International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 21s, 2025
https://theaspd.com/index.php

The Effect of Single Versus Double Screws in Tenting Screw Technique for Horizontal Ridge Augmentation Before Dental Implant Placement: A Randomized Clinical Trial

Omar Saad Abd ElSalam[1], Antonious Naeem Ayad[2], Ahmed Abdel Meguid Mustafa[3], Ahmed Abdallah Khalil[3]
[1]Department of oral medicine, oral diagnosis and periodontology, faculty of dentistry, Minia university, Minia, Egypt. (https://orcid.org/0009-0000-2652-1937),
[2]Lecturer of oral and Maxillofacial Radiology, Faculty of Dentistry Minia University, Minia, Egypt. (https://orcid.org/0000-0001-5068-5536),
[3]Professor of oral medicine, oral diagnosis and periodontology, faculty of dentistry, Minia university, Minia, Egypt. (https://orcid.org/0000-0003-0060-6785).
***Corresponding author**: Omar Saad Abd ElSalam**,** Department of oral medicine, oral diagnosis and periodontology, faculty of dentistry, Minia university, Minia, Egypt. omar.sa3d12pg@dent.s-mu.edu.eg, https://orcid.org/0009-0000-2652-1937
Received date: 06-09-2023
Accepted date: 17-10-2023
Published date: 15-06-2024

***Abstract: Objectives**: Dental implants have emerged as a significant therapeutic modality for partial and total edentulism. Elevated failure rates have been linked to implants positioned in resorbed ridges with inadequate alveolar bone architecture. Objectives: The aim of this work was to evaluate the effectiveness of screw tent technique in horizontal ridge augmentation and compare the effect of using single screw versus double screws on obtaining maximum bone gain. **Materials and Methods:** This randomized clinical trial was conducted on 16 patients requiring horizontal ridge augmentation (class I Seibert's classification) in premolar and molar area aged from 20 to 55 years old, both sexes. Patients were randomly allocated into two equal groups: Group A indicated for lateral ridge augmentation in premolar-molar area was candidates for screw tent technique using single screw at crest position, and group B indicated for lateral ridge augmentation in premolar-molar area was candidates for screw tent technique using double screws, one at a crestal position and the other one 5 mm apical to the first one. **Results:** Regarding clinical and radiographic data, the amount of bone width gains both at alveolar crest and 5mm apically was statistically significant for both groups ($P < 0.05$). No significant difference was observed between group A and group B preoperative, and 6 months postoperative regarding width at alveolar crest and width at 5 mm apically ($P > 0.05$). **Conclusions**: The present study demonstrated that the screw tenting technique is effective for horizontal ridge augmentation. Both groups showed comparable improvements in alveolar ridge width after six months. So, using double screws doesn't provide any clinical or radiographic significance over using single screw for horizontal ridge augmentation in screw tenting technique.*
***Keywords:** Allograft, Alveolar Ridge Augmentation, Dental Implantation, Bone Screws, Guided Bone Regeneration, Demineralized Bone Matrix.*

INTRODUCTION

Dental implants have emerged as a significant therapeutic option for addressing partial and total edentulism. Elevated failure rates have been linked to implants positioned in resorbed ridges with inadequate alveolar bone architecture. The placement of implants at suboptimal sites due to bone insufficiency may result in the application of oblique forces on the implant during function, hence significantly augmenting the force magnitude exerted on the surrounding bone [(1)].

Numerous classification schemes for alveolar ridge abnormalities have been suggested. In 1983, Seibert presented his extensively utilized taxonomy of ridge defects. In this classification, Class I defects denote buccolingual tissue loss with normal apicocoronal ridge dimensions, Class II defects indicate apicocoronal tissue loss with normal buccolingual ridge dimensions, and Class III defects signify deficiencies in both width and height [(2)].

Bone regeneration and in patients with markedly atrophic ridges have persistently been a subject of debate. Despite the availability of several procedures, identifying a suitable method that imparts qualities to bone akin to those of the recipient site might be challenging [(2)].

Multiple alveolar ridge augmentation techniques exist to achieve sufficient bone volume and thereafter implement the optimal treatment plan. Guided Bone Regeneration, Ridge Splitting, Distraction Osteogenesis, and Autogenous Block Bone Grafting are primary procedures that yield good results in the reconstruction of bone defects. It is challenging to establish that one augmentation approach yields superior effects compared to another. Research on augmentation strategies appears to be consistent and reports positive outcomes for each method [(3)].

Guided Bone Regeneration (GBR) is a widely utilized technique that involves positioning a membrane over the defect to establish a protected environment, allowing osteogenic cells to migrate and remain undisturbed over the exposed section of the implant [4, 5].

