tools in situations where traditional sutures or mechanical devices are impractical [4]. Understanding the wound healing process is fundamental to evaluating the efficacy of different closure techniques. Wound healing involves four distinct phases: hemostasis, inflammation, proliferation, and remodeling [5]. Each phase plays a critical role in tissue repair and scar formation.

Hemostasis and inflammation set the stage for wound cleaning and preparation, while proliferation and remodeling ensure tissue restoration and strength enhancement over time [6]. The choice of wound closure method depends on various factors, including the wound's location, size, and tension. Sutures remain a reliable choice, providing controlled and precise tissue approximation. However, the advent of tissue adhesives like cyanoacrylate has introduced new possibilities for faster application, reduced infection risk, and better cosmetic outcomes [7]. Cyanoacrylate adhesives polymerize quickly upon contact with moisture, forming a strong bond that holds the wound edges together. This property, coupled with their bacteriostatic effect, makes them an attractive option for many surgical applications [8]. Sutures are widely used for wound closure, providing reliable and controllable approximation of tissue edges. Various suture materials and techniques are available, tailored to different types of wounds and surgical needs [9]. The ideal suture should be easy to handle, cause minimal tissue reaction, and provide sufficient strength to maintain tissue approximation until healing is complete [10]. Cyanoacrylate adhesives are prominent in modern wound closure. They offer benefits like faster application, reduced infection rates, and improved cosmetic results. However, their efficacy varies based on factors like wound length and location [11]. Cyanoacrylate tissue adhesives have been used effectively in various surgical specialties, demonstrating comparable results to traditional sutures with some added advantages [12]. The success of wound closure techniques is often measured by the cosmetic outcome of the scar. Various tools and scales, such as the Visual Analog Scale (VAS) and the Scar Cosmesis Assessment and Rating (SCAR) scale, are employed to assess scar quality from both clinical and patient perspectives [13]. These evaluations consider factors like scar visibility, erythema, dyspigmentation, and patient satisfaction, providing a comprehensive view of the healing process and the effectiveness of the closure method used [14]. This study aims to compare the efficacy of cyanoacrylate tissue adhesive and subcuticular sutures in the closure of maxillofacial incisions. The primary endpoints include the time required for closure, incidence of early wound complications, patient satisfaction with the cosmetic outcome, and overall scar quality as assessed by both clinicians and patients.

Method

This clinical study was conducted as a prospective comparative randomized clinical trial at the Maxillofacial Surgical Department at Al-Imamain Al-Kadhemain Medical City in Baghdad. Patients were randomly assigned to either the subcuticular suture group (Group A) or the tissue adhesive group (Group B) using a block randomization system. A total of 32 patients (19 males and 13 females) with 40 incisions were included in the study, which ran from December 2021 to August 2023. Inclusion criteria included patients with clean surgical incisions on the neck and face, incisions less than 6 cm in length, and patients older than 18 years who agreed to participate and return for post-operative evaluation. Exclusion criteria included patients with peripheral vascular disease, diabetes mellitus, allergies to cyanoacrylate compounds or formaldehyde, bleeding disorders, history of hypertrophic scar formation, radiotherapy or chemotherapy recipients, facial incisions communicating with the oral cavity, wounds for malignant pathologies, and unwillingness to follow up. Materials and Instruments Materials used included GluSeal tissue adhesive, Glu applicator, 4/0 or 3/0 Vicryl absorbable sutures, 4/0 Nylon sutures, normal saline solution, Povidone iodine 10%, bandages, surgical plaster, surgical ruler, surgical blade No.15, suture cutting scissors, surgical scalpel handle No.3, needle holder, tissue forceps, and a cooling box for tissue adhesive transportation. Procedure of Closure/Application All procedures were performed under aseptic conditions in the same operating theater. For Group A, subcuticular suturing was done with 4.0 monofilament synthetic nylon. The suture was placed through the dermal-epidermal junction and tied off, with a dressing applied afterward. For Group B, after achieving hemostasis and drying the wound, the tissue adhesive was applied in thin layers using an applicator, ensuring proper alignment of wound edges either manually or with forceps. The adhesive was polymerized before applying a protective gauze bandage. Both procedures were performed by the same operator.

