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Cyanoacrylate tissue adhesive *vs.* conventional sutures in free gingival grafts: a prospective clinical randomized study

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Abstract

Objective: The present prospective randomized clinical study compared the use of Dermabond® tissue adhesive as a substitute for sutures, in free gingival graft fixation.

Materials and Methods: Twenty individuals with absence of keratinized mucosa (KM) or KM height less than 1.0 mm in the buccal area of the mandibular incisors were selected to receive free gingival grafts. The patients were distributed into two groups: G1, composed by 8 patients with 10-mm grafts fixed with sutures; G2, composed by 10 patients with 10-mm grafts fixed with Dermabond®. All grafts had the same height (5mm) and thickness (1mm). Bleeding on probing, probing depth, gingival recession, keratinized mucosa height, attached keratinized mucosa height and clinical attachment level were measured at 0, 15, 30, 45, 90 and 180 days.

Results: ANOVA test showed significantly smaller graft contraction and significant increase in attached keratinized mucosa ($p < 0.05$) in G2, compared to G1. Additionally, G2 exhibited significant clinical root coverage ($p < 0.05$).

Conclusions: The free gingival grafts fixed with Dermabond® tissue adhesive presented a faster clinical surgery, better dimensional stability, clinical root coverage, and did not alter the clinical healing process.

Keywords: Autogenous gingival graft. Dermabond®. Free gingival graft. Mucogingival surgical therapy.

Introduction

Studies have suggested that a lack of keratinized tissue can induce periodontal alterations (Nabers, 1966; Sullivan and Atkins, 1968; Maynard and Ochsenbein, 1975). The reestablishment of attached keratinized mucosa (AKM) is recommended for subjects who are not able to maintain proper oral hygiene and thus experience local inflammation and progression of gingival recession (Lang and Loe, 1972; Wennstrom and Zucchelli, 1996; Barbosa *et al*., 2009). To improve the height of keratinized mucosa (KM) in the absence or inadequate amount of this tissue, different grafting techniques for KM augmentation have been proposed (Mormann *et al*., 1981; Breault *et al*., 1999; Harris, 2001; Minsk, 2002).

The technique of free gingival graft (FGG) has been used to create or increase the amount of AKM. Some aspects of the surgical technique must be carefully considered, particularly dimensional changes due to the healing contraction of the gingival graft and adequate coaptation of the borders for surgical wound healing. These two factors have been shown to contribute to the success of the surgical procedure (Zingale, 1974; Breault *et al*., 1999; Minsk, 2002).

Conventional sutures are a more widely used method for border coaptation in gingival surgeries. However, new tissue fixation approaches have been developed in order to reduce surgical time, post-surgery pain and bacterial plaque accumulation (Breault *et al*., 1999; Minsk, 2002; Barbosa *et al*., 2009). One alternative is the border coaptation using a cyanoacrylate-based chemical adhesive (Frisch and Bhaskar, 1968). This type of adhesive presents low toxicity and has been shown to be simple and effective,

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minimizing problems generated by the suturing procedures (Bhaskar *et al*., 1966; Frisch and Bhaskar, 1968; Almurabak and Al-Haddab, 2013; Brock, 2016; Malhotra *et al*., 2016). Concerning the current knowledge, the present study analyzed the behavior of gingival grafts fixed using the medical chemical adhesive Dermabond®.

The problem investigated in the present study was: whether the use of Dermabond® impacts on the gingival graft contraction in linear or area measurements, whether it improves surgical time, and whether it can interfere in clinical healing process.

Materials and Methods

The present study was approved by the Ethics and Research Committee (number CAAE 0264.04213.000-05).

A convenience sample was used, and the power of the sample to perform the present analysis was 80.63%. A block randomization designed to randomize subjects into groups, resulting in equal sample sizes, was used in the present study to avoid bias. This method is used to ensure a balance in sample size among groups over time. The inclusion criteria were based on each patient's current stable medical condition and the ability to withstand the stress of dental surgery. Patients with mandibular central incisors presenting inadequate keratinized mucosa (absent or KMC < 1mm), and with gingival recession on buccal sites were selected.

The following exclusion criteria were used: smokers, pregnant, subjects using any systemic medication that can interfere with the surgical procedure or graft healing, presence of exostosis or active periodontal disease, undergoing orthodontic treatment, presence of cervical restorations or crowns in the surgical area.

The total sample consisted of 26 patients, 15 females and 11 males, ranging from 35 to 62 years of age. Five patients did not comprise the eligibility criteria and two patients in Group 1 and one patient in Group 2 were excluded because they missed the appointment to register the data in different times.

The final sample of 18 patients was divided into: Group 1, consisting of 8 patients submitted to grafts fixed by sutures (n = 16 teeth); and Group 2, consisting of 10 patients submitted to grafts fixed by Dermabond® (n = 20 teeth). The dependent variables analyzed in the present study were the final height and width of the graft during and after the healing period, using sutures or fixed with Dermabond®.

Patients underwent scaling and root planning, as well as oral prophylaxis, four weeks prior to the gingival graft procedure.

An experienced examiner (blind with respect to the treatment group) performed all measurements for Bleeding on Probing (BP), Probing depth (PD), gingival recession (GR), and clinical attachment level (CAL). The PD and CAL were measured for a single tooth, according to the Figure 1, and 20 minutes later a second measurement was made for the same tooth. Measurements of the height and the length of the graft were evaluated after surgical procedures, in the same way.

Therefore, five subjects were evaluated twice in the same visit by the same examiner. Upon completion of all measurements, the intra-examiner variability measurements were tested using the Wilcoxon test ($p<0.05$). The intra-examiner variability was not significant for any clinical parameter ($p>0.794$). Kappa index (k) was calculated to analyze the intra-examiner concordance for 10 patients, in relation to the result of each group and each measurement. The intra-observer agreement obtained ranged from good to excellent (Group 1, k= 1.0 and Group 2, k= 0.79).