The tenting approach, derived from guided bone regeneration principles, entails elevating the periosteum to facilitate osteoblast migration into the gap, so initiating osteogenesis. The gap is filled using osteoinductive or osteoconductive materials, or a combination of both. A barrier-like collagen membrane can restrict epithelial cell migration [6, 7, 8].

The aim of this work was to evaluate the effectiveness of screw tent technique in horizontal ridge augmentation and compare the effect of using single screw versus double screws on obtaining maximum bone gain.

MATERIALS AND METHODS

The study has been approved by the research ethics committee of the Faculty of Dentistry, Minia University (Committee No: 88- Decision No: 626).

The study is registered at the U.S. National Library of Medicine website of clinical trials (clinicaltrials.gov) under ID: NCT07060027.

The sample size calculation was conducted using G Power software through a paired T test. The significance threshold was established at 0.01 (type I error), with a total power of 95%. The effect size was determined to be 2.14, based on ridge width gain after 6 months utilizing the tenting screw technique from prior studies. The minimum sample size calculated was 8 for each group, resulting in a total sample size of 16 for both groups.

All participants were aged from 20 to 55 years old, both sexes, systemically healthy according to the dental modification of the Cornell index questionnaire. Only patients with deficient sites in premolar molar area were selected. Gingival health according to the new classification system [9], The augmentation recipient site is devoid of any pathological diseases, possesses at least one tooth area with a ridge deficiency, and is intended to receive a dental implant. The region must be delineated by a minimum of one tooth, have a class I ridge defect as per Seibert's classification, and possess sufficient interocclusal space to support the requisite restorative components. The exclusion criteria included pregnant females, individuals with parafunctional behaviors such as bruxism and clenching, and smokers.

Grouping and randomization:

Patients were randomly allocated using computer generated randomization tables into two equal groups: Group A indicated for lateral ridge augmentation in premolar-molar area (class I Seibert's classification) was candidates to screw tent technique using single screw at crest position, and group B indicated for lateral ridge augmentation in premolar-molar area (class I Seibert's classification) was candidates to screw tent technique using double screws, one at a crestal position and the other one 5 mm apical to the first one..

All patients underwent comprehensive periodontal examinations, standardized periapical radiographs, and diagnostic study casts. Horizontal ridge width was measured with a bone calliper to the nearest millimetre at the midride crestal level and 5 mm apically (figure 1.d & figure 2.d). Stent was used for the standardization of the measurements, a preoperative cone-beam computed tomography (CBCT) was conducted to assess bone height and width as well as the quality of the underlying bone, and clinical and radiographic measurements were reiterated at re-entry following a 6-month healing period.

Surgical Phase:

All patients were administered prophylactic antibiotics (1 gm Amoxicillin-clavulanate, Augmentin ®, GlaxoSmithKline, UK) one hour before surgery and subsequently every twelve hours for four days. They were also instructed to rinse with 0.12% Chlorhexidine (Orovex ®, MACRO, Egypt) for one minute prior to surgery and twice daily for two weeks postoperatively. All procedures were performed under local anaesthesia utilizing articaine hydrocholoride 4% with 1:100000 epinephrine (Septanest®, Septodont, USA). Sulcular incisions around teeth with mesial or distal vertical releasing incisions if needed. A full thickness flap is reflected on the buccal, and a full thickness flap is reflected on the lingual/palatal to expose the residual alveolar ridge (figure 1.c & figure 2.c). Multiple cortical perforations were performed with a 1/2 round bur to increase angiogenesis and supply of growth factors in all defect areas (figure 1.e & figure 2. e). In group A: single titanium tenting screw was placed in a crestal position to aid in graft stability (figure 1.f) while in group B: double titanium tenting screws were placed, one at a crestal position and the other one placed 5 mm apical to the first one (figure 2.f). The screws that were used had 1.4 mm body diameter, 7-9 mm screw length and 3 mm screw head diameter. In both groups the defect was filled with allogenic putty demineralized bone matrix (Maxxeus® Community tissue service, USA) with a buccal overlay of cortico-cancellous particulate allograft (Maxxeus® Community tissue service, USA), The graft was extended by a minimum of 10 to 12 mm in the apicocoronal orientation (figure 1.g & figure 2.g). The grafted site was covered with Bovine pericardium membrane (Tuto patch® rti surgical, Germany), the membrane was stabilized by bone tacs and periosteal sutures (figure 1.h and figure 2.h). Tension-free primary flap closure was accomplished and secured with a 5-0 Polypropylene suture (Assut®, Pully-Lausanne, Switzerland). The sutures were removed after 2 weeks. 6 months later at the re-entry, the tenting screws were removed and dental implant (Dual®, titan industries, Egypt) was placed at the augmented site.