Study Variables

- Time of Closure/Application: The time taken for wound closure was recorded using a stopwatch from the start of epidermal closure to the completion of the last knot or adhesive layer. The time for placing subcutaneous sutures was not included.
- Early Complications: Patients were evaluated on days 5 and 10 post-operation for wound infection, acute inflammatory reaction (erythema), and wound dehiscence .
- Scar Cosmesis Outcome: At 4 months' post-operation, the cosmetic outcomes were evaluated using the Scar Cosmesis Assessment and Rating (SCAR) scale by a plastic surgeon blinded to the closure technique. Patient satisfaction was assessed using a visual analog scale (VAS) rating their aesthetic satisfaction from 0 (very unsatisfied) to 10 (extremely satisfied) .

Statistical Analysis

Data were analyzed using SPSS version 25.0 software. Descriptive statistics such as frequency, percentage, mean, standard deviation, and median were used. The chi-square test was employed to test the association between qualitative variables, and the independent t-test was used to compare means between two quantitative variables. For non-normally distributed data, the Mann-Whitney test was utilized. A p-value of ≤ 0.05 was considered significant.

18 years old female with history of swelling in neck, excisional biopsy under general anesthesia was taken as shown in (Figure 2-9)

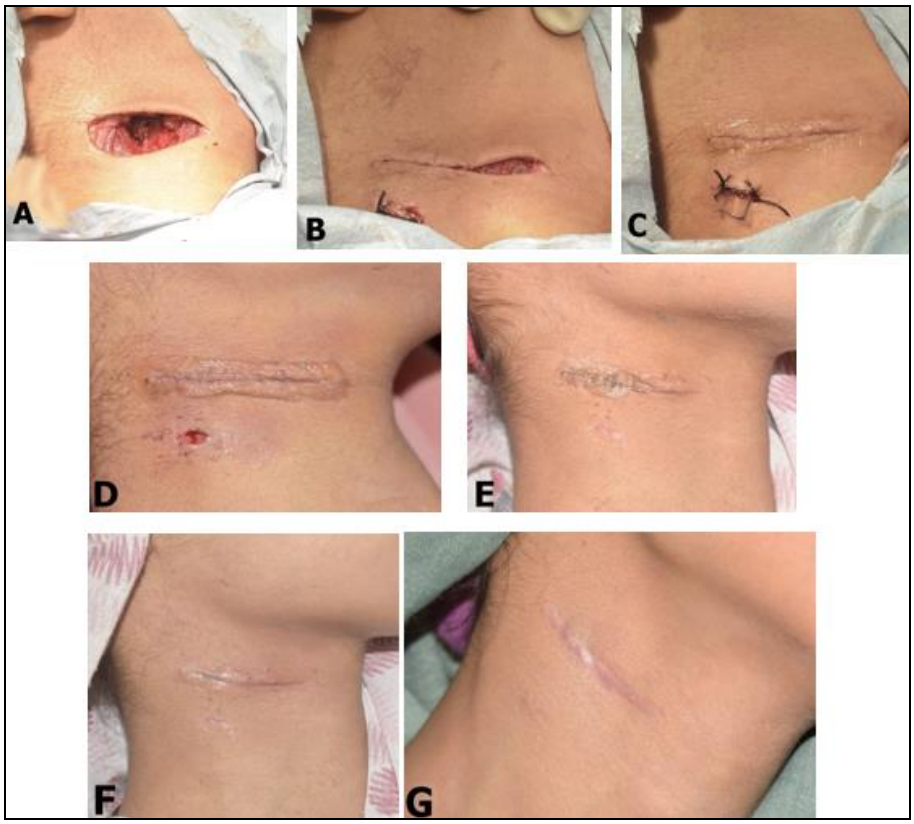

Fig 1: Pictures through A to G show the process of adhesive application. A) Defect after completion of surgery. B) Subcutaneous tissue closure, on the left side deep dermal suture was placed. C) After adhesive application and complete polymerization. D) 2nd post-operative day follow up. E) 10th post op. follows up, part of the adhesive already begun to shed. F) After adhesive removal. G) Post op. 4 months follow up.

Results

The 40-incisions were distributed as follows: In group B were 2 (10%) cheek, 1 (5%) forehead, 3 (15%) infraorbital, 3 (15%) lateral eyebrow, 1(5%) midline neck, 3 (15%) parotid region, 5 (25%) submandibular, 2 (10%) submental. In group A, 2 (10%) cheek, 2 (10%) forehead, 3 (15%) infraorbital, 2 (10%) lateral eyebrow, 3 (15%) parotid region, 6 (30%) submandibular, 2 (10%) submental. The site of incisions in total was, (10%) cheek, (7.5%) forehead, (15%) infra-orbital, (12.5%) lateral eyebrow, (2.5%) midline neck, (15%) parotid region, (27.5%) submandibular and (10%) submental, as shown in (Figure 2).