The clinical measurements were performed using a periodontal probe (UNC-15. Hu-Friedy. USA). The graft thickness and dimensions, as well as the gingival margin width, were measured using a modified digital caliper, as used by Yared *et al*. (2006). In addition, the dimensions of the KM before and after surgery were recorded in the same way and using Schiller's solution.

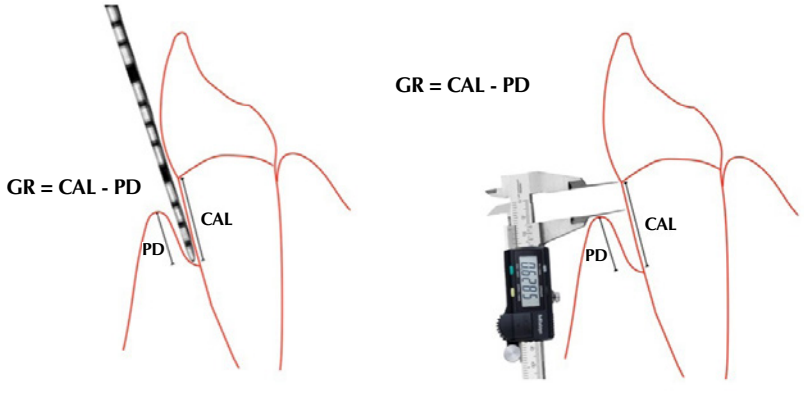

Figure 1. Schematic representation of all measurements: Gingival recession (GR), clinical attachment level (CAL), probing depth (PD).

Surgical procedures were performed by a single professional, as described in Breault *et al*. (1999) and Barbosa *et al*. (2009). After elevating a partial thickness flap from the mucogingival line, an apical fenestration was performed to remove any inserted fibers. The remaining KM was removed, and scaling and root planning were performed without additional chemical treatment on root surfaces.

The graft dimensions were standardized with 10-mm height x 5-mm length x 1-mm thickness, according to the Figure 2. The grafts were fixed using 5-0 nylon suture (Ethicon Products, Somerville. USA) in the Group 1, and using Dermabond® (Ethicon Products, Somerville, USA) in the Group 2 (Figure 3).

Surgical templates were prepared according to the graft-standardized dimensions. The templates were placed in the palatal area between first premolar and first molar on the right or left side. The graft was removed using the same technique and same place for both groups. After removing the epithelial and connective tissue obtained from the palatal area, the thickness was adjusted and measured using a modified digital caliper (Yared *et al*., 2006) for both groups (Figure 4).

The graft donor beds were sutured using 5-0 nylon (Ethicon Products, Somerville. USA) and protected with surgical cement (Coe Pack Standard. GC America Inc. Alsip. IL, USA).

The grafts in Group 1 were fixed with silk sutures using a mucoperiosteal loop suture to minimize the graft transfixing. The grafts in Groups 2 were fixed using a #3 clinical explorer, by placing a drop of Dermabond® adhesive to seal the graft borders. Care was taken to avoid cyanoacrylate contamination between the graft and the surgical bed. All grafts were placed 1 mm below the level of the gingival margin (Figures 5 and 6). Receptor beds were also protected using surgical cement (Coe Pack Standard, GC America Inc, Alsip, IL, USA).

The total surgical time for each procedure was calculated using a chronometer (Vollo® VL501) and the time for fixing with Dermabond® or suturing the gingival graft was calculated separately, to determine the difference in time to fix the graft.

Subjects were given post-operative instructions: use of analgesic medication (Acetaminophen 750 mg q.i.d., or as needed) to reduce pain symptoms; discontinue tooth brushing for 30 days around the surgical site and mouth-rinse with 0.12% chlorhexidine solution twice a day. After seven days, the cement and sutures were removed, and new cement was placed onto the receptor bed, for an additional period of seven days.

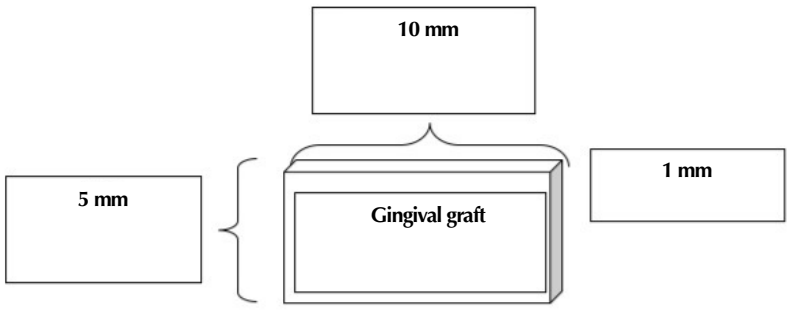

Figure 2. Standardized dimensions of height, length and thickness of the gingival graft.

