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Butylcyanoacrylate tissue adhesive for columellar incision closure

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Abstract

Cosmetic outcome of the columellar incision closure in external rhinoplasty patients has been a subject of discussion. This study was conducted to assess whether tissue adhesives provide an alternative option for sutureless closure of columellar skin incisions for cases utilizing open technique rhinoplastic surgery. One hundred and one patients undergoing external rhinoplasty were randomized to either topical application of butylcyanoacrylate or polypropylene sutures for columellar skin closure. The majority of tension on the wound edges was taken up using 5-0 chromic catgut. Cosmetic outcomes were evaluated by two otolaryngologists independently using visual analogue and Hollander wound evaluation scales in a blinded manner. There was no statistically significant difference in cosmesis between the surgeons' evaluation scores for either type or repair of the columellar incision. Since the tissue adhesive forms its own protective barrier, post-operative care is simplified. Closure with adhesives eliminates the need for post-operative suture removal requiring an extra visit that should lead to more efficient use of physician and patient time. Butylcyanoacrylate performs cosmetically as well as standard suture closure of columellar skin incision used for external rhinoplasty.

Key words: Tissue Adhesives; Rhinoplasty; Evaluation Studies; Wound Healing

Introduction

External rhinoplasty has gained world-wide acceptance, as a result of excellent surgical exposure of the nasal framework.[1] The necessity for columellar incision, its subsequent closure with sutures, removal of the sutures, and the resulting columellar scar are the most frequently cited disadvantages of the technique.[2] The ideal method of columellar incision closure should be simple, rapid, inexpensive, painless, and bacteriocidal, and should also achieve optimal cosmetic results. Standard closure technique of the columellar incision is suturing with 6-0 polypropylene suture or nylon following subcutaneous closure with an absorbable suture material.

Cyanoacrylates were first synthesized in 1949 by Ardis, but their adhesive properties and potential uses in surgery were introduced by Coover *et al*. 10 years later.[3] This material polymerizes when applied to a moist tissue surface and has the ability to bond human tissues together. Histotoxicity associated with cyanoacrylate adhesives is related to the by-products of polymer degradation, length of the alkyl group of the cyanoacrylate derivative, and the rate at which degradation occurs.[4] While the shorter-chain cyanoacrylates such as methyl and ethyl cyanoacrylates (SuperGlue) have been associated with tissue toxicity due to rapid degeneration, the longer-chain derivatives, like butylcyanoacrylate have been shown to be non-toxic to tissues.[5]

The use of butylcyanoacrylate for laceration repair can yield similar or better cosmetic outcome and complication rates than the use of conventional sutures.[6] Although the efficiency of the cyanoacrylate adhesives for lacerations and surgical incisions has been studied largely, their place has never been assessed for the columellar incision repair. This study was conducted to assess whether tissue adhesives are an effective alternative for closure of columellar skin incision for patients undergoing open approach rhinoplastic surgery.

Materials and methods

One hundred and one patients, undergoing external rhinoplasty or septorhinoplasty, mostly under general anaesthesia, were eligible for inclusion in the study protocol. Patients were generally in good health, without significant systemic abnormalities. Specific exclusion criteria were multiple trauma, previously diagnosed peripheral vascular disease, insulin-dependent diabetes mellitus, blood clotting disorders, known personal or family history of keloid formation or scar hypertrophy, and known allergy to cyanoacrylate compounds or formaldehyde. The protocol of this study was reviewed and approved

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by the Institutional Review Board of the Faculty of Medicine of Inonu University. An informed consent was obtained from each patient.

Patients were randomly allocated by coin toss to utilization of either topical application of butylcyanoacrylate or five interrupted polypropylene 6-0 sutures for columellar skin closure. Sixty-seven patients (38 males, 29 females) were randomized to the suture group, and 34 patients (18 males, 16 females) were randomized to the adhesive group. Open technique rhinoplasty was started with a 'V' incision made at the junction of the lower one-third and upper two-thirds of the columella. This columellar incision was carried laterally around to, or just posterior to, the caudal margin of the medial crura, and from there extended in each vestibule as an infracartilaginous incision. For closure of the columellar incision at the end of the operation, a subcutaneous 5-0 chromic catgut suture was initially applied in addition to several sutures to the paracolumellar skin with 5-0 chromic catgut to aid in apposition of the wound edge margins, relieve tension and ensure adequate skin edge eversion. Haemostasis was obtained by using bipolar electrocautery intraoperatively and by applying pressure just before the dispensing of the tissue adhesive or standard suture application. Polypropylene 6-0 was used as a conventional method of columellar skin closure.

