

# Is preoperative vestibular depth a factor affecting shrinkage of free gingival graft: A quasi-experimental study

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## Research article

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# Abstract

**Background** The purpose of the present study was to evaluate the effect of preoperative vestibular depth (VD) on FGG dimensional shrinkage.

**Methods** This study was performed on 20 patients with insufficient attached gingiva width (AGW). Under local anesthesia, a partial thickness bed with submarginal incision was created. An FGG was prepared from the palate and sutured to the prepared bed. Clinical parameters including VD, probing depth (PD), keratinized gingiva width (KGW), AGW, vertical graft dimension (VGD), horizontal graft dimension (HGD) and graft area (GA) were evaluated preoperatively and 1, 3, and 6 months postoperatively. Because the distribution of data was normal, t-test and repeat measurement test were performed to analyze the data.

**Results** Six months after FGG surgery, AGW and KGW raised to  $6.15 \pm 1.01$  mm and  $7.55 \pm 1.1$  mm, which were statistically significant ( $P < 0.001$ ). The shrinkage rate of HGD, VGD, and GA were 13%, 34%, 42% respectively after 6 months. The VD was increased 2.05 mm compared to baseline which was statistically significant ( $P < 0.01$ ). 6 months after surgery, KGW and AGW were  $6.95 \pm 0.89$  mm and  $5.62 \pm 0.88$  mm in patients with baseline VD  $< 9$  mm, and  $8.57 \pm 0.53$  mm and  $7.07 \pm 0.34$  mm in patients with baseline VD  $\geq 9$  mm respectively. The difference of postoperative KGW and AGW between these two groups (based on baseline VD) was statistically significant. ( $P < 0.01$ ,  $P = 0.001$  respectively). The decrease in KGW and AGW in patients with VD  $< 9$  mm was 1.62 and 1.45 mm respectively after 6 months and this decrease was greater than patients with VD  $\geq 9$  mm.

**Conclusions** It was concluded that the shrinkage of FGG was significantly greater in patients with less preoperative VD 6 months after surgery.

**Trial registration:** This study was retrospectively registered by Iranian Registry of Clinical Trials (IRCT) with the number: IRCT20101204005305N18. Registered 22 September 2019. <https://irct.ir/trial/41736>

## Background

It is widely accepted that mucogingival problems often affect patients aesthetically and functionally (1, 2). However, existing literature has not documented minimal attached gingiva width to maintain periodontal health. An increase in attached gingiva width is required in cases of inadequate attached gingiva, especially in orthodontic or prosthetic treatments, better plaque removal from the gingival margin, and aesthetic improvement (3–8).

FGG is the most common technique to increase keratinized and attached gingiva width (9, 10). Palatal mucosa is the most common site for FGG preparation, because of the close histologic resemblance to keratinized gingiva (11–13). The high predictability and stability for more than four years of newly formed keratinized tissue is one of the benefits of this method (14).

After FGG surgery, newly formed keratinized tissue shrinks an average of 30–45% during the first year. The shrinkage rate in the vertical dimension is higher than shrinkage rate in the horizontal dimension (15, 16). The success of gingival graft techniques is reduced by graft shrinkage (17). Graft preparation from the tuberosity area, graft with an appropriate thickness, using the graft on the denuded bone surface, application of atraumatic methods and graft fixation with minimal suture can all reduce graft shrinkage rate during the healing phase (1, 18–21).

Preoperative VD may be another factor affecting FGG shrinkage. Based on the recent literature review that we performed, there wasn't any study about this topic. It has been shown that gingival recession and inadequate width of keratinized gingiva are commonly associated with shallow vestibular depth and high attached muscle fibers (22, 23). Shallow vestibular depth prevents the insertion of removable prosthesis as well as compromises oral health control procedures (24). It also compromises the apical stability of graft tissue due to the greater effects of muscle attachment, and eventually causes graft shrinkage in the vertical dimension within one year after surgery. In other hand, the vestibular depth also decreases within one year after surgery, because of graft shrinkage (25–31).

