

ORIGINAL RESEARCH

A comparative clinical and histological evaluation of isoamyl-2-cyanoacrylate and silk suture in closure of surgical wound in alveoloplasty

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Abstract

Objective: This study was done to compare the clinical and histological healing of surgical wounds in cases of alveoloplasty when wound closure was done by Isoamyl 2-cyanoacrylate adhesive and 3-0 Mersilk.

Methodology: This randomized prospective split mouth study was conducted on 35 patients requiring bilateral alveoloplasty on the mandibular anterior region. The wound was divided into two equal lengths and each half was randomly assigned as Group 1, where surgical incisions were closed with sutures and in Group 2 closed with isoamyl-2-cyanoacrylate. Wound healing was assessed clinically by 2 independent observers on 3rd, 7th, 14th and 21st postoperative days. Out of 34 subjects, 17 randomly underwent biopsy on 7th day and 14th day postoperatively for histological evaluation by 2 independent observers.

Results: Erythema was more in cyanoacrylate at 3rd day but had less erythema on 7th and 14th day and on 21st day Cyanoacrylates and sutures had similar observations. Tenderness was less in Cyanoacrylates on 3rd postoperative day and similar in all the post operative days. Wound healing was better in Cyanoacrylates in 3rd, 7th, 14th day and 21st day according to Wound Healing Index. Inflammatory cell infiltration was higher in sutures on both 7th and 14th day. On 7th day sutures had more vascularity and on 14th day both were having similar vascularity. Fibroblastic activity was more in Cyanoacrylates on 7th but on 14th day suture had more fibroblastic activity.

Conclusion: The result suggested that isoamyl-2-cyanoacrylate has better initial healing compared to suture and was easy and safe to use.

Keywords: Wound Healing, Cyanoacrylate, Suture, erythema, tenderness, vascularity, fibroblastic activity

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Introduction

Humans have managed wounds from the beginning of civilization. Sutures are the most common and conventional materials used for approximation of wound margins. Sutures placed by an embalmer on the abdomen of a mummy have been recorded in 1100 BC. Edgar Smith papyrus reports use of artificial

materials like sutures and wound closure devices around 4000 BC ^[1]. In ancient Indian medicine, Sushruta considered by many to be father of plastic surgery is reported to have relieved intestinal obstruction by surgical intervention wherein intestines were opened any obstruction removed, then were washed out with milk, lubricated with butter and

sutured with ant heads. Sushruta even used sutures which were made from flax, hemp, bark fibre or hair^[2].

Sutures are associated with certain disadvantages like wound dehiscence, foreign body reaction, tissue tearing which eventually leads to delayed wound healing. Needle prick injury to operator and the need for suture removal inconveniences patients. The use of tissue adhesives as an alternative to, or replacement for, sutures in wound closure has long been an area of interest. A group of these tissue adhesives are Cyanoacrylates. Cyanoacrylate was first synthesized by 'Adris' in 1949^[3]. 'Coover' in 1959 described their adhesive properties^[4]. They have a wide range of applications in surgery and are supposed to offer some advantages such as: effective and immediate homeostasis, ease of application, bacteriostatic properties^[5] and rapid adhesion to hard and soft tissues. It has a wide range of application in surgery such as repair of organs, vessels, skin and mucosa grafts, closure of lacerations and incisions, post extraction dressings^[6,7], in the fixation of mandibular fractures^[8], in cleft palate surgery^[9].

The aim of this study is to evaluate the efficacy of Isoamyl-2-cyanoacrylate tissue adhesive in closure of intraoral wounds by comparing the clinical and histologic evaluation of healing of surgical wounds in cases of alveoloplasty when wound closure was carried out by isoamyl 2-cyanoacrylate adhesive and 3-0 Mersilk suture on half circle Round body needle.

Materials and Methods

A total of 35 Patients of either gender who reported to the Department of Oral and Maxillofacial Surgery of Farooqia Dental College requiring bilateral alveoloplasty on the mandibular anterior region were the study subjects. Ethical clearance and written informed consent was obtained for the study. Exclusion criteria were patients with any evidence of systemic diseases such as Diabetes mellitus, peripheral vascular disease, bleeding and clotting disorders, or collagen vascular disease, history of keloid formation or a tendency to form hypertrophic scars, any local pathology of soft tissue or bone of acute nature, HIV positive individuals, allergic to any known drug, a history of contact dermatitis to aldehydes, Uncooperative patients, Poorly compliant patients, who failed to follow instructions regarding oral hygiene.