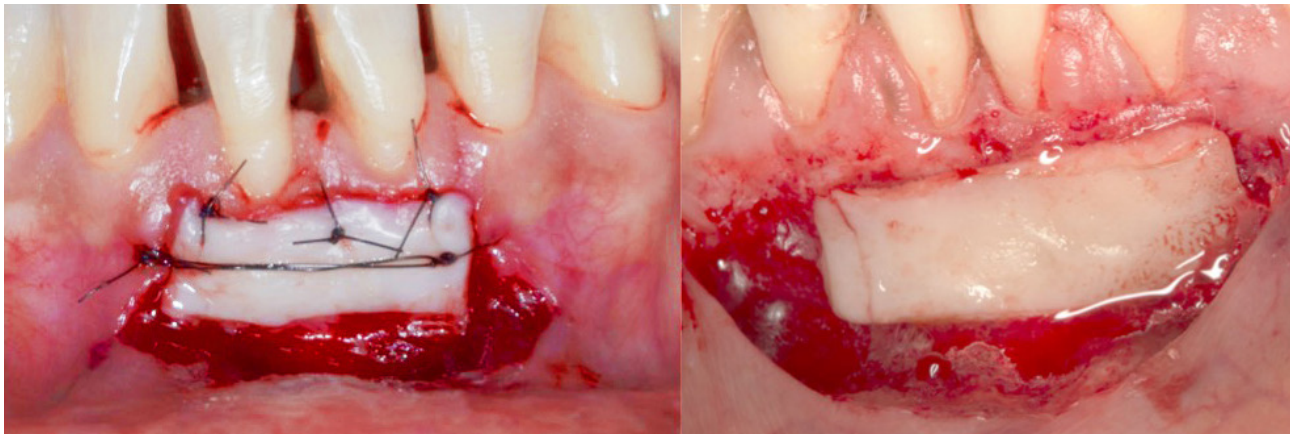

Figure 3. Graft fixed by 5-0 nylon suture (Ethicon Products, Somerville, USA) in Group 1, and fixed by Dermabond® (Ethicon Products, Somerville USA) in Group 2.

Figure 4. Modified digital caliper (according to Yared et al., 2006) used for standardized graft preparation.

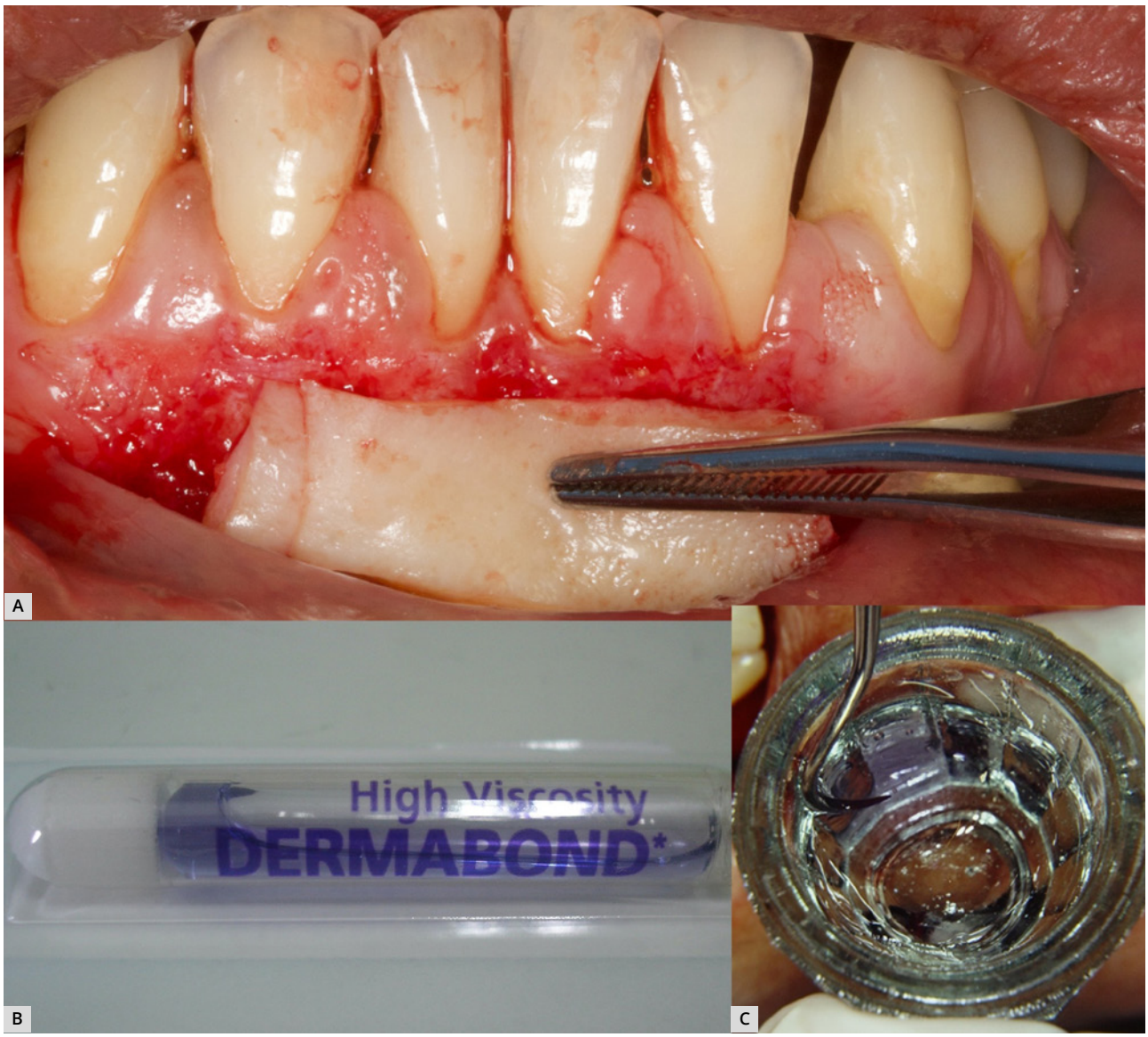

Figure 5. A) Positioned graft. B) Dermabond® (Ethicon Products, Somerville, USA). C) Dermabond® adhesive being picked up by a #3 clinical explorer.