Due to the lack of documents in the literature regarding the effect of preoperative vestibular depth on the amount of FGG shrinkage, this study was conducted to investigate the effect of preoperative vestibular depth on the postoperative FGG shrinkage rate.

## Methods

### Study design and population

The design of the present study was quasi-experimental and the gathered data analyzed before and after the intervention. The study population consisted of patients who referred periodically to the Department of Periodontics at the Faculty of Dentistry, Kerman University of Medical Sciences, with inadequate attached gingiva associated with single-rooted teeth of mandibular jaw (premolars, canines or incisors). The participants were entered in this study by non-probability sampling (convenience) method. The sample size was calculated considering  $\alpha = 0.05$ ,  $\beta = 0.2$ ,  $d = 1.15$ , and in view of the standard deviation difference (2.5) and mean difference (1.8) acquired in hatipoglu's study (12). The result was 18 cases and by taking into account the 10 percent possibility of sample loss, sample size was set on 20.

The criteria for inclusion in the study were as follows: the need for gingival augmentation in single-rooted teeth of mandibular jaw considering KGW <2 mm, AGW <1 mm, no need for root coverage, need for prosthetic or orthodontic treatments, need for improvement of oral hygiene, no systemic diseases that contraindicated periodontal surgery, not using medications affecting on periodontium, no pregnancy, no smoking, no traumatic occlusion and acceptable oral hygiene (O'Leary plaque index less than 20%). The exclusion criteria in this study were as follows: poor oral hygiene, need to use medication affecting the periodontium during follow-up period, incomplete follow-up data.

Prior to conducting this study, the procedure was fully explained to each patient, potential problems were identified, and then a consent form was signed by the participants. This study was approved by the Kerman University of Medical Science with ethics code of IR.KMU.REC.1391.06 and with IRCT registration number: IRCT20101204005305N18 (Registration date 2019-09-22).

### **Pre-operative measurements:**

KGW, AGW, PD, and VD were measured before surgery. The KGW [the mid-buccal distance from the gingival margin to the mucogingival junction (MGJ) of the tooth] was determined by a Michigan-O-Probe\* with 0.5-mm accuracy using a Roll technique to determine MGJ and then, the mid-buccal AGW was calculated by subtracting the gingival probing depth (PD) from the KGW.

To determine the VD, alginate impression was prepared from the patient and special tray was made after casting. Then, after border molding, an alginate impression was taken again. After preparation of final cast, the deepest part of the vestibule was marked with a pencil and the distance of the mid-buccal gingival margin to the line marked in the vestibular depth was measured in millimeter (Fig.1).

### **Surgical procedure:**

After prepping and draping, local anesthesia<sup>†</sup> was injected (2% lidocaine with 1/100,000 epinephrine) in recipient and donor sites. In the recipient bed, a partial-thickness incision was made using a 15c blade. the coronal incision was made sub-marginally at the MGJ, and two vertical incisions were created 10 mm apart and were extending apically as far as the vestibules allowed at a height of at least 9 mm, at both ends of the horizontal incision. The mesial and distal incisions were then connected apically. Any muscle fibers were removed with scissors creating an appropriate periosteal bed. Then, the FGG was prepared by using a mucotome<sup>‡</sup> with a thickness of 1.5 mm and a dimension of 9 x 10 mm from the palatal area of the maxillary premolars and first molar with preserving the marginal gingiva at donor site (containing epithelium and a thin layer of underlying connective tissue). The reason for using the mucotome was to equalize the graft thickness. The graft donor site was covered with periodontal dressing after suturing with a 5-0 silk suture<sup>§</sup>.

The prepared FGG was adapted on the recipient bed and the lip or cheek adjacent to the graft was placed under tension to make certain that the grafts were free of movement during muscle traction. The graft stabilized with a 5-0 seralon® suture<sup>¶</sup>. Interrupted sutures were applied in the coronal border and vertical stabilizing sutures were used for graft fixation. Then, FGG in the recipient site was covered with periodontal dressing.