Method of study

This is a randomized, prospective, split mouth study where the surgical incisions were randomly divided into two groups. Group 1: Surgical incisions were closed with sutures using 3-0 black braided silk, Mersilk round body (atraumatic) needle, Group 2: Surgical incisions were closed with isomyl-2-cyanoacrylate (Amcrylate).

Wound healing was clinically and histologically evaluated in both the groups by 2 different evaluators

independently. Alveoloplasty was performed on 35 patients using 2% lignocaine with adrenaline 1:80000 under aseptic conditions. Incision in all cases was done such that the distance from midline would be the same. After achieving adequate haemostasis, the incision was closed by Isoamyl-2-cyanoacrylate in one side and on the opposite side by 3-0 mersilk with round body (atraumatic needle). Post-operative instructions were given to the patients. Analgesics were given postoperatively for 3 days.

Clinical evaluation

Clinical evaluation of the surgical sites was done by 2 independent evaluators on the 3rd, 7th, 14th and 21st day post-operative days. The criteria were: Presence of tenderness and erythema = 1, Absence of tenderness and erythema = 0. Wound healing was assessed by WHI (Wound Healing Index)^[10]. The criteria are: score 1 = uneventful healing with no edema, erythema, suppuration, patient discomfort, or flap dehiscence, score 2 = uneventful healing with slight edema, erythema, patient discomfort, or flap dehiscence, but no suppuration, Score 3 = poor wound healing with significant edema, erythema, patient discomfort, flap dehiscence, or any suppuration.

Histological evaluation

17 subjects were randomly selected for histological evaluation by taking punch biopsy on both the glued and sutured sites on 7th post-operative day and the remaining on 14th post-operative day. Specimens were examined for degree of inflammatory cell infiltration, vascularity and fibroblastic activity by 2 blinded pathologists. The criteria were: Inflammatory cell infiltration 0 = nil, 1 = mild, 2 = moderate, 3 = severe, Vascularity, 1 = inadequate, 2 = adequate, 3 = rich; Fibroblastic activity (density of connective tissue stroma) 1 = mild, 2 = moderate, 3 = dense.

Results

The randomized prospective study was done on 35 patients who satisfied the aforementioned criteria. 1 patient was excluded from the study as the patient did not report for postoperative follow up. The study sample comprised of 17 males and 17 females, ages ranging from 35 to 80 years. Statistical analysis was done using SPSS 16. Chi – square test and Cramer's V test was done. Since 2 evaluators evaluated the observations Cohen's Kappa coefficient statistics was also used. The Cohen's Kappa coefficient analysis shows both the evaluators to be statically significant. Both the sutures and cyanoacrylate were statistically highly significant. ($p < 0.1$).

Clinical assessment

The evaluation by 2 independent evaluators for clinical assessment of wound healing by evaluating erythema, tenderness and wound healing on 3rd, 7th, 14th and 21st postoperative days have been tabulated as follows.

Table 1: Evaluation of presence or absence of erythema evaluator 1(E1) and Evaluator 2(E2)

		Evaluator 1(E1)		Evaluator 2(E2)		Total
		0(absent)	1(present)	0(absent)	1(present)	
Cyanoacrylates(n=34)	3 rd day	4(11.8%)	30(88.2%)	4(11.8%)	30(88.2%)	34(100%)
	7 th day	29(85.3%)	5(14.7%)	16(47.1%)	18(52.9%)	34(100%)
	14 th day	29(85.3%)	5(14.7%)	30(88.2%)	4(11.8%)	34(100%)
	21 st day	32(94.1%)	2(5.9%)	33(97.1%)	1(2.9%)	34(100%)
Sutures(n=34)	3 rd day	11(32.4%)	23(67.6%)	7(20.6%)	27(79.4%)	34(100%)
	7 th day	19(55.9%)	15(44.1%)	18(52.9%)	16(47.1%)	34(100%)
	14 th day	15(44.1%)	19(55.9%)	30(88.2%)	4(11.8%)	34(100%)
	21 st day	32(94.1%)	2(5.9%)	33(97.1%)	1(2.9%)	34(100%)

Table 2: Evaluation of presence or absence of tenderness evaluator 1(E1) and evaluator 2(E2)