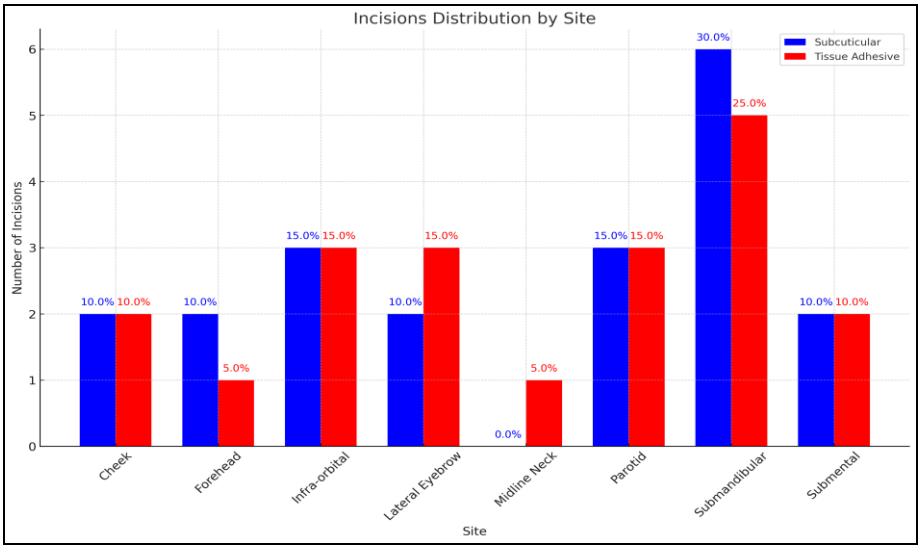

Fig 2: Incisions distribution

The complications of wounds were monitored at 5 and 10 days' post-operation: Infection No patient in either group exhibited signs of infection (purulent discharge) from any wound at both 5 and 10 days after surgery, as shown in Table 1. Acute Inflammatory Reaction (Erythema): At 5 days' post-operation, erythema was observed in 2 patients in Group A only. There was no significant association between the inflammatory reaction and the method used for closing the wound (p-value 0.48), as presented in Table 1. At 10 days' post-operation, erythema was observed in 1 patient in Group B only, with no significant difference between the inflammatory reaction and the method used for closing the wound (p-value 1.0), as shown in Table 1.

Table 1: Infection and acute inflammatory reaction (Erythema) complication of wound after 5-and 10-Days Post Operation

			Group		Total	P-Value
			Subcuticular	Adhesive		
5 days after operation	Wound Infection	No	20	20	40	/
			100.0%	100.0%	100.0%	
	Acute Inflammatory reaction	No	18	20	38	0.48
			90.0%	100.0%	95%	
		Yes	2	0	2	
			10.0%	0.0%	5%	
10 days after operation	Wound Infection	No	20	20	40	/
			100.0%	100.0%	100.0%	
	Acute Inflammatory reaction	No	20	19	39	1.00

Wound dehiscence: After 5 days follow up dehiscence was observed in 2(10%) patients in group A only, p-value 0.48. After 10 days follow up wound dehiscence was observed in 1(5%) of patient in group B only, p-value 1.0. as presented in (Table 2). There was no statistically significant difference in the occurrence of wound dehiscence complications between the two groups.

Table 2: Wound dehiscence complication of wound after 5-and 10-Days Post Operation

		Group			Total	P-Value
			Subcuticular	Adhesive		
5 days after operation	Wound Dehiscence	No	18	20	38	0.48
			90.0%	100.0%	95.0%	
		Yes	2	0	2	
			10.0%	0.0%	5.0%	
10 days after operation	Wound Dehiscence	No	20	19	39	1.00
			100.0%	95.0%	97.5%	
		Yes	0	1	1	
			0.0%	5.0%	2.5%	

Regarding scar evaluation, six clinical items (scar spread, erythema, dyspigmentation, track mark or suture mark, hypertrophy/atrophy, and overall impression) and two patient items (itch or pain from the scar in the past 24 hours) were assessed using the Scar Cosmesis Assessment and Rating Scale. Patients were evaluated four months post-operation.

1. **Scar Spread**
- In Group A, 6 patients (30%) showed near invisible scars, 8 patients (40%) showed pencil-thin lines, 2 patients (10%) showed mild spread noticeable on close inspection, and 4 patients (20%) showed moderate spread or obvious scarring.
- In Group B, 7 patients (35%) showed near invisible scars, 6 patients (30%) showed pencil-thin lines, 1 patient (5%) showed mild spread noticeable on close inspection, and 6 patients (30%) showed moderate spread or obvious scarring.
- P-value: 0.78, indicating no statistically significant difference in cosmetic outcomes regarding scar spread between the two groups. Severe spread (score 4) was not observed in any patient, as shown in Figure 3-5 and Table 3-5.

