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Cyanoacrylate tissue adhesive or silk suture for closure of surgical wound following removal of an impacted mandibular third molar: A randomized controlled study

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ABSTRACT

Aim: The aim of the study was to compare postoperative sequelae and wound healing outcome following closure of surgical wound with either cyanoacrylate tissue adhesive or silk suture.
Methods: Subjects with mesio-angularly impacted mandibular third molar were allocated randomly into 2 equal groups. The control group had wound closure with silk suture and study group with cyanoacrylate tissue adhesive. Subjects were followed up for 7 postoperative days. Postoperative pain, swelling, trismus, bleeding, wound dehiscence and wound infection were evaluated.
Results: Sixty subjects in each group completed the study. No significant difference was observed in the mean postoperative pain, swelling, trismus, wound dehiscence and infection between the 2 groups. There was a statistically significant difference in postoperative bleeding between the 2 groups on postoperative day 1, with more bleeding in the control group.
Conclusions: This study shows that cyanoacrylate tissue adhesive compares favourably with silk suture as a wound closure material. In addition, cyanoacrylate tissue adhesive seems to have beneficial haemostatic effect on postoperative bleeding.

1. Introduction

Surgical extraction of impacted mandibular third molar is a common procedure in oral surgery. The most common method of wound closure following third molar surgery is suturing. However, suturing in this confined space increases surgical time and necessitates good suturing skills (Pasqualini et al., 2005). Needle penetration during suturing also causes trauma to tissues (Edwab, 1995). Silk has been the most universally used suture material in dentistry and many other surgical disciplines (Brandt and Jenkins, 2012). Silk is easy to handle, economical and has good knot security (Silverstein et al., 2009). However, it is non-absorbable, thus there is need for a second appointment to remove the sutures. The removal may increase both direct and indirect costs to the patient. Although absorbable sutures are available, most have unpredictable resorption rates in the oral cavity; they may weaken and dissolve early, or remain in the incision area for too long (Brandt and Jenkins, 2012). These have prompted the need for an alternative method of wound closure.

The use of cyanoacrylate tissue adhesive as an alternative to suturing in surgical procedures was first reported in 1959, and since has been an area of interest (Coover et al., 1959). Cyanoacrylate has gained increased use in surgery over the years and has been described to be effective. It has an immediate haemostatic effect when used in the treatment of prolonged oral bleeding (Al-Belasy and Amer, 2003). It rapidly adheres to hard and soft tissues and its ease of application shortens operation time (Javelet et al., 1985; Giray et al., 1997). It also has an antimicrobial effect in the oral cavity because of its bacteriostatic nature (Giray et al., 1997).

Cyanoacetate and formaldehyde react with a base to form a liquid monomer. The monomer formed penetrates into irregular surfaces and chemically changes into a polymer on contact with moisture through an exothermic hydroxylation reaction to form a strong bridge which keeps the wound edges in contact and thus allows for healing by primary intention (Quinn, 1998; Bhatia, 2010). The presence of saliva in the intraoral mucosa serves as good

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moisture for the bonding process of cyanoacrylate. The polymerization reaction takes about 10–15 s. Cyanoacrylate is non-absorbable and takes about 7–10 days to slough off the mucosa and skin after application (Bhatia, 2010). They are characterized according to the length of the carbon chain conjugated to the cyanoacrylate component. The chain ranges from methyl, ethyl, butyl, amyl to octyl (Saltz and Toriumi, 2004). The elongation of this chain prolongs the heat generated during curing, thus becoming less toxic and resulting in minimal damage to the soft tissue (Toriumi et al., 1998). Its use in internal tissues has been queried because of the reactions, toxicity, and possible carcinogenicity (Vinters et al., 1985; Toriumi, 1990).

In the maxillofacial field, cyanoacrylate has been used for sutureless closure of extraction socket, repair of sinus perforation in sinus lift procedure (Choi et al., 2006), in periodontal surgery following gingivectomy, periodontal flaps and biopsies (Kulkarni et al., 2007), and as an effective local haemostatic agent in oral surgery for patients on anticoagulants (Al-Belasy and Amer, 2003). It has also been employed in the treatment of superficial ulcers, aphthous ulcers and ulcers due to leukaemia (Ylikontiola et al., 1997). Several studies have also shown its efficacy in cleft lip repair (Mourougayan, 2006; Knott et al., 2007). It has also been applied in fixation of mandibular fractures and also in the treatment of central vascular malformation of the mandible (Mehta et al., 1987; Shultz et al., 1988).

Only a few studies have investigated the use of cyanoacrylate in the closure of surgical wound following impacted mandibular third molar extraction (Ghoreishian et al., 2009; Joshi et al., 2011; Setiya et al., 2015).