After surgery, the patients were advised not to brush the treated sites within two postoperative weeks, and instructed to use a soft diet. Chlorhexidine mouthwash 0.2% was prescribed twice daily for 4 weeks and ibuprofen 400 mg tablets were also prescribed every 6 hours as needed. After two weeks, dressing and sutures were removed, the surgical sites were washed with normal saline and plaque control was initiated by the patients.

## Postoperative measurements:

Post-surgery measurements were consisted of PD, VD, KGW and AGW, HGD, VGD and GA. The HGD and VGD were measured in the midway of apico-coronal and mesio-distal dimensions of FGG (Fig. 2). The GA was calculated by multiplying its length and width. The shrinkage percentage of VGD and HGD and the GA shrinkage were calculated using the following Formulas.

$$\frac{\text{Preoperative horizontal dimension} - \text{postoperative horizontal dimension}}{\text{preoperative horizontal dimension}} \times 100 = \text{horizontal shrinkage}$$

$$\frac{\text{preoperative vertical dimension} - \text{postoperative vertical dimension}}{\text{preoperative vertical dimension}} \times 100 = \text{vertical shrinkage}$$

$$\frac{\text{preoperative area} - \text{postoperative area}}{\text{preoperative area}} \times 100 = \text{Area shrinkage}$$

The above measurements were repeated 1, 3 and 6 months after surgery.

## Statistical analysis

Data were analyzed using SPSS 18 software. Kolmogorov-Simonov test was performed to analyze the normal distribution of the data. Given the normal distribution of the data, T-test and repeated measurement test were applied.

## Results

One patient was excluded from the study because of failing to follow-up, therefore, this study was performed on 19 remaining patients (11 females and 8 males) with the mean age of 37 years. Postoperative healing of all cases was normal and no unexpected complication was recorded.

The results of this study showed that the KGW was  $1.81 \pm 0.62$  mm preoperatively, which increased to  $8.5 \pm 1.26$  mm,  $8.02 \pm 1.25$  mm and  $7.55 \pm 1.1$  mm, 1, 3 and 6 months after surgery, respectively. This increase was statistically significant at all times ( $P < 0.001$ ) (Table 1).

The AGW was  $0.39 \pm 0.54$  mm before surgery, which increased to  $7.1 \pm 1.08$  mm,  $6.65 \pm 1.11$  mm and  $6.15 \pm 1.01$  mm, 1, 3 and 6 months after surgery, respectively. The results showed a statistically significant increase in the AGW during different measurement steps compared to pre-operation ( $P < 0.001$ ) (Table 1).

The results showed that the VD was  $9.02 \pm 1.74$  mm before surgery, which reached to  $9.26 \pm 1.40$  mm,  $10.31 \pm 1.27$  mm and  $11.07 \pm 1.37$  mm, 1, 3 and 6 months after surgery, respectively. This increase in VD was statistically significant ( $P < 0.001$ ) (Table 1). The HGD was  $10.18 \pm 1.16$  mm at baseline, decreased to  $9.36 \pm 1.09$  mm,  $9.15 \pm 1.14$  mm and  $8.92 \pm 1.18$  mm, 1, 3 and 6 months after surgery, respectively. The highest descending changes were during the first month after surgery. The results showed a statistically significant difference in the different measurement steps compared to baseline ( $P < 0.001$ ) (Table 1). The

VGD was  $8.89 \pm 0.45$  mm before surgery, changed to  $6.65 \pm 0.85$  mm,  $6.28 \pm 0.82$  mm and  $5.89 \pm 0.77$  mm, 1, 3 and 6 months after surgery, respectively. Overall, changes in the VGD had a descending trend over time, and most of the changes occurred during the first month after surgery. This change was statistically significant ( $P < 0.001$ ) (Table 1).