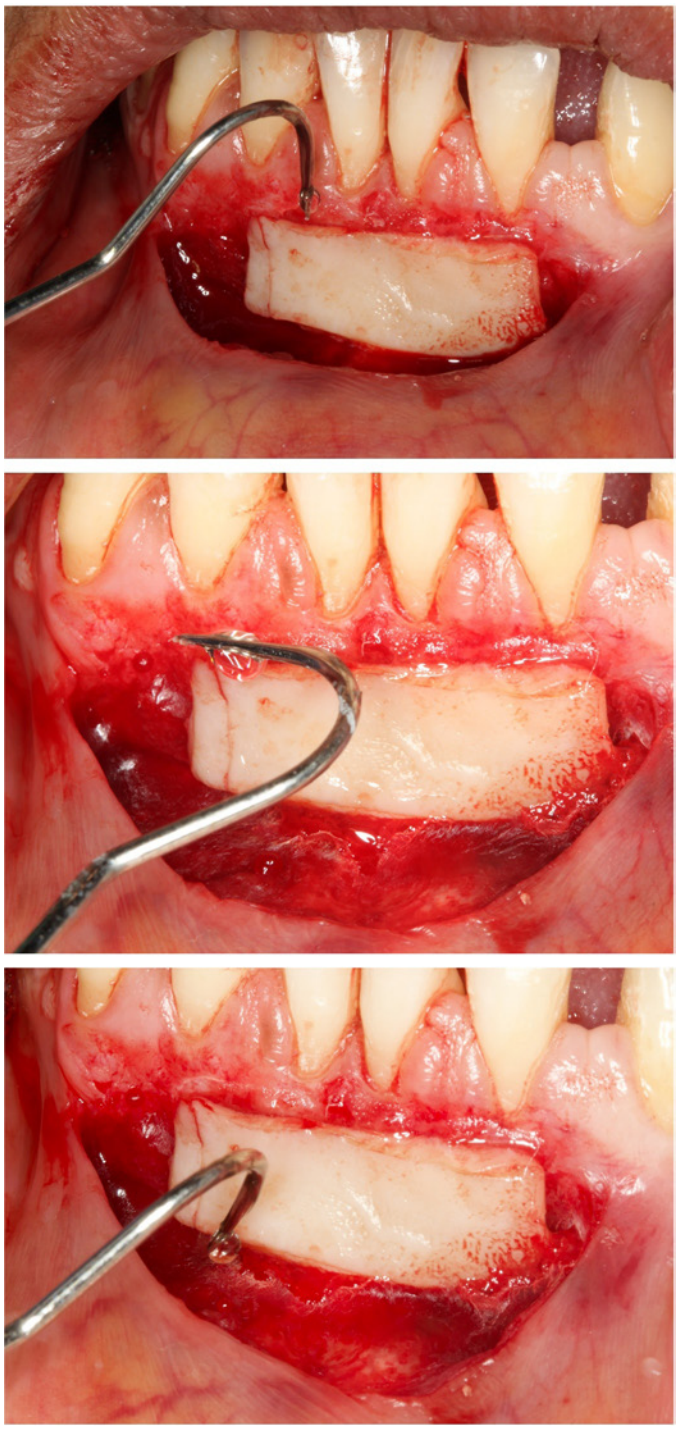

Figure 6. #3 clinical explorer inserting drops of Dermabond® adhesive to seal the graft borders.

The height and length of the graft were measured at baseline (T0), 15 (T1), 30 (T2), 45 (T3), 90 (T4) and 180 (T5) days after surgery, using the modified digital caliper (Yared *et al*., 2006). In addition, probing depth, clinical attachment level and gingival recession measurements were carried out 45, 90 and 180 days after surgery. At 90 and 180 days, the KM and AKM were measured again (Figures 7 and 8).

Qualitative variables were presented as absolute and relative frequencies; and quantitative variables, as mean ± standard deviation (median). Normality of the quantitative variables was assessed using the Shapiro-Wilk test. To compare quantitative variables between the two groups, the Student *t*-test or the Wilcoxon Mann-Whitney test were used, both for independent samples.

Two-way analysis of variance models for repeated measures were constructed to assess the differences between groups (sutured vs. bonded) and within groups (time-points 0, 1, 2, 3, 4, and 5). Paired Student's *t*-test was used for *post-hoc* comparisons between evaluations, and Student's *t*-test for independent samples was used for *post-hoc* comparisons between groups, with *p*-values adjusted with Bonferroni corrections. The analyzes were built on the software R (v. 3.5.1), with a significance level of 5%.

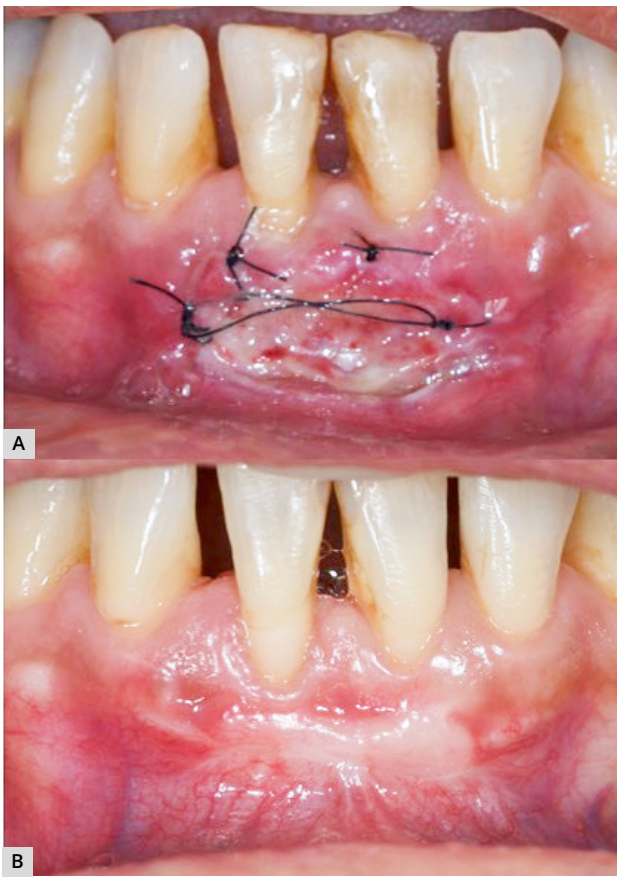

Figure 7. Aspect at (T0), 15 days (A) and 180 days (B) after surgery, in Group 1.