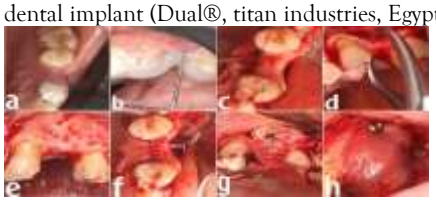

Figure 1: illustrating a clinical case of group A. (a) preoperative view of ridge. (b) measuring KM width using prefabricated stent. (c, d) flap reflection and measuring of ridge width using bone caliper. (e) multiple cortical perforations. (f) tenting screw in place at crestal position. (g) filling the defect with allogenic DBM and buccal overlay of corticocancellous particulate allograft. (h) membrane fixation using bone tacs.

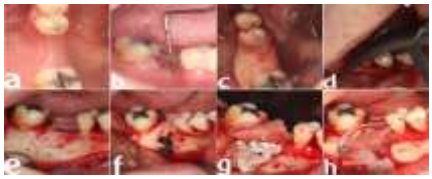

Figure 2: illustrating a clinical case of group B. (a) preoperative view of ridge. (b) measuring KM width using prefabricated stent. (c, d) flap reflection and measuring of ridge width using bone caliper. (e) multiple cortical perforations. (f) tenting screws in place one at crestal position and the other is 5 mm apically. (g) filling the defect with allogenic DBM and buccal overlay of corticocancellous particulate allograft. (h) membrane fixation using bone tacs.

Postoperative instructions:

Standard verbal and written postoperative instructions for periodontal surgery were provided to all patients, including ice compression on the surgical site for the initial 4 hours and a liquid and/or soft food diet for 3 days. As with other surgical treatments, patients were advised to contact our clinic if any complications arose during the postoperative period. Patients were monitored for indications of discomfort, inflammation, infection, wound dehiscence, or membrane exposure 24 hours postoperatively, subsequently daily for the first week, and then monthly for six months.

Clinical assessment:

At the six-month re-entry, Keratinised Mucosa Width (KMW) was assessed using a periodontal probe to the nearest millimetre, while horizontal ridge width was measured using a bone calliper to the nearest millimetre at the midridge crestal level and subsequently 5 mm apically. Same stent was used for the standardization of the measurements

Radiographic evaluation:

CBCT was used to measure ridge width and bone density at baseline and at 6 months postoperatively. Prior to CBCT scan, patient's position was adjusted using Frankfort-Horizontal plane and the office floor as reference points. All cases were acquired with the SCANORA® 3Dx CBCT dental device (Scan duration 18 - 34 seconds, Effective exposure duration 2.4 - 6 seconds, Focal point 0.5 mm, kV 60-90, mA 4-10). CBCT scans of the patients were stored in "Digital Imaging and Communications in Medicine" (DICOM) format. The axial, sagittal, coronal, and reconstructed CBCT 3D images were transformed utilising the OnDemand application. For standardization of the measurements the coronal view should show the bone and screws. In the axial view the sagittal plane should be perpendicular on the long axis of the mandible. The coronal view window was maximized. The coronal view is the master view in radiographic measurement, The lens was used to zoom in till the side ruler reached 1 cm, The ruler was used to measure. All the measurements were taken 3 times by an oral and maxillofacial radiologist then, we took the mean average to reduce the operator (radiologic bias) errors. All CBCTs were taken prior to and six months following the surgical surgery. The DICOM files were segmented, and the coronal view was used as the master view in the radiographic reading.

A baseline grid was superimposed over the baseline image, which included the following reference lines: a "Vertical Line" (VL) at the bucco-oral centre of the ridge, and "Horizontal Lines" (HL) perpendicular to VL at the bone crest and 5mm apical to the bone crest. Horizontal ridge width gain was the difference between ridge width at baseline and 6 months following augmentation at each Crestal level and 5mm apically. Bone density was measured by using the bone profile icon in the OnDemand software tools. We take the mean average of the bone density level at 5mm apically to considered as the bone density of the segmented area, after that and all readings after that were analyzed. Graphical abstract showing the study design is shown in Figure 3.

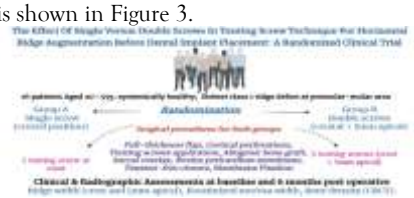

Figure 3: Graphical abstract of the study.