The KGW and AGW were  $7.83 \pm 0.98$  mm and  $6.5 \pm 0.82$  mm in patients with VD less than 9 mm in the first postoperative month, whereas in patients with  $VD \geq 9$  mm, values were  $9.64 \pm 0.80$  and  $8.14 \pm 0.55$  mm, respectively. The results showed that the decrease in KGW and AGW was significantly greater in patients with  $VD < 9$  mm in the first month after surgery ( $P < 0.001$ ). The decrease in KGW and AGW was also greater in patients with the baseline  $VD < 9$  mm in the third and sixth months after surgery in comparison with the patients with the baseline  $VD \geq 9$  mm ( $P < 0.001$  and  $P < 0.01$  respectively) (Table 2).

## Discussion

The present study was carried out to assess the effect of preoperative VD on postoperative FGG shrinkage. In this study, the KGW and AGW increased significantly after surgery compared to baseline ( $P < 0.001$ ). The amount of new KG and AG averaged 5.74 mm and 5.76 mm respectively. This amount of increase was in accordance with the results of McGuire's study.(32) In the McGuire's study, the results showed that the average increase of KGW was 3.65 mm in the control group (FGG). This amount was less than in our study, because of the different baseline widths of FGG in the two studies (4 mm v 9 mm). Silva et al. reported 5.4 mm increase in KGW which was in accordance with our study (33).

The change in PD was not significant after surgery ( $P = 0.10$ ). This result was similar to the other related studies. (34, 35) The shrinkage of FGG was one of the variables which assessed in this study. The shrinkage of FGG in horizontal and vertical dimensions was statistically significant at months 1,3, and 6 after surgery ( $P < 0.001$ ).

HGD shrinkage was 0.82 mm (8.05%) and 1.26 mm (12.3%) at 1 and 6 months after surgery. The greatest amount of shrinkage of HGD was occurred in the first month after surgery.

In Hatipoglu's study, an average of 10.2% horizontal shrinkage was reported (36). In another study, Guncu et al. evaluated the effect of tissue adhesives on dimensional shrinkage of FGG. In this study, 14.25% horizontal shrinkage was shown in the control group (using suture for graft stabilization) at 3 months after surgery (37). The different amount of horizontal shrinkage of FGG in these three studies can be because of the different dimensions and thickness of FGG at the baseline. In Hatipoglu's and Guncu's studies, the baseline dimensions of FGGs were not equal and standard, and the thickness of FGG varied between 1 to 2 mm. In the present study, the primary dimensions of FGG were about  $10 \times 9$  mm and the thickness of FGG was about 1.5 mm because of the use of mucotome.

In a study conducted by Silva et al., the mean horizontal graft shrinkage was 22% in non-smokers and 25% in smokers after three months, which was higher than our results (10.1%) (33). The primary horizontal dimension of prepared FGG in Silva's study was about 14 mm and in our study was about

10 mm. This difference in amount of shrinkage may be partly related to different horizontal dimension of FGG. It can be concluded that if the primary horizontal dimension of FGG is greater, the horizontal shrinkage of FGG will be more. This is only a hypothesis and more studies will be needed to approve it.

In our study, the mean vertical graft shrinkage was 3 mm (33.74%) after six months. Mörmann et al. showed an average vertical graft shrinkage of 42.3% after 12 months postoperatively (38). In the study of Wei et al., the mean vertical graft shrinkage in the control group (FGG) was 16% six months after surgery (39). Hatipoglu et al. reported that the mean vertical graft shrinkage after 6 months was 24.8%. (12) The difference in baseline vertical dimension of FGGs, the thickness of FGGs and the type of suturing techniques may be the causes of these different results.