If patients were randomized to the butylcyanoacrylate group, the product used was LiquiBand (MedLogic Global Ltd, Plymouth, Devon, UK). It is dispensed in a 0.5 ml plastic vial with a tapered cone applicator tip. A sterile 25-gauge needle was attached before each columellar incision closure to provide precise placement of the tissue adhesive. The bevel of the needle was held parallel to the skin surface and positioned approximately 0.5 cm above the wound. The wound edges were approximated manually, and the adhesive was dropped onto the opposed skin edges. Care was taken to prevent infiltration of butylcyanoacrylate into the columellar skin incision. The adhesive was applied on and around the incision, extending 3 mm beyond the incision for adequate bonding. Manual approximation of the wound was maintained for 30 sec to allow complete polymerization. The time required for columellar skin closure following subcutaneous suturing was recorded for both groups and included the time needed to perform skin closure using one of the two alternative methods (skin sutures or butylcyanoacrylate). This time did not include application of the subcutaneous sutures because this was an initial and identical part of both methods of closure.

The three-month basal view photographs of each subject were given to two otolaryngologic surgeons who were blinded to the method of repair of the columellar incision. Each surgeon was asked to rate the cosmetic results of the columellar incision site using a visual analogue scale.[7] The wound cosmesis visual analogue scale was based on a 100-mm line, with the best possible scar positioned at point 100 on the right side of the line and the worst possible scar positioned at point 0 on the left side of the line. The score was determined by measuring the distance in millimeters from point 0 to the recorded mark for each patient.

Additionally, the same surgeons rated the cosmetic appearance of the columellar incision using a previously validated six-point Hollander wound evaluation scale.[8] This scale addresses six clinical variables: absence of step-off, contour irregularities, wound-margin seaparation greater than 2 mm, edge inversion, excessive distortion, and overall cosmetic appearance. Each of these variables received a score of either 0 (the worst score) or 1 (the best score), which were then added together to give the total cosmetic score. Columellar incisions receiving a score of 6 were considered to have an optimal cosmetic appearance. A score of 5 or less was regarded as being a suboptimal cosmetic result. Wound evaluation scores of both the adhesive and suture groups were then compared to determine if any significant difference was evident between wounds closed with sutures versus wounds closed with tissue adhesive.

Patients in the suture group were instructed to keep the columellar wounds well lubricated with an antibiotic ointment and left open. These patients returned for suture removal four days after surgery. All patients were examined once every week in the first post-operative month, and once a month for the second and third months. Columellar wounds were examined for infection, inflammation, dehiscence and scarring in addition to cosmetic and functional nasal evaluations.

Statistics of the results were computed using Minitab 10 software.[9] Statistical analysis with Student's *t*-test was performed on the differences in treatment time between the wounds closed with sutures and those closed with butylcyanoacrylate. For the primary outcome the results of cosmesis visual analogue scale for both treatment groups were compared using the Student's *t*-test (two-tailed with equal variances) for independent samples. Wound evaluation scale results were compared with chi-square analysis. The interclass correlation coefficient was used to measure agreement between the rating surgeons.

Results

The adhesive and suture groups were comparable for age (mean, 26 and 24; age range, 17–34 years and 16–32 years, respectively). During the first post-operative week, stitch abscess occurred in three patients in the suture group despite adequate intraoperative and post-operative care and administration of ampicillin-sulbactam for seven days. Evacuation of the abscess by means of a minute stab incision with a sharp needle tip caused suboptimal wound healing in two of these three patients. There were no instances of dehiscence, haematoma or seroma in either group of patients. All patients exhibited good approximation of the skin edges. Complete sloughing of the butylcyanoa-

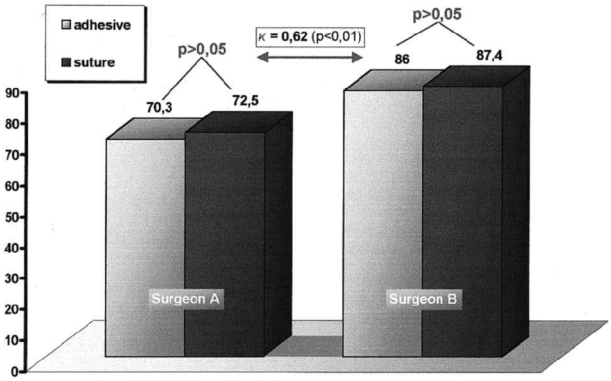

FIG. 1
Visual analogue scale results of the rating surgeons.