The aim of this study was to compare postoperative sequelae and wound healing outcome following closure of surgical wound after mandibular third molar surgery with either cyanoacrylate tissue adhesive or silk suture.

2. Methodology

This was a randomized controlled clinical study to compare the use of cyanoacrylate tissue adhesive and suturing for closure of the surgical wound after extraction of impacted mandibular third molars. History and clinical examination were carried out for all patients presenting at the oral surgery clinic for extraction of impacted mandibular third molar to determine the subjects eligible for the study. Standard periapical radiographs of the impacted tooth were taken for each subject. Informed consent was obtained from subjects who met the inclusion criteria.

2.1. Inclusion criteria

1. All subjects of 18 years and above with mesio-angularly impacted mandibular third molar.
2. Subjects without known systemic disease such as Bleeding dyscrasia and immunosuppression (like Diabetes mellitus and AIDS).
3. Subjects not allergic to the drugs or anaesthetic agent in the surgical protocol.
4. Subjects with good oral hygiene.
5. Subjects who were non-smokers.

Approval for the study was obtained from the institution's Health Research and Ethics Committee (HREC).

2.2. Preoperative consideration

Eligible subjects were allocated into either group A (suture) or group B (cyanoacrylate) using a table of random numbers. Subjects and Surgeon were blinded to wound closure method selected until time for the closure.

2.3. Preoperative measurements

The subjects were adequately educated on how to complete the subjective measurements.

Pain: The pain perception was recorded subjectively by the subjects using a Visual Analogue Scale (VAS). The pain scale was 100 mm long, with score zero representing no pain and 100; the worst possible pain.

Facial width: This was recorded by measurement of Tragus to Pogonion (ear to chin), Tragus to Oral Commissure (outer corner of the mouth), Outer Canthus to Gonion (angle of the mandible). The mean value of these three measurements was then calculated. The measurement was done using a tape measure. The measurement was in millimeters.

Mouth opening: The mouth opening was taken as the maximum distance between mesial incisal edges of maxillary and mandibular central incisors in the midline. If these teeth were not present, the edentulous ridge was used with the labial frenum as a guide for centrality. The measurement was done with the use of a vernier-calibrated sliding caliper. The measurement was in millimeters.

2.4. Operative procedure

All the surgical extractions were carried out under local anaesthesia by the same Surgeon. Subjects rinsed with 0.12% chlorhexidine solution for 1 min prior to the procedure, and were given no preoperative medication. The inferior alveolar, long buccal and lingual nerves were anaesthetised with 2% lidocaine hydrochloride with epinephrine 1:80,000 using conventional block technique. Buccal approach with a Ward's triangular flap was used. The flap was reflected and ostectomy performed by buccal guttering technique with a number 8 round ended burr under copious irrigation with sterile 0.9% normal saline solution. The tooth was sectioned with a fissure burr; if necessary, then all parts of the tooth were removed. Once the extraction was completed, socket was curetted and sharp bony edges were rounded up with bone file along with copious irrigation with about 50 ml of 0.9% normal saline.

The bone operating time was recorded by a trained assistant using a calibrated stopwatch. This time was referred to as the time required for tooth delivery from beginning of incision. The measurement was in minutes.

2.5. Closure method

Group A: After achieving haemostasis, the flap was repositioned and closed with 3–0 silk suture (Ethicon, Johnson & Johnson Medical Ltd) using an interrupted suturing technique. Three sutures were placed; one at the mesial relieving incision, the second placed distal to the second molar and the third placed distal to the extraction socket to achieve healing by primary intention (Fig. 1).

Group B: After achieving haemostasis, the flap was repositioned and closed by using cyanoacrylate glue [Amcrylate (IsoAmyl 2-Cyanoacrylate) – Concord Drugs Ltd., Hayathnagar, India, dispensed in ampoules of 0.25 ml]. The wound edges were adapted together with a tissue holding forceps, then 1st layer of cyanoacrylate glue was applied by dropping the liquid from a syringe and needle (provided by manufacturer) along the whole incision lines (distal incision, mesial relieving incision and flap over the socket), followed by another layer after 20 s. The closure was also done to achieve healing by primary intention (Fig. 2).

To prevent inadvertent oral exposure to cyanoacrylate, the flap was isolated from the adjacent oral mucosa with sterile gauze roll.

Fig. 1. Immediate Postoperative Suturing of the surgical wound.

Closure time: The closure time (in seconds) was recorded by a trained assistant using a calibrated stopwatch. In group A, the closure time was regarded as the time between the placement of the first suture and the final suture. In group B, the closure time was regarded as the time between the placement of the first drop of amcrylate and the final drop.