The most horizontal and vertical graft shrinkage were occurred during the first month after surgery (8.05%, 25.19% respectively) and the shrinkage of the vertical dimension was more than the horizontal dimension. This finding was in accordance with the other studies. (12, 33, 40) In the present study, the mean GA decreased by 42.2% during the follow-up period, which was statistically significant ( $P < 0.001$ ). Hatipoglu et al. obtained similar result and showed that graft shrinkage was 35.3% after six months. (12) The shrinkage of FGGs is a well-known clinical event that happens during graft healing in the first postoperative year and the width of new keratinized gingiva remains stable thereafter (40).

The most important variable which was evaluated in this study was VD. The results of the present study showed that the VD had increased 2.05 mm after 6 months and this change was statistically significant ( $P < 0.01$ ). In an old study which was carried out by Egli et al., the mean increase of VD was 2.3 mm after 12 months (29). In Egli's study, the VD was measured from the incisal edge to the floor of the vestibular fold, minus the distance from the incisal edge to the gingival margin. This measurement may be encountered with some errors during realizing the floor of the vestibular fold. But in the present study, all VD measurements were done on the prepared casts to increase the precision.

In this study, since the median VD was statistically 9.02 mm, the patients were divided into two groups of  $VD < 9$  mm and  $VD \geq 9$  mm in order to evaluate the effect of VD on FGG shrinkage rate. The KGW and AGW were 7.83 and 6.5 mm in patients with  $VD < 9$  mm in the first month after surgery, whereas 9.64 and 8.14 mm in patients with  $VD \geq 9$  mm, respectively. After 6 months, the KGW and AGW were reduced in patients with  $VD < 9$  mm, 1.62 and 1.45 mm more than the patients with  $VD \geq 9$  mm, which was statistically significant ( $P < 0.01$ ,  $P = 0.001$  respectively). More shrinkage of FGG vertical dimension in patients with  $VD < 9$  mm may be in accordance to tendency of dissected muscular fibers to insert into their original sites. In lesser VD, the muscular fibers are located more coronal and reattachment to them prevent apical stabilization of graft during healing phase. In recent literature review, we did not find a similar study to compare the results. To assess the shrinkage of FGG, some factors such as preparation of recipient bed (partial thickness or denuded)(20), dimensions of FGG, thickness of FGG(41), performing of periosteal fenestration or not, the flap apical to the recipient bed, phenotype of periodontium(42), suturing techniques, type and size of suture(17, 43), preoperative VD and muscular forces may interfere in

healing of graft and affect the final results(27). Therefore, doing a study with this wide range of confounders is very difficult, but considering these factors is necessary to design the future studies.

## Conclusions

Based on the results of this study, the decrease in KGW and AGW was significantly greater in patients with VD <9 mm, six months after FGG surgery. It was concluded that people with shallow preoperative VD showed greater graft shrinkage compared to individuals with greater preoperative VD.

## Abbreviations

Free gingival graft (FGG)

Vestibular depth (VD)

Attached gingival width (AGW)

Probing depth (PD)

Keratinized gingival width (KGW)

Vertical graft dimension (VGD)

Horizontal graft dimension (HGD)

Graft area (GA)

Mucogingival junction (MGJ)

Standard deviation (SD)

## Declarations

**Ethics approval and consent to participate:** This study was approved by the Kerman University of Medical Sciences with ethics code of IR.KMU.REC.1391.06. A written informed consent was obtained before surgical treatment.

**Consent for publication:** Not applicable

**Availability of data and materials:** The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

**Competing interests:** The authors declare that they have no competing interests

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**Authors' contributions:** Mohammad Mohammadi conceived the ideas; Moein Saeedi & Mohadeseh Arab Solghar collected the data; Hadi Ranjbar analyzed the data; Mahsa Jalali wrote the article.