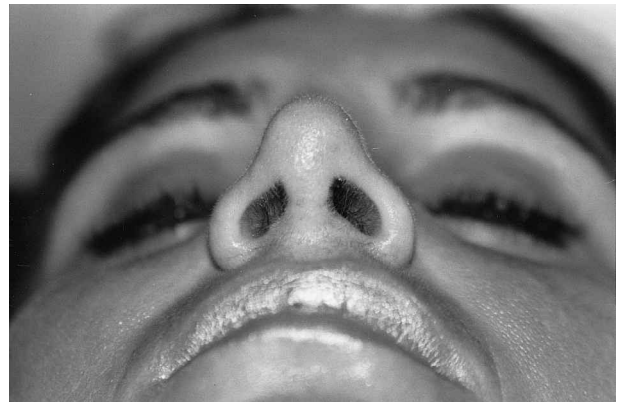

FIG. 2
A basal view photograph taken at three months post-operatively of the columellar skin incision closed by using butylcyanoacrylate.

crylate polymer was observed at seven to 10 days after surgery.

The mean time for suturing was 155 ± 25 sec, whereas the mean time for the columellar incision closure using butylcyanoacrylate was 55 ± 10 sec. The time difference between these two methods was highly significant ($p<0.01$). The cost of closure for each of patient in the adhesive and suture groups were US$2 and US$7, respectively.

Cosmetic outcome was evaluated by two independent otolaryngologists who were blinded as to the method of repair used for each case. The evaluators rated photographs taken at the 3-month follow-up visit. Columellar wounds were comparable in cosmesis visual analogue scale for both surgeons (surgeon A: adhesive 70.3 ± 14.9 mm, suture 72.5 ± 16.8 mm; $p>0.05$; surgeon B: adhesive 86 ± 10.2 mm, suture 87.4 ± 9.6; $p>0.05$; Figure 1).

Optimal and suboptimal healing results deriving from Hollander wound evaluation scores were compared (Table I). There was no statistical difference between each surgeon's evaluation score for the type of repair used for the columellar incision ($p>0.05$). Pearson correlation coefficient was measured to determine the degree of interobserver agreement between the surgeons, with good correlation rate found (k:0.62, $p<0.01$) (Figure 1). Figure 2 shows a three-month basal view photograph of a patient whose columellar skin incision was closed by using butylcyanoacrylate.

Discussion

External approach rhinoplasty has increased in popularity, as it allows the surgeon to use both hands during the procedure, affords better visualization, more precise grafting, and more accurate suture fixation than is possible through an endonasal approach.[10] However, the need for a columellar incision, post-operative care of the closures made with sutures, the necessity of return of the patients and the anxiety of the suture removal are disadvantages of the open technique. Hence, cosmetic outcome of columellar incision closure in external rhinoplasty patients has been a subject of discussion. Ultimate goals of columellar incision closure are lack of infection and a cosmetically appealing, inconspicious scar. The standard method for columellar skin incision closure has been non-dissolving sutures. Application of sutures inevitably causes insertion of a foreign material through the skin that is left in place for several days. Regardless of its composition, suture materials are foreign bodies to the human tissues in which they are implanted, and, to a greater or lesser degree, will elicit a foreign body reaction. Sutures can also have other potential complications, such as sinus and granuloma formation, ischaemia and necrosis from sutures that are too tight, suture disruption, stitch abscess, stitch scars.[11] Polypropylene 6-0 was used in this study for the columellar skin closure because it is the least reactive suture material and encounters the least drag forces with tissue.[12] Percutaneous sutures may damage tissue defenses, encouraging bacterial growth to a greater degree than that encountered with tissue adhesives.[13,14] Although minute, three stitch abscesses developed in the suture group. In one study, histopathological evaluation showed that inflammatory response was increased significantly in sutured skin incisions when compared to skin incision repaired using butylcyanoacrylate on the 3rd, 7th and 14th post-operative days.[15]

The ideal tissue adhesive should be safe for topical application, easy to apply, polymerize rapidly; support the approximated skin edges and maintain skin edge eversion for optimal wound healing and acceptable cosmesis; and eliminate the need for suture removal.[16] The authors have conducted this study to demonstrate if cyanoacrylate tissue adhesive is an acceptable alternative for the commonly used polypropylene suture in the closure of the columellar skin incision. Butylcyanoacrylate has many charac-