		Evaluator 1(E1)		Evaluator 2(E2)		Total
		0(absent)	1(present)	0(absent)	1(present)	
Cyanoacrylates(n=34)	3 rd day	22(64.7%)	12(35.3%)	19(55.9%)	15(44.1%)	34(100%)
	7 th day	26(76.5%)	8(23.5%)	21(61.8%)	13(38.2%)	34(100%)
	14 th day	34(100%)	0	34(100%)	0	34(100%)
	21 st day	34(100%)	0	33(97.1%)	1(2.9%)	34(100%)
Sutures(n=34)	3 rd day	16(47.1%)	18(52.9%)	13(38.2%)	21(61.8%)	34(100%)
	7 th day	20(58.8%)	14(41.2%)	21(61.8%)	13(38.2%)	34(100%)
	14 th day	32(94.1%)	2(5.9%)	34(100%)	0	34(100%)
	21 st day	32(94.1%)	2(5.9%)	33(97.1%)	1(2.9%)	34(100%)

Table 3: Evaluation of wound healing by WHI (Wound Healing Index) [58] by Evaluator 1(E1) and Evaluator 2(E2) where S1=Score1, S2=Score2, S3=Score3

		Evaluator 1(E1)			Evaluator 2(E2)			Total
		S1	S2	S3	S1	S2	S3	
Cyanoacrylates(n=34)	3 rd day	2(5.9%)	30(88.2%)	2(5.9%)	2(5.9%)	30(88.2%)	2(5.9%)	34(100%)
	7 th day	10(29.8%)	23(67.6%)	1(2.9%)	31(91.2%)	3(8.8%)	0	34(100%)
	14 th day	25(73.5%)	9(26.5%)	0	33(97.1%)	1(2.9%)	0	34(100%)
	21 st day	34(100%)	0	0	32(94.1%)	1(2.9%)	1(2.9%)	34(100%)
Sutures(n=34)	3 rd day	11(32.4%)	23(67.6%)	0	7(20.6%)	27(79.4%)	0	34(100%)
	7 th day	21(61.8%)	13(38.2%)	0	21(61.8%)	12(35.3%)	1(2.9%)	34(100%)
	14 th day	30(88.2%)	4(11.8%)	0	22(64.7%)	12(35.3%)	0	34(100%)
	21 st day	32(94.1%)	1(2.9%)	1(2.9%)	19(55.9%)	15(44.1%)	0	34(100%)

Histopathology

The histopathological evaluation by 2 independent evaluators for assessment of wound healing by

evaluating inflammatory cell infiltraton, vascularity and fibroblastic activity on 7th and 14th postoperative days have been tabulated as follows.

Table 4: Inflammatory cells in cyanoacrylates and sutures on 7th day and 14th day where P1=pathologists1 and P2=Pathologists2

	Inflammatory cells	Cyanoacrylates		Sutures	
		7 th day(n=18)	14 th day(n=16)	7 th day(n=18)	14 th day(n=16)
P1(n=34)	Mild(1)	4(22.2%)	12(75%)	1(5.5%)	5(31.2%)
	Moderate(2)	8(44.44%)	4(25%)	6(33.3%)	11(69.8%)
	Severe(3)	6(33.34%)	0	11(61.1%)	0
P2(n=34)	Mild(1)	5(27.78%)	9(56.2%)	3(16.67%)	5(31.2%)
	Moderate(2)	8(44.44%)	7(43.8%)	3(16.67%)	11(69.8%)
	Severe(3)	5(27.78%)	0	12(66.67%)	0

Table 5: Vascularity in Cyanoacrylates and sutures on 7th day and 14th day where P1=pathologists1 and P2=Pathologists2

	Vascularity	Cyanoacrylates		Sutures	
		7 th day(n=18)	14 th day n=16	7 th day(n=18)	14 th day (n=16)
P1(n=34)	Inadequate(1)	0	1(6.2%)	1(5.5%)	0
	Adequate(2)	17(94.45%)	14(87.5%)	14(77.78%)	16(100%)
	Rich(3)	1(5.5%)	1(6.2%)	3(16.67%)	0
P2(n=34)	Inadequate(1)	1(5.5%)	1(6.2%)	0	0
	Adequate(2)	14(77.78%)	14(87.5%)	12(66.67%)	13(81.2%)
	Rich(3)	3(16.67%)	1(6.2%)	6(33.33%)	3(18.8%)