2. **Erythema**
- In Group A, 14 patients (70%) showed no erythema, while 6 patients (30%) showed light pink/some telangiectasia.
- In Group B, 16 patients (80%) showed no erythema, and 4 patients (20%) showed light pink/some telangiectasia.
- P-value: 0.71, indicating no statistically significant difference in cosmetic outcomes regarding erythema between the two groups. Red (score 2) and deep red or purple (score 3) erythema were not observed in any patient, as shown in Figure 3-6 and Table 3-5.

3. **Dyspigmentation**
- In Group A, 10 patients (50%) showed no dyspigmentation, while 10 patients (50%) showed dyspigmentation.
- In Group B, 14 patients (70%) showed no dyspigmentation, and 6 patients (30%) showed dyspigmentation.
- P-value: 0.33, indicating no statistically significant difference in cosmetic outcomes regarding dyspigmentation between the two groups, as shown in Figure 3-7 and Table 3-5.

4. **Track Mark**
- Both groups showed 100% absence of track marks.

5. **Hypertrophy/Atrophy**
- In Group A, 13 patients (65%) showed no hypertrophy or atrophy, 6 patients (30%) showed mild hypertrophy or atrophy (barely visible), and 1 patient (5%) showed moderate hypertrophy or atrophy (clearly visible).
- In Group B, 14 patients (70%) showed no hypertrophy or atrophy, 5 patients (25%) showed mild hypertrophy or atrophy (barely visible), and 1 patient (5%) showed moderate hypertrophy or atrophy (clearly visible).
- P-value: 0.78, indicating no statistically significant difference in cosmetic outcomes regarding hypertrophy/atrophy between the two groups. Severe hypertrophy or atrophy (score 3) was not observed in any patient, as shown in Figure 3-8 and Table 3-5.

6. **Overall Impression**
- In Group A, 17 patients (85%) showed a desirable scar, and 3 patients (15%) showed an undesirable scar.
- In Group B, 17 patients (85%) showed a desirable scar, and 3 patients (15%) showed an undesirable scar.
- P-Value: 1.00, indicating no statistically significant difference in cosmetic outcomes regarding overall

impression between the two groups, as shown in Figure 3-9 and Table 3-5.

7. **Itch or Pain from the Scar in the Past 24 Hours**

- Both groups showed 100% absence of itch or pain.

These results highlight that there were no statistically significant differences in the cosmetic outcomes between the two groups across all evaluated parameters.

Table 3-5: Characteristic of scar in both groups

		Group		Total	P-Value
		Subcuticular	Adhesive		
Spread	None/near invisible	6	7	13	0.78
		30.0%	35.0%	32.5%	
	Pencil-thin line	8	6	14	
		40.0%	30.0%	35.0%	
	Mild spread, noticeable on close inspection	2	1	3	
		10.0%	5.0%	7.5%	
	Moderate spread, obvious scarring	4	6	10	
		20.0%	30.0%	25.0%	
Erythema	None	14	16	30	0.71
		70.0%	80.0%	75.0%	
	Light pink, some telangiectasia may be present	6	4	10	
		30.0%	20.0%	25.0%	
Dys-Pigmentation	Absent	10	14	24	0.33
		50.0%	70.0%	60.0%	
	Present	10	6	16	
		50.0%	30.0%	40.0%	
Track mark	**Absent**	**20**	**20**	**40**	/
		100.0%	**100.0%**	**100.0%**	
Hypertrophy/atrophy	None	13	14	27	0.78
		65.0%	70.0%	67.5%	
	Mild: palpable, barely visible hypertrophy or atrophy	6	5	11	
		30.0%	25.0%	27.5%	
	Moderate: Clearly visible hypertrophy or atrophy	1	1	2	
		5.0%	5.0%	5.0%	
Overall impression	Desirable scar	17	17	34	1.00
		85.0%	85.0%	85.0%	
	Undesirable scar	3	3	6	
		15.0%	15.0%	15.0%	
Any itch from the scar in past 24h?	No	20	20	40	/
		100.0%	100.0%	100.0%	
Any pain from the scar in past 24h?	No	20	20	40	/
		100.0%	100.0%	100.0%	
Total		20	20	40	40
		100.0%	100.0%	100.0%	100.0%

The assessment of patient's scar was done using visual analogue scale after 4 months post operation. The VAS score showed that 70% of closed wounds in patients were extremely satisfied. Regarding the groups, 65% of closed wounds reported extremely satisfied by patients in group A, in compare to 75% in group B, p-value 0.36. Scores (unsatisfied and extremely dissatisfied) were not recorded in any group. As presented in Table 4.