Statistical analysis

Statistical analysis was performed with IBM® SPSS® (ver. 26. SPSS Inc., IBM Corporation, Armonk, NY, USA). Data explored for normality using Shapiro-Wilk test. Quantitative data were presented by mean and standard deviation. Paired t test was used to compare between two means before and after treatment within each group. Independent t test used to compare means between two groups. Pearson correlation analysis was used to describe the association between numerical variables within each group. A statistically significant level was considered when p value < 0.05.

RESULTS

In this study, 35 patients were evaluated for eligibility; 10 did not satisfy the requirements, and 9 declined to participate. The remaining 16 patients were randomly allocated to two groups, with 8 patients in each group. All assigned patients were monitored and subjected to statistical analysis. **Figure 4**

Figure 4: CONSORT flowchart of the studied groups

Regarding clinical data, for group A, the preoperative mean ridge width was 3.25±0.88 at alevolar crest and was 6.38±1.27 at 5mm apically. 6 months later clinical analysis showed that postoperative mean ridge increased to 5.37±0.58 at alveolar crest and to 9.13±1.32 at 5 mm apically. In group B, the preoperative mean ridge width was 2.5±0.38 at alveolar crest and was 5.75±1.43 at 5mm apically. 6 months later clinical analysis showed that postoperative mean ridge width increased to 4.87±0.58 at alveolar crest and to 8.13±1.21 at 5mm apically. The amount of bone width gains both at alveolar crest and 5mm apically was statistically significant for both groups (P <0.05). KMW decreased from 2.88±0.58 to 2.63±0.79 in group A and from 2.50±0.53 to 2.12±0.58 in group B. the amount of reduction in KMW in both group A and group B was statistically significant (P=0.033, P=0.048, respectively). There was no significant difference seen between groups A and B preoperative, and 6 months postoperative regarding width at alveolar crest, width at 5mm apically, and KMW (P>0.05). **Table 1**

Table 1: Comparison of clinical data of group A and group B preoperative, and 6 months postoperative (n = 16)

	Time of measurement		**Mean difference (CI 95%)**	**P value**
	Group A Before (n=8)	**Group A 6 months After (n=8)**		
Width at alveolar crest	3.25±0.88	5.37±0.58	2.12 (1.96 - 3.22)	**0.003***
Width at 5mm apically	6.38±1.27	9.13±1.32	2.75 (1.73 - 3.77)	**< 0.0001***
Width of keratinized mucosa	2.88±0.58	2.63±0.79	-0.025 ((-0.47) - (-0.02))	**0.033***
	Group B Before (n=8)	Group B 6 months After (n=8)		
Width at alveolar crest	2.5±0.38	4.87±0.58	2.38 (1.88 - 2.86)	**< 0.0001***
Width at 5mm apically	5.75±1.43	8.13±1.21	2.38 (1.58-3.17)	**< 0.0001***
Width of keratinized mucosa	2.50±0.53	2.12±0.58	-0.37 ((-0.74) – (-0.004))	**0.048***
	Group A preoperative (n=8)	**Group B preoperative (n=8)**		
Width at alveolar crest	3.25±0.88	2.5±0.38		0.064
Width at 5mm apically	6.36±1.27	5.75±1.43		0.373
Width of keratinized mucosa	2.88±0.58	2.50±0.53		0.201
	Group A 6 months postoperative (n=8)	**Group B 6 months postoperative (n=8)**		
Width at alveolar crest	5.37±0.58	4.87±0.58		0.108
Width at 5mm apically	9.13±1.32	8.13±1.21		0.139
Width of keratinized mucosa	2.63±0.79	2.12±0.58		0.172

Data are presented as mean ± SD. *: significant as P value <0.05.

Regarding radiographic data, for group A, the preoperative mean ridge width was 3.27±1.33 at alevolar crest and was 7.07±1.47 at 5mm apically (figure 4.a). 6 months later radiographic analysis showed that postoperative mean ridge increased to 5.31±0.17 at alveolar crest and to 9.66±1.97 at 5 mm apically (figure 4.b). In group B, the preoperative mean ridge width was 2.41±0.91 at alveolar crest and was 6.58±1.72 at 5mm apically (figure 5.a). 6 months later clinical analysis showed that postoperative mean ridge width increased to 4.79±0.88 at alveolar crest and to 8.75±1.63 at 5mm apically (figure 5.b). The amount of bone width gains both at alveolar crest and 5mm apically was statistically significant for both groups (P <0.05). Bone density slightly increased from 556.6±228 to 558.8±149.04 in group A and from 475.7±219.6 to 596.7±90.14 in group B. the increased amount of bone density in both groups was statistically insignificant (P=0.974, P=0.105, respectively). There was no significant difference seen between both groups preoperative, and 6 months postoperative regarding width at alveolar crest, width at 5mm apically, bone density (P>0.05). **Table 2.**