Table 6: Fibroblastic activity (density of connective tissue stroma) in Cyanoacrylates and sutures on 7th day and 14th day where P1=pathologists1 and P2=Pathologists2

	Fibroblasticactivity	Cyanoacrylates		Sutures	
		7 th day(n=18)	14 th day(n=16)	7 th day(n=18)	14 th day(n=16)
P1(n=34)	Mild(1)	1(5.5%)	2(12.5%)	1(5.5%)	3(18.8%)
	Moderate(2)	10(55.6%)	9(56.2%)	14(77.8%)	6(37.5%)
	Dense(3)	7(38.9%)	5(31.2%)	3(16.7%)	7(43.8%)
P2(n=34)	Mild(1)	0	4(25%)	1(5.5%)	2(12.5%)
	Moderate(2)	11(61.1%)	8(50%)	17(94.5%)	9(56.2%)
	Dense(3)	7(38.9%)	4(25%)	0	5(31.2%)

Discussion

Surgical incisions require good approximation so that wounds heal uneventfully. Many studies have been conducted on extraoral uses of cyanoacrylates but very few on intraoral applications of these cyanoacrylates. This study was done to evaluate clinically as well as histologically the intraoral wound healing when incisions were closed by Isoamyl-2-cyanoacrylate.

In our study the clinical signs of inflammation observed were tenderness and erythema. Wound healing was assessed by utilising Wound healing index ^[10]. The histologic assessment included parameters such as inflammatory cell infiltration, vascularity, and density of fibrocellular connective tissue.

In our study erythema was seen more in the cyanoacrylate site on 3rd post-operative day than in sutured site by both the evaluators. On 7th postoperative day according to Evaluator1, sutures was having more erythema than Cyanoacrylates but according to Evaluator2 Cyanoacrylates was having more erythema than sutures whereas, in a study by Vastani *et al.*^[4] suture side in patients demonstrated more erythema in 7th post-operative day than cyanoacrylate side. On 14th post-operative day in our study according to Evaluator1 sutured patients had higher erythema than Cyanoacrylates but according to Evaluator2 both Cyanoacrylates and suture had similar erythema whereas, a study by Vastani *et al.*^[4] demonstrated that suture side in patients had more erythema. In our study on 21st postoperative day Cyanoacrylates and sutures had similar erythema according to both the evaluators, whereas in a similar study by Vastani *et al.*^[4] both cyanoacrylate and suture had no erythema on 21st day. In our study according to Evaluator1 on 3rd day post operatively

tenderness was higher in sutures than Cyanoacrylates. According to Evaluator2 also tenderness was higher in suture site than Cyanoacrylate site whereas in a study by Kumar M S *et al.*^[11] on 3rd day postoperatively 1 patient out of 10 patients had mild tenderness in sutured side. In a study by Giray *et al.*^[12] tenderness was present in sutured side on 3rd day postoperatively. On 7th day postoperatively in our study according to Evaluator1 tenderness was higher in suture site than Cyanoacrylate site, according to Evaluator2 tenderness was similarly demonstrated on both the Cyanoacrylates and sutures whereas in a similar study by Vastani *et al.*^[4] it was found that the sutured side showed a greater incidence of tenderness but in studies done by Kumar M S *et al.*^[11] and Giray *et al.*^[12] no patient had tenderness on 7th day post operatively on both cyanoacrylate and sutured side. According to Evaluator1 in our study on 14th day postoperatively sutured side had patients with tenderness but absent in cyanoacrylate similar to Vastani *et al.*^[4] whereas according to evaluator2 both Cyanoacrylate and sutured side had no tenderness similar to study done by Giray *et al.*^[12]. In our study on 21st day postoperatively according to Evaluator1 sutured side had tenderness but absent in cyanoacrylate and according to evaluator2 both Cyanoacrylate and sutured side had similar observation of tenderness whereas in a study done by Giray *et al.*^[12] no tenderness was observed in cyanoacrylate side as well as sutured side on 21st day post operatively but in a similar study done by Vastani *et al.*^[4] observed that tenderness was absent and similar in both cyanoacrylate and suture.

In our study in evaluation of wound healing by wound healing index, according to wound healing index^[10], wound healing was better in sutures on 3rd, 7th and

14th post-operative day in sutures but similar on 21st post-operative day.