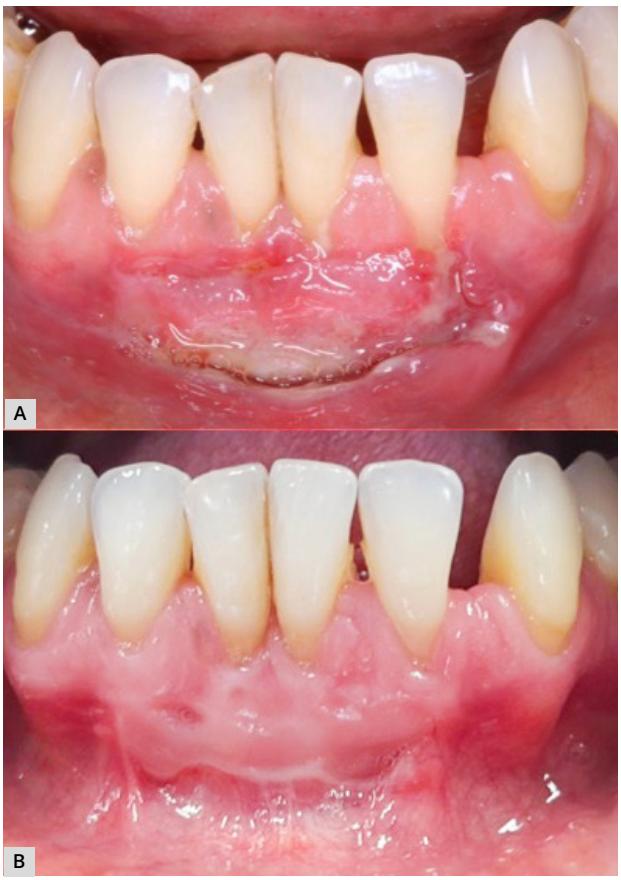

Figure 8. Aspect at (T0), 15 days (A) and 180 days (B) after surgery, in Group 2.

Results

Regarding clinical parameters at T0, GR and CAL values were lower in the sutured group ($p = 0.001$ and $p < 0.001$, respectively), as well as AKM values ($p = 0.011$) (Table 1).

The evaluation of the graft length showed a reduction in all other evaluations in relation to T0, and the T3 evaluation was lower than all other evaluations in the sutured group ($p < 0.001$) (Table 2).

In the evaluation of the graft height, in all evaluations the values of the sutured group were lower than the bonded group ($p < 0.001$). In the Dermabond® group, the T5 score was lower than T1 and T2. In the sutured group, there was a reduction in all evaluations in relation to T0, and T3 was lower in all evaluations ($p < 0.001$) (Table 2).

Table 1. Clinical parameters (T0): Dermabond® fixed grafts *versus* Sutured grafts.

Clinical parameters	Dermabond fixed grafts (n=20) mean ± SD (median)	Sutured grafts (n=16) mean ± SD (median)	p-value
Bleeding on Probing (BP)	-	-	-
Probing depth (PD)	1.25 ± 0.53 (1)	1 ± 0* (1)	0.057[W]
Gingival recession (GR)	3.34 ± 1.51 (3.54)	2.04 ± 0.85 (2)	0.001[T]
Clinical attachment level (CAL)	4.59 ± 1.68 (4.99)	3.02 ± 0.86 (3)	<0.001[T]
Keratinized mucosa (KM)	1.25 ± 0.84 (1.76)	0.98 ± 0.46 (0.89)	0.106[W]
Attached keratinized mucosa (AKM)	0.50 ± 0.43 (0.64)	0.16 ± 0.22 (0)	0.011[W]

* All values are the same.
[W] Wilcoxon Mann-Whitney test for independent samples. [T] Student t-test for independent samples.

Table 2. Evaluation of graft length and height (T0 – T5): Dermabond® fixed grafts *versus* Sutured grafts.

Measures	Dermabond fixed grafts (n=20) mean ± SD (median)	Sutured grafts (n=16) mean ± SD (median)	*p*-value[1]	*p*-value[2]
Length			0.860	<0.001
T0	10 ± 0* (10)	10 ± 0* (10)		
T1	9.58 ± 0.25 (9.54)	9.68 ± 0.23 (9.73)†		
T2	9.60 ± 0.24 (9.61)	9.60 ± 0.22 (9.62)$^{\dagger,€}$		
T3	9.50 ± 0.34 (9.50)	9.28 ± 0.24 (9.24)$^{\dagger,€,‡}$		
T4	9.53 ± 0.35 (9.55)	9.53 ± 0.35 (9.69)†,§		
T5	9.50 ± 0.42 (9.64)	9.53 ± 0.35 (9.68)†,§		
Height			<0.001	<0.001
T0	-	5 ± 0* (5)		
T1	4.62 ± 0.26 (4.69)	3.53 ± 0.12 (3.56)†		
T2	4.55 ± 0.31 (4.64)	3.50 ± 0.19 (3.54)†		
T3	4.48 ± 0.39 (4.49)	3.18 ± 0.10 (3.15)$^{\dagger,€,‡}$		
T4	4.48 ± 0.40 (4.58)	3.60 ± 0.12 (3.58)†,§		
T5	4.35 ± 0.39 (4.34)$^{€,‡}$	3.58 ± 0.12 (3.61)†,§		

* All values are the same.
P-value [1] refers to group comparison, and p-value[2] refers to longitudinal comparison.
† indicates measures significantly different for T0 measure, $^{€}$ for T1 measure, ‡ for T2 measure and § for T3 measure.
For height, in all times there was difference between the groups.