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## FOOTNOTES

\* Hu-Friedy, USA

† Darou Pakhsh Company, Tehran, Iran

‡ PR4, DEPPELER, Swiss

§ Coe-Pak, GC, Japan

|| SUPA medical devices, IRAN

¶ Serag Wiessner, Naila, Germany

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## Tables

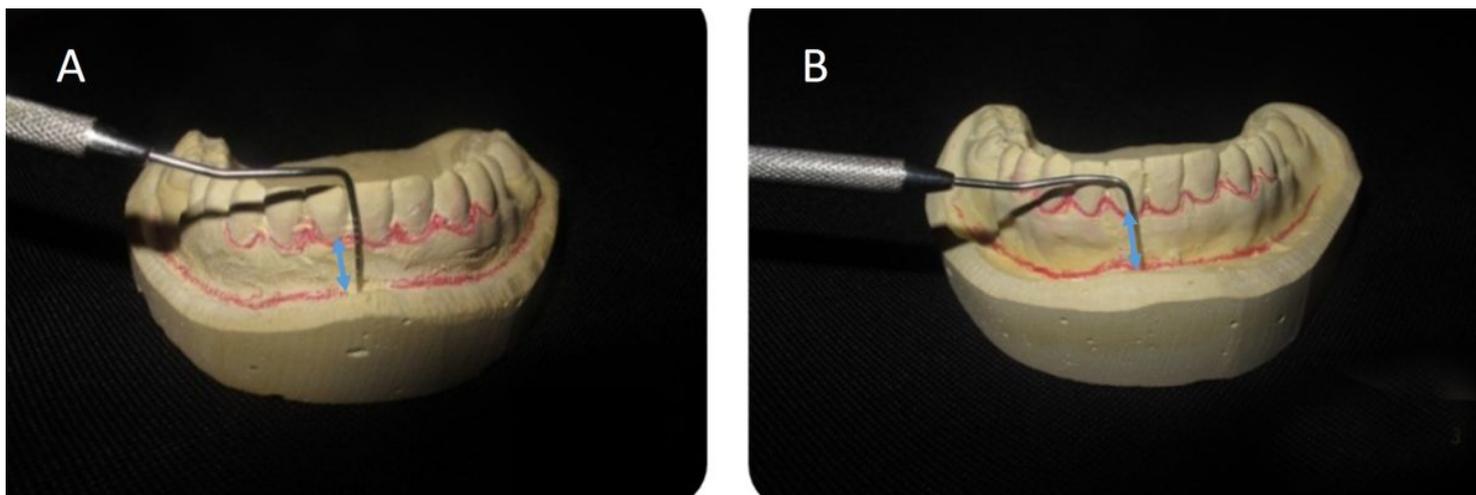
Table 1 - Clinical parameters (Mean±SD) at baseline and 1, 3 and 6 months after surgery

Clinical parameters	Baseline	1 month	3months	6 months	P value
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	
Keratinized gingiva width (mm)	1.81±0.62	8.5±1.26	8.02±1.25	7.55±1.1	<0.001
Attached gingiva width (mm)	0.39±0.54	7.1±1.08	6.65±1.11	6.15±1.01	<0.001
Probing depth (mm)	1.58±0.53	1.39±0.39	1.37±0.36	1.39±0.35	0.10
Vestibular depth (mm)	9.02±1.74	9.26±1.40	10.31±1.27	11.07±1.37	<0.001
Horizontal graft dimension (mm)	10.18±1.16	9.36±1.09	9.15±1.14	8.92±1.18	<0.001
Vertical graft dimension (mm)	8.89±0.45	6.65±0.85	6.28±0.82	5.89±0.77	<0.001
Graft area (mm <sup>2</sup> )	90.71±12.21	62.80±12.91	57.98±12.09	52.90±11.25	<0.001

Table 2 - Effect of baseline vestibular depth on the width of keratinized and attached gingiva 6 months after Surgery