In our study on 7th day postoperatively, according to both the pathologists sutures had more severe inflammatory cell infiltration than cyanoacrylates similar to study by Vastani *et al.*^[4] and in a study by Kulkarni *et al.*^[13] on 7th day postoperatively cyanoacrylate had mild inflammatory infiltration but sutures had moderate inflammatory infiltrations. In a study by Giray ^[12] on 7th day postoperatively inflammatory cell infiltration was minimal in Cyanoacrylates but severe in sutures. In our study on 14th day postoperatively, according to both the evaluators sutures had more moderate inflammatory cell infiltration than cyanoacrylates similar to study by Vastani *et al.*^[4] and Giray ^[12].

In our study according to both the Pathologists on 7th day postoperatively Cyanoacrylates had more adequate vascularity than sutures similar to Vastani *et al.*^[4] where Cyanoacrylates had more adequate vascularity. In a study done by Kulkarni *et al.*^[13] vascularity was moderate in both suture and Cyanoacrylates on 7th day postoperatively. On 14th day in our study sutures had more adequate vascularity when compared with cyanoacrylate.

In our study on 7th day, cyanoacrylate had more moderate fibroblastic activity and the density of connective tissue stroma than sutures. In a study done by Giray *et al.*^[12] on 7th day postoperatively fibroblastic activity was moderate in both Cyanoacrylates and sutures. In a study done by Vastani *et al.*^[4] on 7th day postoperatively Cyanoacrylates had moderate fibroblastic activity than sutures. In our study on 14th day suture had more fibroblastic activity than cyanoacrylate. In a study done by Giray *et al.*^[12] on 14th day postoperatively

fibroblastic activity was similar in both Cyanoacrylates and sutures. In a study done by Vastani *et al.*^[4] fibroblastic activity was moderate in both Cyanoacrylates and suture.

The overall incidence of inflammation was higher on the sutured side and higher vascularity in cyanoacrylate on the 7th postoperative day and there was not much difference observed between the sutured side and the glued side in 14th day, indicating that the inflammatory response and vascularity became similar by the 14th postoperative day. These results are in accordance with intraoral studies conducted by Bhaskar *et al.*^[14], Vastani ^[4] as well as Kulkarni *et al.*^[13]. Studies on closure of skin incisions with cyanoacrylate by Galil *et al.*^[16] depicts faster healing with cyanoacrylate, they found that initial healing up to 5 days was faster in cyanoacrylate treated tissue and the inflammatory response was less in sutured incisions and between 1 to 3 weeks healing was similar. According to a preliminary report by Bhaskar *et al.*^[14] the absence of seepage under the covering formed by cyanoacrylate may be responsible for the reduced postoperative pain with cyanoacrylate compared with the conventional dressings. They also observed that this material inhibits *Staphylococcus aureus* and *Escherichia coli* growth, thus minimizing infective sequelae^[16]. The increased inflammatory response on the sutured side could be attributed to increased plaque accumulation on the suture threads and also could occur because of the tissue reaction to the suture material used, according to a study by Kulkarni *et al.*^[13] However, Giray *et al.*^[12] attribute it to increased plaque accumulation on the sutured side and local trauma caused by the suture needle penetrating the flaps.

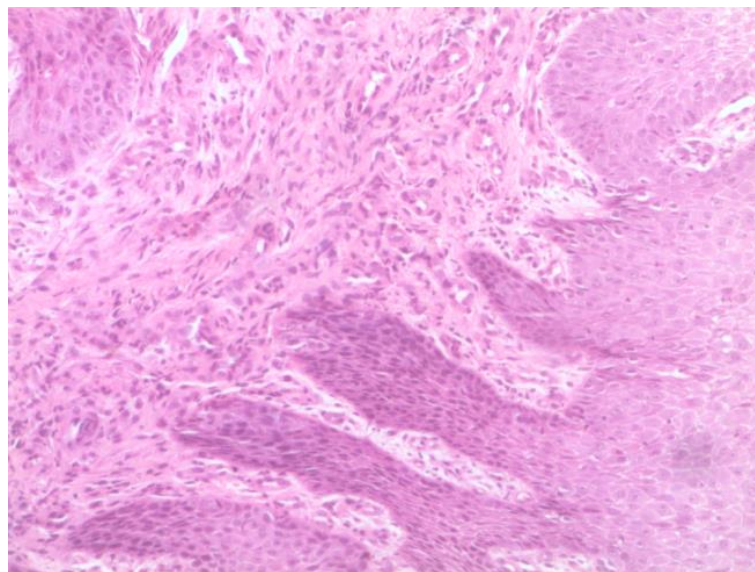


Fig 1: Hemotoxylin-eosin-stained photomicrograph at 20x magnification showing intense inflammatory response of connective tissue on 7th day postoperatively in sutured side