When analyzing the clinical parameters at T0 and T5, lower GR and CAL values were observed in the sutured group in both evaluations (*p*-values 0.009 and 0.005, respectively). There was a reduction in GR and CAL values in both groups, from T0 to T5 ($p<0.001$ for both), and an increase in KM and AKM values from T0 to T5 ($p<0.001$ for both) (Table 3).

The surgical procedure total time was 26'30" for the Dermabond® group and 35'50" for the suture group, with a difference of 9'20".

The time to only fix the graft was 1'10" ± 30" for the Dermabond® group and 9'30" ± 1'30" for the suture group. The mean difference in graft fixation time with Dermabond® was 10' faster than with sutures.

Table 3. Clinical parameters (T0 – T5): Dermabond® fixed grafts *versus* Sutured grafts.

Clinical parameters	Dermabond fixed grafts (n=20) mean ± SD (median)	Sutured grafts (n=16) mean ± SD (median)	*p*-value[1]	*p*-value[2]
Probing depth (PD)			-	-
T0	1.25 ± 0.53 (1)	1 ± 0* (1)		
T5	1 ± 0* (1)	1 ± 0* (1)		
Gingival recession (GR)			0.009	<0.001
T0	3.34 ± 1,51 (3.54)^{G}	2.04 ± 0.85 (2)^{G}		
T5	2.35 ± 1.38 (2.22)^{G,†}	1.49 ± 0.82 (1.4)^{G,†}		
Clinical attachment level (CAL)			0.005	<0.001
T0	4.59 ± 1.69 (4.99)^{G}	3.02 ± 0.86 (3)^{G}		
T5	3.35 ± 1.38 (3.22)^{G,†}	2.50 ± 0.82 (2.43)^{G,†}		
Keratinized mucosa (KM)			0.317	<0.001
T0	1.25 ± 0.84 (1.76)	0.98 ± 0.46 (0.89)		
T5	4.61 ± 0.51 (4.60)†	4.55 ± 0.53 (4.56)†		
Attached keratinized mucosa (AKM)			0.088	<0.001
T0	0.50 ± 0.43 (0.64)	0.16 ± 0.22 (0)		
T5	3.61 ± 0.51 (3.60)†	3.55 ± 0.53 (3.56)†		

* All values are the same.
P-value [1] refers to groups comparison, and p-value[2] refers to longitudinal comparison.
† indicates measures significantly different of T0 measure.
G indicates difference between groups.
For height, in all times there was difference between the groups.

Discussion

The present study highlights that the gingival graft fixation using Dermabond® (medical tissue adhesive) stabilized significantly the height contractions of gingival graft, resulting in improved KM and root coverage, when compared with fixation using sutures. The mean surgical time using Dermabond® was 10' faster than with sutures, and no clinical healing problems were observed. Another point to be considered is that randomized clinical studies using Dermabond® for the fixation of human gingival grafts are scarce in the literature.

Histological studies have demonstrated that the epithelium starts to cover the graft at the edges of the remaining gingiva, by first filling in vital areas. This is considered to be the first manifestation of the acceptance of a graft (Mormann *et al*., 1981; Minsk, 2002).

Grafts with 0.92-mm thicknesses presented a mean contraction of 30%, whereas grafts with smaller thicknesses (0.37mm) presented a greater contraction (about 45%) (Mormann *et al*., 1981). In the present study, all grafts were standardized with similar thicknesses (1mm). Grafts thicker than 1mm presented less primary contraction, due to the ease of revascularization and faster integration into the receiving bed. However, greater secondary contraction may occur (Pennel *et al*., 1969). The height and length contractions in the present study were greatest at the T2 timepoint. These results are consistent with other studies that found greater graft contractions at 30 days (Sullivan and Atkins, 1968; Zingale, 1974; Barbosa *et al*., 2009; Gumus and Buduneli, 2014). The graft contraction seemed to occur in two periods. First, a smaller contraction occurred when the graft thickness was thinner, and a net of vascularization was formed on the grafts (Pennel *et al*., 1969). A second contraction occurred at the graft integration during the healing process (Oliver *et al*., 1968).

The increase in the KM parameters in the present study have great clinical significance, since adequate AKM is necessary for the maintenance of periodontal health. This is consistent with other studies that demonstrate the occurrence of gingival recession in KM bands smaller than 1mm (Pennel *et al*., 1969). Furthermore, it was observed that smaller KM bands correspond to greater severity of gingival recession (Miyasato *et al*., 1977; Al-murabak and Al-Haddab, 2013). In this context, the AKM has a greater capacity to resist trauma (e.g. tooth brushing) compared to the alveolar mucosa (Sullivan and Atkins, 1968).

The narrow AKM bands are associated with a more apical location of the gingival recession, and are not capable of hindering its progression (Agudio *et al*., 2008). Its reestablishment is necessary due to the presence of a persistent inflammatory process and the progression of gingival recession (Stoner and Mazdyasna, 1980).