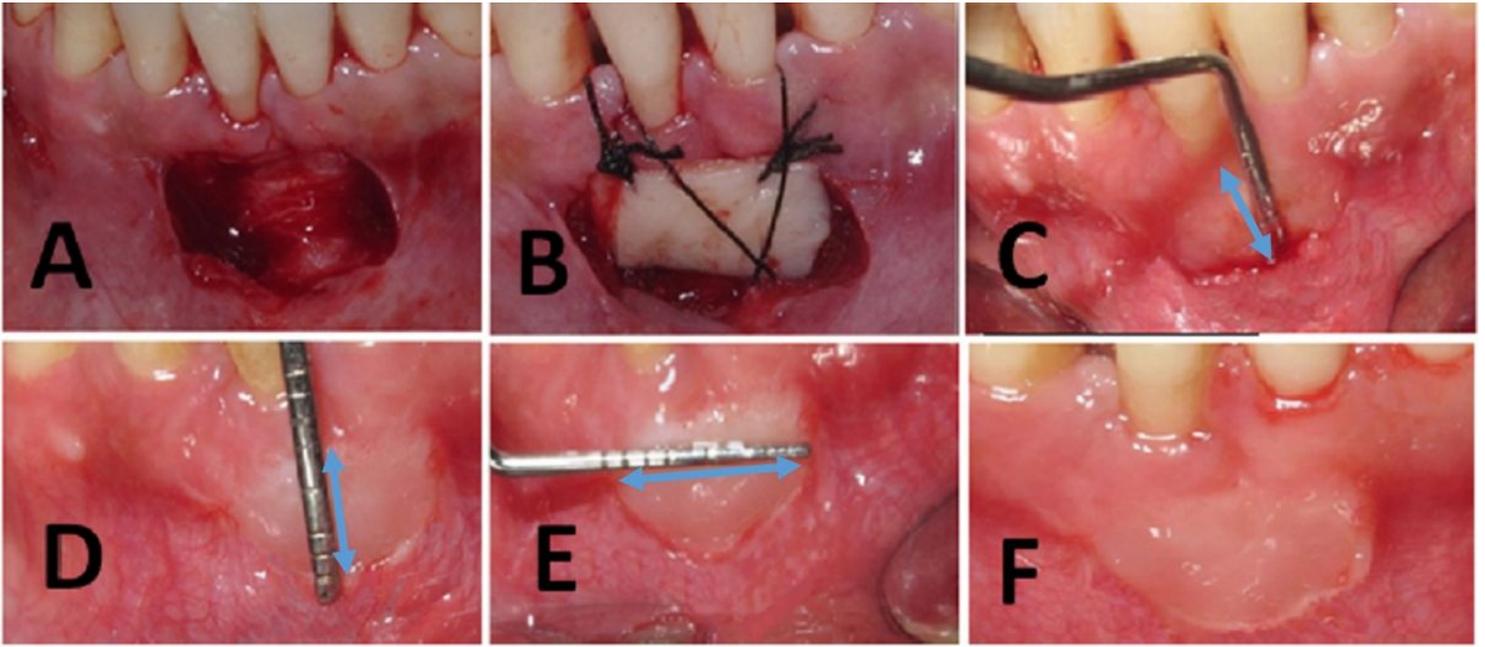
Clinical parameter	Vestibular depth		P Value		
	< 9mm	≥ 9mm			
Attached gingiva width	1 month	Mean ± SD(mm)	6.50±0.82	8.14±0.55	<0.001
	3 months	Mean ± SD(mm)	6.04±0.91	7.71±0.39	<0.001
	6 months	Mean ± SD(mm)	5.62±0.88	7.07±0.34	0.001
Keratinized gingiva width	1 month	Mean ± SD(mm)	7.83±0.98	9.64±0.80	0.001
	3 months	Mean ± SD(mm)	7.33±0.93	9.21±0.69	<0.001
	6 months	Mean ± SD(mm)	6.95±0.89	8.57±0.53	P <0.01

## Figures



**Figure 1**

Preoperative vestibular depth. (A) Vestibular depth 6 months after operation. (B)



**Figure 2**

Preparation of recipient site (A) Graft placement on recipient site (B) Vertical graft dimension one month after operation (C) Vertical graft dimension Three months after operation (D) Horizontal graft dimension Three months after operation (E) Free gingival graft after six month (F)