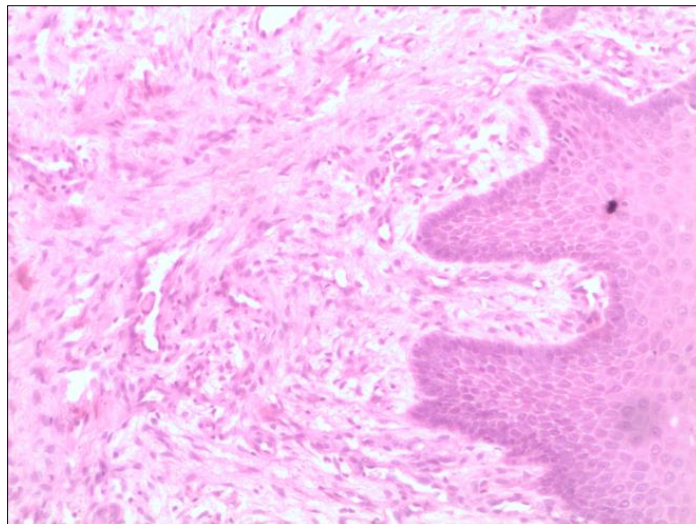


Fig2: Hemotoxylin-eosin-stained photomicrograph at 20x magnification showing moderate inflammatory response of connective tissue on 7th day postoperatively in Cyanoacrylate side

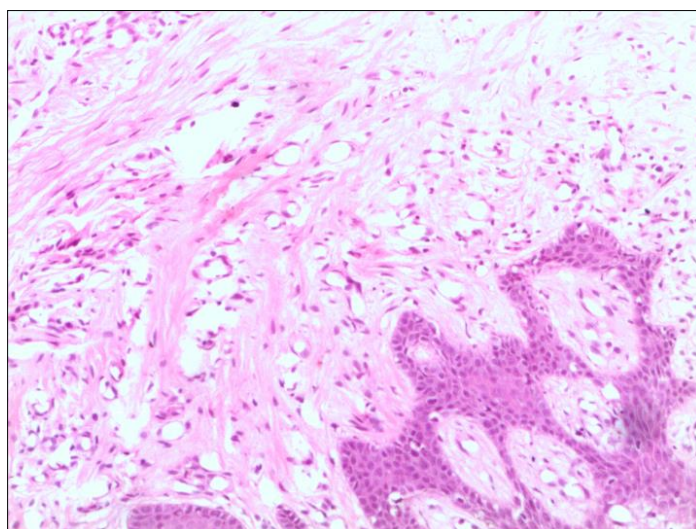


Fig 3: Hemotoxylin-eosin-stained photomicrograph at 20x magnification showing mild inflammatory response and moderate fibroblastic activity of connective tissue on 14th day postoperatively in sutured side

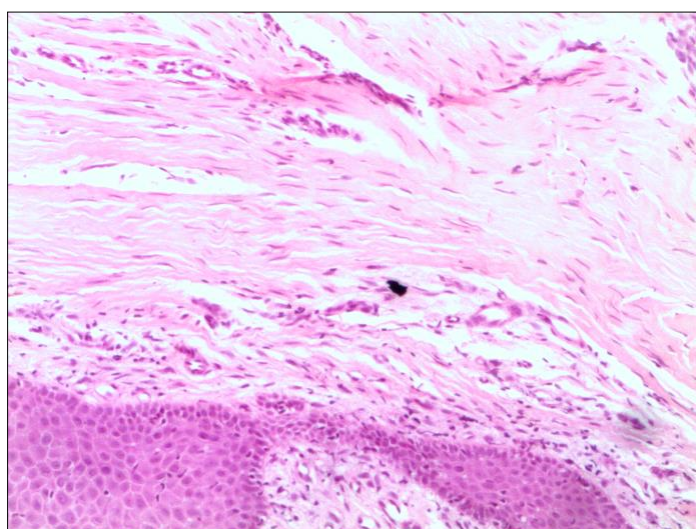


Fig 4: Hemotoxylin-eosin-stained photomicrograph at 20x magnification showing moderate fibroblastic activity of connective tissue on 14th day postoperatively in cyanoacrylate side