2.6. Postoperative procedure

After the extraction, subjects were informed to eat a soft diet and avoid using the operated side for mastication within the first 24 h. Normal oral hygiene including warm saline mouth rinse and tooth brushing started a day after surgery. All subjects were given similar postoperative medications which were commenced immediately after the procedure; Caps. Amoxicillin 500 mg 8 hrly for 5 days (GlaxoSmithKline UK), Tabs metronidazole 200 mg (May & Baker, Nigeria), Tabs. Diclofenac Sodium 50 mg 12 hrly for 3 days (Olfen Switzerland) and Tabs. Dexamethasone 8 mg stat, then 4 mg 6 hrly in 2 doses.

2.7. Postoperative evaluation

Postoperative pain, swelling (facial width) and trismus were measured as described preoperatively. Pain was measured for 5 consecutive postoperative days. Swelling and trismus were measured on postoperative days 1, 3 and 7.

Fig. 2. Application of Cyanoacrylate Tissue Adhesive.

Bleeding: The subjects were also asked to indicate their subjective perception of bleeding on a modified VAS in a similar fashion for 3 postoperative days; from day 1 to day 3. This is an adopted tool (Setiya et al., 2015). The scale used was a categorical ordinal scale. It was 4 cm long, subdivided into 4 equal parts with score 0 corresponding to No bleeding, 1: oozing, 2: Accidental Low Bleeding, 3: Continuous Low Bleeding, and 4: Massive Bleeding (Table 1).

Wound dehiscence: Presence of gaping along the incision line was regarded as dehiscence. This was assessed by visual inspection and by gentle probing with a Williams probe. The assessment was done on the 7th postoperative day.

Wound infection: A diagnosis of surgical wound infection was established if there was "purulent discharge from the surgical site or there are other signs of infection, such as fever, lymphadenopathy, or persistent swelling and pain that cannot be explained by surgical trauma" (Ren and Malmstrom, 2007). The assessment was done on postoperative days 1, 3 and 7.

2.8. Data analysis

Data were analysed using the statistical package for social sciences (SPSS) for Windows (version 16.0, Chicago, IL, USA). The student *t*-test was used in analysis of measures of pain, interincisal mouth opening and facial swelling between the 2 groups. The proportion of those with wound healing complications in the 2 groups was compared using Chi-square. Cross-tabulation test was used in the analysis of postoperative bleeding between the two groups. The critical level of significance was set at $P < 0.05$.

3. Results

A total of 120 participants who completed the study were included in the analysis. Out of the 120 subjects, 75 were females while 45 were males, with a male to female ratio of 1:1.7. The mean age (±SD) of the participants was 27.2 (6.9) years. There were 60 subjects each in group A (Suture) and group B (Cyanoacrylate). There was no statistically significant difference in gender distribution, mean age and indication for extraction between the 2 groups.

The mean bone operating time in group A was 15.2 (8.8) min while that of group B was 15.5 (5.9) min ($P = 0.86$). The mean wound closure time in group A was 355.4 (10.5) s compared to 191.9 (8.8) s in group B ($P < 0.001$). No possible side effect to cyanoacrylate tissue adhesive was seen in any of the subjects that participated in the study.

Pain: There was no statistically significant difference in the preoperative mean VAS score between the 2 groups (*P*-value = 0.95). The mean (±SD) postoperative VAS scores were highest on day 1 in both groups. The mean (±SD) postoperative VAS scores were lower in group B compared to group A on all

Table 1
Bleeding assessment.

0	No Bleeding	The subject does not detect any blood in saliva
1	Oozing	The subject detects slight blood but it is not very much noticeable
2	Accidental Low Bleeding	The subject has low bleeding sometimes
3	Continuous Low Bleeding	The subject has low bleeding often
4	Massive Bleeding	Continuous high bleeding

postoperative days except day 3. However, the difference was not statistically significant (Table 2).

Swelling: The difference in the mean preoperative facial width between the 2 groups was not statistically significant (*P*-value = 0.66). The highest mean postoperative swelling was seen on day 1 in both groups. The mean postoperative swelling was lower in group B compared to group A on postoperative days 1, 3 and 7. However, the difference was not statistically significant (Table 2).

Interincisal distance: The difference in the mean preoperative interincisal distance between the 2 groups was not statistically significant (*P*-value = 0.57). The minimum interincisal distance was seen on postoperative day 1 in both groups. The mean interincisal distance was higher in group A compared to group B on postoperative days 1, 3 and 7. However, the difference was not statistically significant (Table 2).