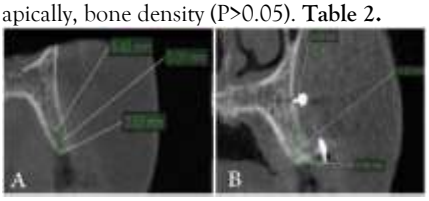

Figure 4: radiographic case of group A. a) Preoperative radiographic, b) 6 months 1postoperative radiograph

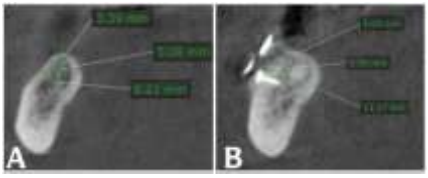

Figure 5: radiographic case of group B. a) Preoperative radiographic, b) 6 months postoperative radiograph

Table 2: Comparison of radiographic data of group A and group B preoperative, and 6 months postoperative (n = 16)

	Time of measurement		Mean difference (CI 95%)	P-value
	Group A Before (n=8)	**Group A 6 months After (n=8)**		
Width at alveolar crest	3.27±1.33	5.31±0.17	2.05 (0.88 - 3.22)	**0.004***
Width at 5mm apically	7.07±1.47	9.66±1.97	2.58 (1.26 - 3.90)	**0.002***
Bone density	556.6±228.5	558.8±149.04	2.0 (-137.4 - 141.9)	**0.974**
	Group B Before (n=8)	**Group B 6 months After (n=8)**		
Width at alveolar crest	2.41±0.91	4.79±0.88	2.38 (1.71 - 3.06)	**<0.0001***
Width at 5mm apically	6.58±1.72	8.75±1.63	2.18 (1.12 - 3.23)	**0.002***
Bone density	475.7±219.6	596.7±90.14	121.0 (-32.78 - 274.7)	0.105
	Group A preoperative (n=8)	**Group B preoperative (n=8)**		
Width at alveolar crest	3.27±1.33	2.41±0.91		0.158
Width at 5mm apically	7.07±1.47	6.58±1.72		0.545
Bone density	556.6±228.5	475.7±219.6		0.481
	Group A 6 months postoperative (n=8)	**Group B 6 months postoperative (n=8)**		
Width at alveolar crest	5.31±0.17	4.79±0.88		0.123
Width at 5mm apically	9.66±1.97	8.75±1.63		0.333
Bone density	58.8±149.04	596.7±90.14		0.548

Data are presented as mean ± SD. *: significant as P value <0.05.

Discussion

After tooth extraction, bone remodelling can lead to inadequate ridge dimensions, making it difficult to insert dental implants in a proper three-dimensional location. The resulting bone deficiency, often accompanied by soft tissue loss, presents a significant obstacle for clinicians in ensuring proper implant placement. To address these challenges, bone augmentation procedures, both horizontal and vertical, are commonly employed. These techniques, grounded in various biological principles, are designed to restore adequate bone volume and provide a stable foundation for dental implants [10].

This study is the first to directly compare the effects of using a single screw versus double screws in the screw tent technique for horizontal ridge augmentation prior to dental implant placement. There has been no prior research specifically assessing the impact of adding a second screw placed 5 mm apically to the first.

We hypothesized that the addition of a second, apically positioned screw in the screw tent technique would offer improved support for the graft material, particularly in cases where the graft is subjected to compressive forces. This configuration could theoretically enhance the containment of the graft material, promoting more uniform bone regeneration compared to the single-screw configuration.

By introducing this novel approach, this study aimed to fill a gap in the literature, offering a recent prospection on how dual screw placement might enhance bone regeneration and improve the outcomes of ridge augmentation.

The materials and techniques used for horizontal ridge augmentation were carefully selected to optimize bone regeneration and ensure successful outcomes. The use of allograft material was pivotal due to its osteoconductive properties, biocompatibility, and ability to act as a scaffold for new bone formation. Allografts also eliminate the need for a secondary donor site, thereby reducing patient morbidity [11].

To enhance angiogenesis and improve the regenerative potential, cortical perforations were performed at the defect sites. This technique promotes the migration of osteogenic cells into the grafted area, thereby improving vascularization and bone regeneration [12].

In this study, a statistically significant increase was observed six months after the screw tent technique using a single screw, compared to baseline measurements, in both the width at the alveolar crest and the width at 5 mm apically ($P < 0.05$). However, no significant changes were noted in bone density between the preoperative and postoperative assessments. Radiographically, there was a significant increase in the width at the alveolar crest and at 5 mm apically ($P < 0.05$) six months postoperatively. Conversely, a statistically significant reduction in KMW was noted over the same period. We noted the same results in the double screw group.