TABLE I
OPTIMAL AND SUBOPTIMAL HEALING EVALUATIONS OF THE RATING SURGEONS

	Surgeon A		Surgeon B	
	Adhesive	Suture	Adhesive	Suture
Optimal	19	46	22	47
Suboptimal	15	21	12	20
p	>0.05		>0.05	

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teristics of the ideal tissue adhesive because it distributes evenly over tissues, polymerizes in the presence of moisture, allows sufficient time for surgical manipulation before polymerization, and provides a very strong bond.[17] Butylcyanoacrylate has been used widely with good outcomes in various otolaryngologic surgical procedures.[18] Ellis and Shaikh[5] have used butylcyanoacrylate in 178 cases for the closure of a variety of skin incisions following blepharoplasty, facelift and local facial flaps. They believe that butylcyanoacrylate is the ideal tissue adhesive for cutaneous wound closure.

The histotoxicity elicited by butylcyanoacrylate polymer has been raised as a concern in some studies. In one study, subcutaneous application of butycyanoacrylate in rabbit ears resulted in significant inflammation and some tissue necrosis.[4] These effects may also be caused by heat damage to the tissue, or incomplete polymerization when a formulation designed for surface use reacts too rapidly in the warmer and wetter subcutaneous environment. Butylcyanoacrylate appears to be safe when used for skin closure, although infiltration below the level of the skin should be avoided, to minimize contact with vascularized tissues and the risk of foreign body reaction.[4,5,17]

Wound repair using butylcyanoacrylate has been found to be an effective alternative to suturing of selected superficial facial lacerations in randomized, controlled trials.[6,19] Even the long-term (one-year) evaluations showed that wounds repaired with butylcyanoacrylate were cosmetically comparable to those for which cutaneous closure was performed using conventional suturing.[20]

In the present study, a prospective randomized clinical trial was performed to compare butylcyanoacrylate with standard suture closure of columellar incisions. The characteristics of the skin in the columellar incision, such as the anatomy, length, depth etc., were similar in both groups. Moreover, the surgical interactions in all of the patients were performed by the first author.

The primary outcome measure for this trial was two physicians' assessments of cosmetic appearance of the healed columellar incision. The method of comparison was a previously validated cosmesis scale applied to photographs taken three months following surgery. The visual analogue and Hollander wound evaluation scales have previously been shown to be reliable and valid outcome measures of cosmesis[7,8] and have been used in previous laceration repair trials.[6,16] The Hollander wound evaluation scale also has excellent interphysician concordance for total cosmetic score.[8,21] To our knowledge, this is the first study to compare the columellar incision closure using tissue adhesives or conventional suture technique in a randomized trial (Figure 2).

Wounds treated with tissue adhesives exhibit a superior resistance to bacterial growth over sutured wounds.[22] Bacterial counts in wounds closed with cyanoacrylate tend to be lower than sutured wounds for two reasons. First, percutaneous puncture using suture material increases the risk of infection. In addition, cyanoacrylate has bacteriostatic activity and Gram-positive bactericidal activity.[22,23] Use of the cyanoacrylate vial for more than one laceration repair when a new sterile needle tip is used, although not recommended by the manufacturers, has been shown to be non-infectious.[23] The bacteriostatic nature of the adhesive and the completely occlusive nature of the closure may have contributed to the absence of infection in the adhesive group. In contrast, three minute suture infections occurred in the group treated with percutaneous sutures. The stitch as an ingrained foreign material may make the tissue prone to minor skin infection. Two of these three cases resulted in suboptimal healing.

Following surgery, collagen has fully matured and the wound has recovered most of the skin's original tensile strength by one year when most collagen remodelling has taken place. However, at three months, a wound has 80 per cent of its original tensile strength, so it is unlikely that significant changes in wound or scar remodelling would occur between three months and one year.[24] Studies have demonstrated that minimal changes to wound healing occur between three and 12 months, hence there is a strong correlation between wound evaluation scores assigned at three months and results at one year. Assessment of wound three months after wound closure therefore provides a reliable measure of long-term cosmetic outcome.[24] An argument may be raised that the use of photographs in this study may have masked differences between groups that would have been more visible to the naked eye. However, it was impractical to have the rating surgeons examine each patient at each time point, due to time constraints.