Bleeding: On postoperative day 1, 26 (43.4%) subjects in group A did not notice any bleeding compared to 42 (70.0%) subjects in group B (*P*-value = 0.02). More bleeding was seen in group A than in group B (Fig. 3). There was no statistically significant difference in postoperative bleeding on days 2 and 3 between the 2 groups (*P*-value = 0.38 and 0.49, respectively) (Fig. 3).

Wound dehiscence: Only 10 (8.3%) subjects had wound dehiscence following third molar surgery. Out of the 10 subjects, 6 were found in group B, however there was no statistically significant difference between the 2 groups (*P*-value = 0.51).

Wound infections: Only 2 (1.6%) subjects developed wound infection postoperatively. The wound infection was seen on day 3, 1 in each group.

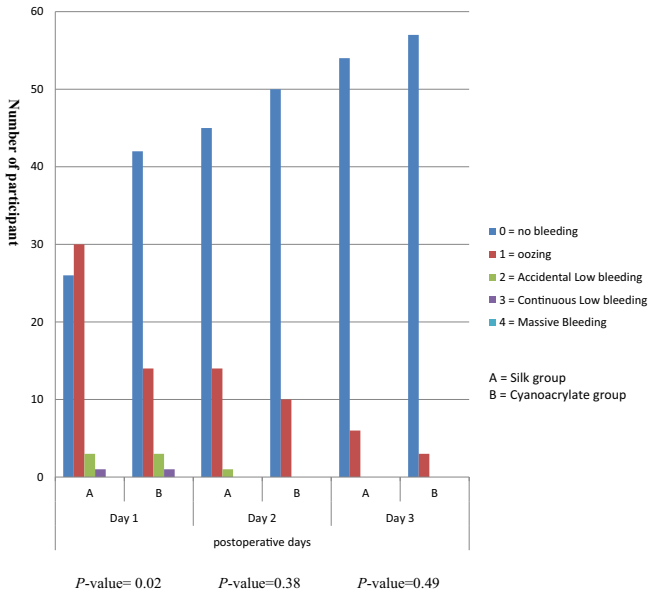

Fig. 3. Comparison of postoperative bleeding between the 2 groups.

4. Discussion

Postoperative sequelae such as pain, swelling and trismus have an influence on the postoperative quality of life after third molar surgery (Lars Andersson et al., 2010). These sequelae along with wound healing outcomes have been used to evaluate the efficacy of wound closure methods (Setiya et al., 2015).

In the present study, the wound closure time was significantly lower using cyanoacrylate tissue adhesive compared to suturing. This is similar to a previous study which reported that the time for wound closure with fibrin sealant was significantly lower compared to suturing (Gogulanathan et al., 2015). The use of tissue adhesive is simpler and involves less tissue handling compared to suturing. Generally, reduction in wound closure time will reduce total operating time, with the expected reduction in the rate of postoperative complications (Lars Andersson et al., 2010).

Pain affects the quality of life of a patient during the postoperative period (Ibikunle et al., 2016). In the present study, the postoperative pain severity was lower in the tissue adhesive group except on the 3rd postoperative day; however this difference was not statistically significant. Previous studies similarly reported lower postoperative pain with the use of tissue adhesives for wound closure compared to suturing (Joshi et al., 2011; Gogulanathan et al., 2015; Setiya et al., 2015). Pain is a cardinal sign of inflammation arising from surgical trauma during the operative procedure including needle penetration during suturing. The reduced pain severity reported in previous studies was attributed to reduced tissue handling with the use of tissue adhesive. It was also hypothesized that the wound seal created by tissue adhesive leads to reduction in exposed nerve endings (Gogulanathan et al., 2015).

Postoperative swelling is an expected sequela of third molar surgery and mainly caused by the surgical manipulation. The magnitude is related to the extent and duration of surgical trauma from the procedure (Lars Andersson et al., 2010). The method of wound closure after third molar surgery has been reported to have an effect on postoperative swelling. Wound closure that allows for

Table 2
Comparison of preoperative and postoperative pain, swelling and trismus assessment between the 2 groups.