Our findings align with Deeb GR et al. study [13] and César Neto JB et al. study [14], that have demonstrated the effectiveness of screw tenting techniques in horizontal ridge augmentation. The current study demonstrated an average horizontal ridge width gain of 2.75 mm in group A and 2.38 mm in group B after 6 months of healing period. The average gain in horizontal width for this study was slightly less than the 3.22 mm reported in Caldwell study [15] in 2015, and the 3.00 mm reported in Tu Lam study [16] in 2020. In 2019, Naenni published a systematic review of prospective studies comparing primary bone augmentation procedures [17]. The average gain recorded in trials using radiographic analysis for horizontal bone augmentation was 2.90 ± 0.83 mm, whereas clinical analysis yielded 3.45 ± 1.18 mm. In comparable to this systematic review, the present study shows an average gain less than the results pooled from the systematic review as the studies that were included had used different augmentation techniques, bone grafts and biomaterials. Additional factors that make difference in bone width gain among studies include: the phenotype of the soft tissue, surgical technique, the experience of the surgeons, initial bone width and defects anatomy.

A minority of papers in the systematic review performed radiographic assessment [18,19, 20, 21, 22, 23], None used CBCT superimposition to standardize the region of interest. Only one study conducted both clinical and radiographic analyses on the same sample [22].

Another systematic review published by Elnayef in 2018 concluded that the final gain of the studies that used GBR in lateral ridge augmentation is 2.59±023 mm which is almost the same as our study results [24].

No instances of membrane exposure or infection at the graft sites were documented throughout the 6-month follow-up, potentially attributable to the tension-free flap design. Various investigators have documented varied frequencies of consequences, including infection [15, 25] and membrane exposure [18, 20, 26, 27].

The significant increase of ridge width in both groups may be due to the ability to create a stable environment for graft material using tenting screws aids in maintaining space, promoting new bone formation, and ensuring dimensional stability. This stability is critical for effective angiogenesis and osteogenesis, enhanced further by the cortical perforations that stimulate growth factor release [14].

In the current study the results reveal reduction in KMW compared to the preoperative measurements in both groups from 2.88±0.58 mm to 2.63±0.79 mm (P= 0.033) and from 2.63±0.79 mm to 2.12±0.58 mm (P= 0.048) in group A and group B, respectively. Postoperative swelling and flap advancement along with large graft volume can lead to considerable vestibular depth reduction itself a potentially significant, although usually temporary in nature, complication. This is often accompanied by significant coronal advancement of the mucogingival junction. In addition, there's no statistical significance (p=0.172) between the postoperative KM width reduction in both groups A and B, this indicate that neither using single screw nor double screws have an advantage on the behalf of KM width as the same surgical protocol, flap advancement and suturing technique was used in both groups. These findings agree with Cockerham's study that was published in 2020 which had reduction in KM from 4.3 ± 1.8 to 3.6 ± 1.6 and from 4.1± 2.0 to 3.5±1.7 in both groups of the study respectively [28].

Our findings demonstrate a slight increase in bone density in both groups. In Group A, bone density changed from 556.6 ± 228.5 to 558.8 ± 149.04 (P = 0.974), while in Group B, it increased from 475.7 ± 219.6 to 596.7 ± 90.14 (P = 0.105). These changes were not statistically significant. It is worth noting that bone density may require more than six months to exhibit statistically significant changes, which could explain the lack of significant findings within the study period. In addition, there's no statistical significance (P= 0.548) between the postoperative increase of density in both groups A and B this indicate that neither using single screw or double screws have an advantage on the behalf of bone density as the same allogenic graft material has been used in both groups.

The present study employed an innovative radiographic technique to assess ridge dimensional alterations in buccolingual width after horizontal ridge augmentation. The robust association seen between the majority of clinical and radiographic width measurements substantiates the utilized radiographic method. This facilitated accurate measurements and a concurrent assessment of ridge dimensions alterations with negligible to no mistakes in the reproducibility of measurement locations. This supports the prospective application of this method in similar study designs.

The present study demonstrated that the screw tenting technique is effective for horizontal ridge augmentation, with no significant differences in clinical or radiographic outcomes between single and double screw configurations. Both groups showed comparable improvements in alveolar ridge width, bone density, and comparable reduction KMW after six months, indicating that a single screw provides sufficient stabilization for graft materials in most cases. So, using double screws doesn't provide any clinical or radiographic significance over using single screw for horizontal ridge augmentation in screw tenting technique

This study had several limitations that should be considered. The relatively small sample size of 16 patients may limit the generalizability of the findings, and the 6-month follow-up period may not be long enough to assess the long-term stability of the augmented ridge. The exclusion criteria, which included individuals with parafunctional habits and smokers, may not reflect the full spectrum of patients who might require such procedures. Subsequent research including bigger sample sizes and prolonged follow-up durations is essential to validate these findings and assess the long-term effects of "Ridge Augmentation" employing these methodologies.