Table 4: Visual analogue scale score in both groups

		Group		Total	P-Value
		Subcuticular No. of wounds	Tissue adhesive No. of wounds		
VAS Score	Average	1	0	1	0.36
		5.0%	0.0%	2.5%	
	Satisfied	6	5	11	
		30.0%	25.0%	27.5%	
	Extremely satisfied	13	15	28	
		65.0%	75.0%	70.0%	
Total		20	20	40	
		100.0%	100.0%	100.0%	

VAS, Visual analogue scale No, Number

Discussion

The present study aimed to compare the efficacy of cyanoacrylate tissue adhesive versus subcuticular sutures for wound closure in the maxillofacial region, focusing on various parameters including patient age, incision length, site of incision, time of closure, early complications, and cosmetic outcomes. Age and Gender Distribution The study included patients aged 18-60 years, with the mean ages being 34.1 years in Group B (tissue adhesive) and 34.2 years in Group A (subcuticular suture), comparable to the mean age reported by Soni *et al*. [14]. Patients below 17 were excluded due to the higher elastin content in younger skin causing more tension at the skin's edges, leading to poorer scars [15]. The gender distribution was 59% males and 41% females, which aligns with the range reported by Sahu *et al*. [16]. Incision Length Both groups had incision lengths of 6 cm or less. In Group A, longer incisions were avoided due to difficulties in suture removal for this technique [17], while in Group B, longer incisions were prone to brittleness and failure when tissue adhesive was applied [18]. The mean incision lengths were 33.75 mm in Group A and 36.55 mm in Group B, Site of Incision The distribution of wounds was 16 in the neck region, 6 in the parotid/preauricular region, and 18 in the peri-orbital/cheek region, similar to the study by Soni *et al*. [14], which included 13 neck wounds, 7 parotid region wounds, and 20 peri-orbital region wounds among 29 patients. Time of Closure/Application The study findings indicate that tissue adhesive significantly reduces wound closure time (106.25±25.43 seconds) compared to subcuticular sutures (188.40±44.11 seconds), with a p-value of < 0.001, with mean times of 1 min 18 seconds for the adhesive group and 3 min 42 seconds for the suture group. Tissue adhesive application also increases efficiency when multiple incisions are closed in the same patient, as the adhesive can be applied immediately to the next incision after the first one is finished. Early Complications Early complications were assessed at 5 and 10 days' post-operation for wound infection, wound dehiscence, and erythema. No patient showed signs of infection in either group at any follow-up point, likely due to clean surgical wounds and the exclusion of patients with systemic diseases affecting the immune system. These results are in agreement with Soni *et al*., who reported no wound infections, three infections in the suture group [14, 19]. Wound dehiscence was observed in two cases (10%) in Group A and one case (5%) in Group B, with no significant difference between the groups (p-value 0.48 at 5 days, 1.0 at 10 days). These findings are consistent with other studies, who reported similar incidences of wound dehiscence [20, 21]. Erythema was seen in two patients in Group A and one patient in Group B, and it responded well to anti-inflammatory treatment. Cosmetic Evaluation Cosmetic outcomes were assessed using the SCAR scale and Visual Analog Scale (VAS) four months' post-operation. The SCAR scale revealed no significant differences between the groups regarding scar spread, erythema, dyspigmentation, hypertrophy/atrophy, track marks, and overall impression. These findings are supported by studies from Huang *et al*. and Ogawa *et al*., who examined the effects of mechanical forces and inflammation on scar formation [22, 23]. VAS results showed no significant difference in cosmetic satisfaction between the groups, with Group A scoring 8.85±0.87 and Group B scoring 8.40±1.04 (p-value 0.37). This aligns with the findings of Ong *et al*., Handschel *et al*., Nipshagen *et al*., Sniezek *et al*., and Matin, who found no significant difference between tissue adhesive and suture groups on VAS scores [24, 26].

Conclusion

Tissue adhesive could be used as another option to sutures for maxillofacial incision skin closure that is efficient, valid and much quicker in means of application. Scars cosmesis outcome in tissue adhesive was similar to the scars in subcuticular suture. Comparable to sutures, tissue adhesive can withstand the tension of incision closure without noticeable variations in wound dehiscence and infection rate.

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