		Subjects		*P*-value
		Group A Mean (±SD) (mm)	Group B Mean (±SD) (mm)	
Pain	Preoperative Score	4.6 (1.2)	4.7 (1.1)	0.95
	Postoperative day 1	11.2 (1.4)	9.3 (1.1)	0.41
	Postoperative day 2	7.1 (0.7)	6.9 (0.7)	0.87
	Postoperative day 3	6.6 (0.6)	6.9 (0.8)	0.81
	Postoperative day 4	4.9 (0.5)	4.8 (0.5)	0.97
	Postoperative day 5	3.7 (0.4)	3.3 (0.4)	0.63
Facial width	Preoperative value	127.9 (6.7)	127.4 (6.5)	0.66
	Postoperative day 1	130.2 (6.3)	129.6 (6.1)	0.59
	Postoperative day 3	130.0 (6.3)	129.5 (6.2)	0.64
	Postoperative day 7	129.3 (6.7)	128.2 (6.2)	0.38
Maximum interincisal distance	Preoperative value	49.2 (6.5)	48.5 (6.4)	0.57
	Postoperative day 1	36.7 (12.0)	34.9 (11.0)	0.38
	Postoperative day 3	41.4 (9.6)	39.5 (10.2)	0.30
	Postoperative day 7	45.7 (8.7)	44.2 (8.4)	0.36

drainage causes reduced swelling (Waite and Cherala, 2006). In this study, there was no statistically significant difference in the postoperative swelling between the 2 groups during the follow-up days even though the values were lower in the cyanoacrylate group. The 2 techniques closed the wound by primary intention, thus no allowance for drainage; this could have been responsible for the nil difference in the postoperative swelling between the 2 groups. Although a similar study that compared suturing with cyanoacrylate reported a difference in magnitude of swelling in favour of cyanoacrylate when comparison of facial measurement was done between both groups on the 1st postoperative day (Setiya et al., 2015). Another study that used fibrin glue reported a slightly higher postoperative oedema compared to suturing (Gogulanathan et al., 2015). This difference could be due to a tight seal created by the tissue adhesive.

Previous studies that compared cyanoacrylate to suture for wound closure following mandibular third molar surgery did not evaluate for trismus. In a similar study using fibrin glue, the postoperative mouth opening was better in the fibrin glue group than the suture group on the 1st and 7th day (Gogulanathan et al., 2015). In this present study, there was no statistically significant difference in the mean postoperative interincisal distance between the 2 groups throughout the evaluation periods. The difference in the mean bone operating time between the 2 groups was not statistically significant, and this could have accounted for the similarity in the mouth opening ability in the 2 groups.

Minimal postoperative bleeding in the form of oozing should resolve within 36–72 h postoperatively (Lars Andersson et al., 2010). Half of the participants that had wound closure by suturing in the present study experienced oozing on postoperative day 1, while only 5% still had oozing on the 3rd postoperative day. Cyanoacrylate has been shown to have a haemostatic effect in the oral cavity, although the exact mechanism of action has not been reported (Al-Belasy and Amer, 2003). It is hypothesized that the ester forms a macrofilm causing mechanical blockage, which also acts as a surface agent to activate the clotting cascade (Samuel et al., 1997). In the present study, this beneficial effect of cyanoacrylate was seen on postoperative day 1 only. The superior haemostatic effect of cyanoacrylate over suturing was also reported in a previous study (Setiya et al., 2015).

The most significant index of effectiveness of incision closure is good apposition of wound edges (Dumville et al., 2014). Wound healing characteristics are usually considered the primary outcome in most studies that compare wound closure techniques (Dumville et al., 2014). Wound dehiscence and wound infections are two important complications usually evaluated in assessing wound healing (Farion et al., 2012). In the present study, although more dehiscence was noticed in the cyanoacrylate group than in the suture group, the difference was not statistically significant. Wound healing outcome between cyanoacrylate and suture for wound closure following third molar surgery was also reported to be similar (Setiya et al., 2015). A previous systematic review that compared tissue adhesives and suture for wound closure reported more wound dehiscence in the cyanoacrylate group than in the suture group (Dumville et al., 2014). In the systematic review, the studies reviewed were for skin closure at different sites, however none was done in the oral cavity (Dumville et al., 2014). Although the systematic review excluded sites with high tension, the tensile strength of cyanoacrylate may still be lower than that of sutures and this could have accounted for more dehiscence. Cyanoacrylate has a bacteriostatic effect, and this is believed to have a favourable effect on reducing wound infection (Giray et al., 1997). However, studies did not report any significant difference in the proportion of infection in incisions closed by cyanoacrylate tissue adhesives and sutures (Dumville et al., 2014). There was also no difference in the occurrence of wound infection between the 2 groups in the present study.

5. Conclusion

This study shows that cyanoacrylate tissue adhesive compares favourably with silk suture as a wound closure material and may therefore be a suitable alternative to silk suture for wound closure following extraction of an impacted lower third molar. Cyanoacrylate may have some beneficial haemostatic effect with significant effect on postoperative bleeding.

Conflict of interest

None declared.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jcms.2018.10.018.

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