CONCLUSION

The present study demonstrated that the screw tenting technique is effective for horizontal ridge augmentation. Both groups showed comparable improvements in alveolar ridge width after six months. So, using double screws doesn't provide any clinical or radiographic significance over using single screw for horizontal ridge augmentation in screw tenting technique.

Author contributions

Dr. Omar Saad Abd ElSalam was responsible for conceptualization and design of the study, collecting the data and writing the manuscript, Dr. Antonious Naeem Ayad was responsible for the radiographic assessment, Professor. Ahmed Abdel Meguid Mustafa, Professor Ahmed Abdallah Khalil were responsible for the reviewing and revising the manuscript.

Acknowledgement and funding

There was no external support for this study and no one to acknowledge

Conflict of Interest

The authors have no conflicts of interest to declare

Ethical approval

The study has been approved by the research ethics committee of the Faculty of Dentistry, Minia University (Committee No: 88- Decision No: 626). An informed consent was obtained from all participants included in this study.

REFERENCES

1. Amr A, Ghaffar KA, Elhamid E. Xenogenic flexible bone lamina graft: a successful alternative to the autogenous onlay bone block graft in alveolar ridge augmentation: a clinical, radiographic and histological evaluation. J. Dent. Treatment Oral. Care. 2017;1. DOI: 10.12816/0032612

2. **Jensen O**. Site classification for the osseointegrated implant. J Prosthet Dent. 1989;61(2):228–34.