Creeping attachment is the phenomenon of coronal positioning of the gingival edge during the period of graft repair. It can be affected by numerous factors, including good control of bacterial plaque, teeth location in the arch, narrow areas of recession and normal height of the interproximal alveolar bone (Matter and Cimasoni, 1976; Kennedy *et al*., 1985). The data obtained in the present study (0.99 – 1.52mm) was similar to the values found in the literature. It must be reinforced that the amount of creeping attachment achieved in the present study does not suggest that this procedure should be advocated for root coverage, because the predictability of the technique to cover roots is low (Maynard and Wilson, 1980; Carnio *et al*., 2007). However, the significant improvement in height measurements of keratinized tissue in Dermabond® group could impact in the better root coverage.

No patient presented intercurrence in any period, and after 15 days, it was possible to observe the integration of the gingival graft with adjacent tissues. After the 30-day period, the grafts and the donor areas showed a clinical healing. A significant enlargement of AKM was observed. Furthermore, the difference of color between the graft and the surrounding area was rather minimal in all cases. No subject demonstrated graft mobility. Similar clinical assessments were observed after 45, 90 and 180 days for the groups. Graft behavior during postoperative analysis was very similar in all cases, and healing occurred without any unusual reaction in both groups. Based on results found in the literature, adverse reactions would not be expected in the group of grafts fixed with cyanoacrylate (Frisch and Bhaskar, 1968; Bhaskar *et al*., 1971; Mormann *et al*., 1981; Gumus and Buduneli., 2014; Devrukhkar *et al*., 2015; Khurana *et al*., 2016, AlJasser *et al*., 2021).

Studies highlighted that the use of tissue adhesives for graft fixation technique, as an alternative to sutures, can collaborate to increase the range of keratinized tissue, in addition to reducing healing time: Gümüş and Buduneli (2014), using PeriAcryl®; Goel *et al*. (2021), using Hystoacril®; AlJasser *et al*. (2021), using PeriAcryl®; and Alhourani *et al*. (2022), using Icebergglue® (N-BCA + OCA).

The present study showed that the clinical use of Dermabond® tissue adhesive demonstrates biocompatibility, reduces surgical time, is easier to apply, with faster polymerization and produces immediate homeostasis.

Although there are studies on the use of commercial cyanoacrylate in intraoral application, as stated by Veríssimo *et al*. (2021) in a systematic review, there is scarce literature regarding tissue adhesives in the fixation of free gingival grafts, especially when referring to the use of a specific composition of these adhesives for medical use, such as Dermabond®. Only one study, so far, was found with Dermabond® application, but in animal models (De Paula *et al*. 2021).

Considering the clinical advantages of the use of Dermabond® in gingival grafts, the present study presented some limitations, such as the convenience sample and the small number of patients remaining by the end of the study, and some topics could not be in agreement with Consort protocol for clinical studies.

Conclusions

A significant increase of the keratinized mucosa band and attached keratinized mucosa was obtained in both groups. Moreover, the use of Dermabond® tissue adhesive allowed the surgical procedure to be completed faster, and did not cause detectable changes during clinical examination or during the entire process of graft healing.

Regarding dimensional stability, and root coverage in free gingival grafts fixed by Dermabond®, tissue adhesive presented greater height stability.

Clinical significance

Graft fixation with Dermabond® tissue adhesive increased the height of keratinized mucosa and root coverage, when compared with sutures. It did not alter the clinical healing process, reduced the surgical time, and it has clinical potential to be used as a first option to fix free gingival grafts.

Acknowledgments

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References

Agudio G, Nieri M, Rotundo R, Cortellini P and Pini Prato G. Free gingival grafts to increase keratinized tissue: a retrospective long-term evaluation (10 to 25 years) of outcomes. *Journal of Periodontology* 2008; **79**(4):587-594.

AlJasser RN, AlSarhan MA, AlOtaibi DH, AlOraini S. AlNuwaiser R, AlOtaibi A, and Zafar MS. Comparison of polymeric cyanoacrylate adhesives with suturing in free gingival graft stability: a split mouth trial. *Polymers* 2021; **13**(20):3575.

Alhourani MA, Kasem T, and Hamadah O. Comparative study between using a tissue adhesive (N-BCA & OCA) and surgical sutures in free gingival graft surgery: A randomized controlled clinical trial. *Dental and Medical Problems* 2022; **59**(2):241-248.

Al-mubarak L and Al-Haddab M. Cutaneous wound closure materials: An overview and update. *Journal of Cutaneous and Aesthetic Surgery* 2013; **6**:178-88.

Altman DG, Bland JM. How to randomize. *BMJ*. 1999; **319**(7211):703-704.

Barbosa FI, Corrêa DS, Zenóbio EG, Costa FO and Shibli JA. Dimensional changes between free gingival grafts fixed with ethyl cyanoacrylate and silk sutures. *Journal of the International Academy of Periodontology* 2009; **11**(2):170-176.

Bhaskar SN, Beasley III JD, Cutright DE and Perez B. Free mucosal grafts in miniature swine and man. *Journal of Periodontology* 1971; **42**:322-330.

Bhaskar SN, Frisch J, Margetis PM and Leonard F. Application of a new chemical adhesive in periodontics and oral surgery. *Oral Surgery. Oral Medicine. Oral Pathology. Oral Radiology* 1966; **22**:526-535.

Breault LG, Fowler EB, Moore EA and Murray DJ. The free gingival graft combined with the frenectomy: a clinical review. *General Dentistry* 1999; **47**:514-518.

Brock G. The occasional wound "gluing". *Canadian Journal of Rural Medicine* 2016; **21**(4):113-116.

Carnio J, Camargo PM and Passanezi E. Increasing the apico-coronal dimension of attached gingiva using the modified apically repositioned flap technique: A case series with a 6-month followup. *Journal of Periodontology* 2007; **78**(9):1825-1830.