Fig 5: Mandible showing bony spicules in anterior region



Fig 6: Pre-operative measurement using thread



Fig 7: Exposed bony spicules after flap elevation



Fig 8: Bony spicules being removed by Bone file



Fig 9: After application of Isoamyl-2-cyanoacrylate and 3-0 silk suture



Fig 10: 3rd day postoperatively



Fig11: 7th day postoperatively after suture removal



Fig12: 14th day postoperatively



Fig13: 21st day postoperatively

Conclusion

The results of this study of Isoamyl-2-cyanoacrylate glue indicate that it is safe, has rapid application, painless, and easy to use for the closure of intraoral surgical wounds. Isoamyl-2-cyanoacrylate glue caused less intraoperative and postoperative discomfort to the patients in our study, as compared with the wound closure by silk suture. The drawback is that it is expensive and possesses less tensile strength than suture and the closure has to be done while maintaining a saliva free field.

References

1. Robert Gassner Wound closure materials Oral Maxillofacial Surg Clin N Am 14 (2002) 95– 104
2. Mackenzie D. The history of sutures. Med Hist. 1973 Apr;17(2):158-168
3. Ardis.A- U S patent no 2467927, 1949.
4. Vastani A, Maria A. Healing of intraoral wounds closed using silk sutures and isoamyl 2-cyanoacrylate glue: A comparative clinical and histologic study. Journal of oral and maxillofacial surgery. 2013 Feb 28;71(2):241-8
5. Eiferman RA, Snyder JW. Antibacterial effect of cyanoacrylate glue. Archives of Ophthalmology. 1983 Jun 1;101(6):958-60
6. L. Dogon, J. D. Heeley: A study on the use of fluoroalkyl cyanoacrylate adhesive as a hemostatic agent and dressing after exodontias; Oral Surg: April, 1978;45(4):503-515
7. Daniel Howard, Virgil E Whiterust, Robert Bingham: The use of bucrylate” to achieve hemostasis in tooth extraction sites; Oral Surg:1973;35(6)762-765
8. Mehta MJ, Shah KH, Bhatt RG. Osteosynthesis of mandibular fractures with N-butyl cyanoacrylate: a pilot study. Journal of Oral and Maxillofacial Surgery. 1987 May 1; 45(5):393-6.
9. T. Turkaslan and D. Dayicioglu, “Use of adhesive in cleft palate surgery: a new flap fixation technique,” The Journal of Craniofacial Surgery, vol. 16, no. 4, pp. 719–722, 2005.
10. Huang LH, Neiva RE, Wang HL. Factors affecting the outcomes of coronally advanced flap root coverage procedure. Journal of periodontology. 2005 Oct;76(10):1729-34.
11. Kumar MS, Natta S, Shankar G, Reddy SH, Visalakshi D, Seshiah GV. Comparison between Silk Sutures and Cyanoacrylate Adhesive in Human Mucosa-A Clinical and Histological Study. Journal of international oral health: JIOH. 2013 Oct; 5(5):95.
12. Giray CB, Atasever A, Durgun B, Araz K. Clinical and electron microscope comparison of silk sutures and n-butyl-2-cyanoacrylate in human musosa. Australian dental journal. 1997 Aug 1; 42(4):255-8.
13. Kulkarni SS, Chava VK. Comparison of cyanoacrylate and silk sutures on healing of oral wounds--an animal model study. Indian journal of dental research: official publication of Indian Society for Dental Research. 2002 Dec; 14(4):254-8.
14. Surimlar N. Bhaskar, John R. Jacoway, Peter ill. Margetis, Fred Leonard, K. C. Pani; Oral tissue response to chemical adhesives:O.S., O.M. & O.P: September, 1966:Volume 22:Number 3:394-404.
15. Khalil HS, Elshall MA, Al-Harbi Y, Al-Asmar S, Al-Wadee M. Healing of oral surgical wounds using 3/0 silk suture and n-butyl cyanoacrylate tissue adhesive. DENTAL JOURNAL. 2009 Oct; 55(2607):2613.
16. Galil KA, Schofield ID, Wright GZ: Effect of n-butyl-2-cyanoacrylate (histoacryl blue) on the healing of skin wounds. J Can Dent Assoc 7:565, 1984