https://doi.org/10.1016/0022-3913(89)90380-7
3. **Aytekin M, Arisan V**. Alveolar ridge augmentation techniques in implant dentistry. In: Oral and Maxillofacial Surgery. IntechOpen; 2020. https://doi.org/10.5772/intechopen.94285
4. **Elgali I, Omar O, Dahlin C, Thomsen P**. Guided bone regeneration: materials and biological mechanisms revisited. Eur J Oral Sci. 2017;125(5):315–37. https://doi.org/10.1111/eos.12364
5. **Vijayalakshmi R, Rajmohan CS, Deepalakshmi D, Sivakami G**. Use of platelet rich fibrin in a fenestration defect around an implant. J Indian Soc Periodontol. 2012;16(1):108–12. https://doi.org/10.4103/0972-124X.94616
6. **Khojasteh A, Behnia H, Shayesteh YS, Morad G, Alikhasi M**. Localized bone augmentation with cortical bone blocks tented over different particulate bone substitutes: a retrospective study. Int J Oral Maxillofac Implants. 2012;27(6):1481–93.
7. **Takata T, Wang HL, Miyauchi M**. Migration of osteoblastic cells on various guided bone regeneration membranes. Clin Oral Implants Res. 2001;12(4):332–38. https://doi.org/10.1034/j.1600-0501.2001.012004332.x.
8. **Marx RE, Shellenberger T, Wimsatt J, Correa P**. Severely resorbed mandible: Predictable reconstruction with soft tissue matrix expansion (tent pole) grafts. J Oral Maxillofac Surg. 2002;60(8):878–89. https://doi.org/10.1053/joms.2002.33856
9. **Caton JG, Armitage G, Berglundh T, Chapple I, Jepsen S, Kornman KS, Mealey BL, Papapanou PN, Sanz M, Tonetti MS**. A new classification scheme for periodontal and peri-implant diseases and conditions - Introduction and key changes from the 1999 classification. J Clin Periodontol. 2018;45(Suppl 20):S1–S8. https://doi.org/10.1111/jcpe.12935
10. **El Naggar NES, Tawfik MA-M, Ahmed M**. Tenting screws versus conventional fixation screws for vertical augmentation of mandibular ridge. Int J Dent Med Sci Res. 2022;4:567–78. DOI: 10.35629/5252-0406567578
11. **Ashfaq R, Kovács A, Berkó S, Budai-Szűcs M**. Developments in alloplastic bone grafts and barrier membrane biomaterials for periodontal guided tissue and bone regeneration therapy. Int J Mol Sci. 2024;25. https://doi.org/10.3390/ijms25147746
12. **Danesh-Sani S, Tarnow D, Yip J, Mojaver R**. The influence of cortical bone perforation on guided bone regeneration in humans. Int J Oral Maxillofac Surg. 2017;46:261–6. https://doi.org/10.1016/j.ijom.2016.11.002.
13. **Deeb GR, Tran D, Carrico CK, Block E, Laskin DM, Deeb JG**. How effective is the tent screw pole technique compared to other forms of horizontal ridge augmentation? J Oral Maxillofac Surg. 2017;75:2093–8. https://doi.org/10.1016/j.joms.2017.04.017
14. **César Neto JB, Cavalcanti MC, Sapata VM, Pannuti CM, Hämmerle CH, Naenni N**, et al. The positive effect of tenting screws for primary horizontal guided bone regeneration: a retrospective study based on cone-beam computed tomography data. Clin Oral Implants Res. 2020;31:846–55. https://doi.org/10.1111/clr.13665
15. **Caldwell GR, Mills MP, Finlayson R, Mealey BL**. Lateral alveolar ridge augmentation using tenting screws, acellular dermal matrix, and freeze-dried bone allograft alone or with particulate autogenous bone. Int J Periodontics Restorative Dent. 2015;35:75–83. https://doi.org/10.11607/prd.2260
16. Doan TL, Le LD. Efficacy of the tent-pole technique in horizontal ridge augmentation. Pesqui Bras Odontopediatria Clin Integr. 2020;20. doi:10.1590/pboci.2020.109. https://doi.org/10.1590/pboci.2020.109
17. **Naenni N, Lim H, Papageorgiou SN**, et al. Efficacy of lateral bone augmentation prior to implant placement: A systematic review and meta-analysis. J Clin Periodontol. 2019;46(Suppl 21):287–306. https://doi.org/10.1111/jcpe.13052
18. **Antoun H, Sitbon JM, Martinez H, Missika P**. A prospective randomized study comparing two techniques of bone augmentation: onlay graft alone or associated with a membrane. Clin Oral Implants Res. 2001;12(6):632–9. https://doi.org/10.1034/j.1600-0501.2001.120612.x
19. **Aarújo PM**. Análise clínica de substituto ósseo em bloco para aumento horizontal e influência no sucesso dos implantes osseointegrados- estudo em humanos. Odontologia do Centro de Ciências. Brazil: Saúde da Universidade Federal de Santa Catarina; 2016.
20. **Beitlitum I, Artzi Z, Nemcovsky CE**. Clinical evaluation of particulate allogeneic with and without autogenous bone grafts and resorbable collagen membranes for bone augmentation of atrophic alveolar ridges. Clin Oral Implants Res. 2010;21:1242–50. https://doi.org/10.1111/j.1600-0501.2010.01936.x
21. **Da Costa CE, Pelegrine AA, Fagundes DJ, Simoes Mde J, Taha MO**. Use of corticocancellous allogeneic bone blocks impregnated with bone marrow aspirate: A clinical, tomographic, and histomorphometric study. Gen Dent. 2011;59(5):e200–e205.
22. **de Freitas RM, Susin C, Spin-Neto R, Marcantonio C, Wikesjo UM, Pereira LA, Marcantonio EJ Jr**. Horizontal ridge augmentation of the atrophic anterior maxilla using rhBMP-2/ACS or autogenous bone grafts: A proof-of-concept randomized clinical trial. J Clin Periodontol. 2013;40:968–75. https://doi.org/10.1111/jcpe.12148
23. **Mazzocco F, Nart J, Cheung WS, Griffin TJ**. Prospective evaluation of the use of motorized ridge expanders in guided bone regeneration for future implant sites. Int J Periodontics Restorative Dent. 2011;31:547–54.
24. **Elnayef B, Porta C, Suárez-López Del Amo F, Mordini L, Gargallo-Albiol J, Hernández-Alfaro F**. The fate

of lateral ridge augmentation: A systematic review and meta-analysis. Int J Oral Maxillofac Implants. 2018;33(3):622–35. https://doi.org/10.11607/jomi.6290
25. Maiorana C, Beretta M, Salina S, Santoro F. Reduction of autogenous bone graft resorption by means of bio-oss coverage: a prospective study. Int J Periodontics Restorative Dent. 2005 Feb;25(1):19-25.
26. **Shalash MA**, **Rahman HA**, **Azim AA**, **Neemat AH**, **Hawary HE**, **Nasry SA**. Evaluation of horizontal ridge augmentation using beta tricalcium phosphate and demineralized bone matrix: A comparative study. J Clin Exp Dent. 2013;5:e253–e259. https://doi.org/10.4317/jced.51244
27. **Mordini L**. Analysis of bone volume changes following lateral guided bone regeneration. Master Thesis, Tufts University School of Dental Medicine. 2016.
28. Cockerham BL 3rd, Patel A, Greenwell H, Hill M, Shumway B, Hsu HT. Ridge Augmentation Comparing a Cancellous Block Allograft to an Osteoinductive Demineralized Bone Matrix Allograft: A Randomized, Controlled, Blinded Clinical Trial.