Precise skin approximation in an everted orientation should inhibit infiltration and subcutaneous deposition of the polymer. This should prevent any chance of the adhesive acting as a barrier between the growing edges of the incision, which might interfere with initimate apposition of the wound edges and delay wound healing.[25] A columellar strut was used in all patients to support the middle leg of the nasal tip tripod and for the adjustment of the nasal tip projection. The majority of the tension on the wound edges was absorbed by the application of a subcutaneous 5-0 chromic catgut suture and several paracolumellar 5-0 chromic catgut sutures in all the patients either in the group of the tissue adhesives or standard suture application. Closure of the bilateral infracartilaginous and paracolumellar incision lowered the tension and approximated the skin edges at the columellar incision. The columellar incision is also supported by the underlying medial crura of the lower lateral cartilages and additionally reinforced by the paracolumellar sutures bilaterally. This allows the adhesive to be applied while gently pressing the nasal tip inferiorly and the subnasale superiorly, to enhance skin approximation in an everted orientation. Holding the skin edges in close approximation for 30 sec achieved bonding. Care should be taken when using adhesives in skin creases or over areas of

movement, as some adhesives may become brittle and crack after polymerizing.[26] External tape and splint dressing make the nose rather immobile. The above-mentioned sutures and dressing lower the tension and render the columellar incision quite firm. Ointments were avoided in patients receiving tissue adhesive closure, as they may weaken the glue–skin bond. On the other hand, topical antibiotic ointment was used for patients receiving suture closures to reduce infection, accelerate reepithelization and maintain a moist environment.[27] In patients treated with butylcyanoacrylate, the adhesive itself formed a protective dressing, so that these patients only needed to avoid excess moisture. While one might assume that percutaneous sutures may provide a more immediate secure closure of a wound than tissue adhesives, seven days after wound closure, the breaking stengths of wounds closed by either method were shown to be equal.[25]

Octycyanoacrylate is another tissue adhesive, characterized by increased pliability. Some clinicians prefer this formulation for use over flexible skin surfaces.[16] Octylcyanoacrylate, which is painted onto the wound, may be easier to apply on broad and flat areas such as the forehead, while butylcyanoacrylate, which is dropped onto the wound, is preferred for use in tight situations such as lacerations around the eye, where the risk of material dripping into the eye and glueing it shut could otherwise occur.[26] The application of octylcyanoacrylate requires painting the material onto the wound, which may cause malalignment of the edges of the columellar skin incision. On the other hand, butylcyanoacrylate is applied in drop-wise manner along the incision, allowing more precise alignment. Osmond *et al*.[26] concluded that there was little or no difference between these two forms of cyanoacrylate. After reviewing the drop-wise application, the cost differences and the characteristics of the area treated, the authors of the present study prefer using LiquiBand.

An economic evaluation of the two methods of wound closure, sutures and adhesives, was included in this study. The results showed that the tissue adhesive was superior because it resulted in the most efficient use of health care resources.[28] Although LiquiBand is manufactured for single-use, the authors found that each 0.5-ml vial of adhesive can be modified for multidose by interchanging 25-gauge needles at the tip. Since this method of application was shown to be non-infectious,[23] each vial of LiquiBand provided enough adhesive to close approximately seven to eight columellar incisions. The cost of LiquiBand per patient is US$2. On the other hand, the price of a 6-0 polypropylene suture is US$7. Tissue adhesive is a cost-effective method of columellar repair.

In general, suture removal is usually associated with minimal pain, but patients often feel some discomfort, especially since columellar skin sutures are located in a sensitive area of the face. In addition, suture removal occurs right in the centre of a patient's visual area. Therefore, the patients cannot help feeling additional significant annoyance or distress. Since the use of butylcyanoacrylate for columellar skin closure is only a small part of external rhinoplasty, its effects on time and cost of the procedure are negligible.

Rhinoplasty patients are usually discharged on the same (or following) day of the operation. In general, they are asked to return seven days after the operation for the removal of the external splint. Additionally, patients undergoing external approach rhinoplasty return for suture removal on the 4th post-operative day. Use of tissue adhesives for columellar skin closure eliminates the need for post-operative suture removal and related distress that should lead to more efficient use of physician and patient time. Since the tissue adhesive forms its own protective barrier, post-operative care becomes simpler. In our prospective, randomized, controlled clinical trial, we found that butylcyanoacrylate performs as well as standard suture closure techniques in terms of cosmetic outcome when using standardized assessment techniques (Figure 1). Butylcyanoacrylate has a prominent place among methods to achieve the best possible cosmetic results in the closure of columellar skin incision used for external rhinoplasty.

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