Coatoam GW, Behrents RG and Bissada NF. The width keratinized gingival during orthodontic treatment: its significance and impact on periodontal status. *Journal of Periodontology* 1981; **52**(6):307-313.

De Paula DS, Lima LVR,Cavalcante RB, de Barros Silva PG, Alves APNN, and da Silva BR. Fixation of free gingival grafts with cyanoacrylate glues: A histomorphometric and immunohistochemical study. *The Saudi Dental Journal* 2021; **33**:1063-1070.

Devrukhkar VN, Hegde RJ, Khare SS, Saraf TA. Evaluation of isoamyl 2-cyanocrylate tissue adhesive in management of pediatric lacerations: An alternative to suturing. *Annals of Maxillofacial Surgery* 2015; **5**:49-54.

Frane JW. A method of biased coin randomization, its implementation and validation. *Drug Inf J*. 1998; **32**:423-32.

Frisch J and Bhaskar SN. Free mucosal graft with tissue adhesives: Report of 17 cases. *Journal of Periodontology* 1968; **39**:190-195.

Goel A, Ghai D, Sood A, Singh GP, Nagi PK, and Singh P. A comparative evaluation of silk suture and cyanoacrylate adhesive in the stabilization of free gingival graft harvested with erbium: Yttrium-aluminum-garnet laser: A clinical study. *Journal of Pharmacy & Bioallied Sciences* 2021; **13**(Suppl 2):1672.

Gümüş P and Buduneli E. Graft stabilization with cyanoacrylate decreases shrinkage of free gingival grafts. *Australian Dental Journal* 2014; **59**(1):57-64.

Harris RJ. Clinical evaluation of 3 techniques to augment keratinized tissue without root coverage. *Journal of Periodontology* 2001; **72**:932-938.

Kennedy JE, Bird WC, Palcanis KG and Dorfman HS. A longitudinal evaluation of varying widths of attached gingiva. *Journal of Clinical Periodontology* 1985; **12**(8):667-675.

Khurana JV, Mali AM, Mali RS and Chaudhari AU. Comparative evaluation of healing after periodontal flap surgery using isoamyl 2-cyanocrylate (bioadhesive material) and silk sutures: A split-mouth clinical study. *Journal of Indian Society of Periodontology* 2016; **20**:417-22.

Lang NP and Löe H. The relationship between the width of keratinized gingival and gingival health. *Journal of Periodontology* 1972; **43**:623-627.

Malhotra V, Dayashankara Rao JK, Arya V, Sharma S, Singh S and Luthra P. Evaluating the use of octyl-2-cyanoacrylate in unilateral cleft lip repair. *National Journal of Maxillofacial Surgery* 2016; **7**:153-8.

Matter J and Cimasoni G. Creeping attachment after free gingival grafts. *Journal of Periodontology* 1976; **47**:574-579.

Maynard JG Jr and Ochsenbein C. Mucogingival problems, prevalence and therapy in children. *Journal of Periodontology* 1975; **46**(9):543-552.

Maynard JG Jr and Wilson RD. Diagnosis and management of mucogingival problems in children. *Dental Clinics of North America* 1980; **24**:683-703.

Minsk L. Periodontal soft tissue grafting: the free gingival graft. *Compendium of Continuing Education in Dentistry* 2002; **23**:850-852.854.856.

Miyasato M, Crigger M and Egelberg J. Gingival condition in areas of minimal and appreciable width of keratinized gingiva. *Journal of Periodontology* 1977; **4**:200–209.

Mörmann W, Schaer F and Firestone AR. The relationship between success of free gingival grafts and transplant thickness-Revascularization and shrinkage. A one-year clinical study. *Journal of Periodontology* 1981; **52**:74-80.

Nabers JM. Extension of the vestibular fornix utilizing a gingival graft—case history. *Periodontics* 1966; **4**(2):77-79.

Oliver RC, Löe H and Karring T. Microscopic evaluation of the healing and revascularization of free gingival grafts. *Journal of Periodontal Research* 1968; **3**:84-95.

Pennel BM, Tabor JC, King KO, Towner JD, Fritz BD, and Higgason JD. Free masticatory mucosa graft. *Journal of Periodontology* 1969; **40**:162-166.

Stoner JE and Mazdyasna S. Gingival recession in the lower incisor region of 15-year-old subjects. *Journal of Periodontology* 1980; **51**(2):74-76.

Sullivan HC and Atkins JH. Free autogenous gingival grafts. 3. Utilization of grafts in the treatment of gingival recession. *Periodontics* 1968; **6**(4):152-160.

Sullivan HC and Atkins JH. Free autogenous gingival grafts. I. Principles of successful grafting. *Periodontics* 1968; **6**:121-129.

Veríssimo AH, Ribeiro AKC, Martins ARLDA, Gurgel BCDV, and Lins RDAU. Comparative analysis of the hemostatic, analgesic and healing effects of cyanoacrylate on free gingival graft surgical wounds in donor and recipient areas: a systematic review. *Journal of Materials Science: Materials in Medicine* 2021; **32**(9): 98.

Wennstrom JL and Zucchelli G. Increased gingival dimensions. A significant factor for successful outcome of root coverage procedures? A 2-year prospective clinical study. *Journal of Clinical Periodontology* 1996; **23**:770-777.

Yared KF, Zenobio EG and Pacheco W. Periodontal status of mandibular central incisors after orthodontic proclination in adults. *American Journal of Orthodontics and Dentofacial Orthopedics* 2006; **130**(1):6.e1-8.

Zingale JA. Observations on free gingival autografts. *Journal of Periodontology* 1974; **45**:748-759.