ORIGINAL RESEARCH

Comparison between Modified Bone-splitting Technique and Distraction Osteogenesis in Horizontal Alveolar Ridge Expansion: Randomized Clinical Study

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Abstract

Aim: This study aimed to compare modified ridge splitting (RS) and distraction osteogenesis (DO) for horizontal ridge expansion clinically (bone width, pain, and soft tissue healing) and radiographically (bone width).

Material and methods: This randomized clinical trial was conducted on fourteen patients who had a partial edentulous narrow mandibular posterior alveolar ridge (not less than 4-mm width and 12-mm height). All patients were divided randomly into two equal groups: Group I was treated with a modified bone-splitting technique, and group II was treated with DO technique by the fabricated device as AlveoWider®, and without any graft material for both groups. All patients were followed up clinically to evaluate the increase of bone width at preoperative measurement (T0) and 6 months postoperative (T6), and radiographically by cone-beam computed tomography (CBCT) at T0, 3 months postoperative (T3), and T6. Descriptive and bivariate statistics were computed using the SPSS version (SPSS, IBM Inc., Chicago, IL, USA), and $p \leq 0.05$ was considered an indicator of statistical significance.

Results: All patients were female. Patients' ages ranged from 18 to 45 years, with a mean age of 32.07 ± 5.87 years. Radiographically, there is no significant statistical difference in comparing between two groups for the creation of a horizontal alveolar bone; however, there was a highly significant statistical difference ($p < 0.001$) in each group between different interval periods (T0, T3, and T6) with mean start 5.27 ± 0.53, and 5.19 ± 0.72 at T0 reaching to 7.60 ± 0.89 and 7.09 ± 0.96 at T3, and slightly decreases to 7.52 ± 0.79 and 7.02 ± 0.79 in T6 with radiographic evaluation, and it represented clinically in each group with mean 3.57 ± 0.313 and 4.0 ± 0.58 at T0 increase to 6.55 ± 0.395 and 6.52 ± 0.45 at T6 for both groups, respectively. There is a statistically significant difference in soft tissue healing with the average mean of 4.57 ± 0.24 and 3.57 ± 0.509 and pain with an average mean of 1.66 ± 0.22 and 4.74 ± 0.55 with $p = 0.001$ and $p < 0.001$ when comparing between both groups, respectively, that is, $p = 0.001$ is considered to be statistically significant.

Conclusion: Both techniques seem to be useful as augmentation techniques for dental implant placement in a narrow alveolar ridge. Techniques are sensitive and need good experience. The modified splitting technique has fewer complications, less pain, and better soft tissue healing when compared with the DO technique.

Clinical significance: Both techniques are alternative methods for the treatment of the atrophic alveolar ridge with uneventful healing except for minor complications that do not interfere with dental implant placement.

Keywords: Bone splitting, Distraction osteogenesis, Horizontal expansion, Ridge atrophy, Ridge expansion.

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Introduction

Alveolar ridge atrophy has a variety of causes, such as periodontal disease, trauma, and developmental anomalies. Following the extraction of teeth, the residual alveolar ridge undergoes bone remodeling, which involves external and internal bone changes.[1] Bone loss after tooth extraction starts with width loss and then height.[2,3]

Clinically, the greatest loss of the alveolar ridge is usually in the horizontal dimension.[4] Insufficient alveolar ridge width (due to knife-edge configuration or non–space-maintaining defects) may impede the successful placement of dental implants.[5]

Horizontal bone augmentation is necessary procedure for successful implant placement in a narrow alveolar ridge. Modalities include bone grafting,[6,7] guided bone regeneration (GBR),[8,9] alveolar bone splitting (BS) method.[10–12] and DO.[13]

Bone-splitting technique can also be utilized to increase bone width by splitting and expanding the existing residual ridge.[14] Bone-splitting technique was developed by Simion et al.[15] and Scipioni et al.[14] in the early 1990s. Simion et al.[15] aimed at originating a ''self-space making defect'' by separating the buccal cortical bone of narrow alveolar crests in two parts through a longitudinal greenstick fracture to create a gap for inserted dental implants. Osteotomy can be performed using various instruments like a beaver blade, razor-sharp chisel, round bur,

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fissure bur, diamond disk, reciprocal saw, a piezoelectric device, or laser.[16]

Distraction osteogenesis is an alternative method for reconstructing alveolar atrophy.[16] Distraction osteogenesis is a bone regeneration technique that is done by progressive bone fragment elongation within the gap created by osteotomy.[17] McCarthy et al.[18] introduced the DO technique to oral and maxillofacial surgery. Chin and Toth first introduced the use of DO for alveolar deficiencies to correct the vertical mandibular alveolar defect.[19]

However, few reports have been performed on horizontal DO for the expansion of an atrophic alveolar ridge. A horizontal DO system has been developed using a titanium mesh plate and a distraction screw by Takahashi et al.[13] In addition, no clinical studies were conducted to compare DO with BS technique so, this study aimed to compare modified RS and DO for horizontal ridge expansion clinically (bone width, pain, and soft tissue healing) and radiographically (bone width).

Materials and Methods

This randomized clinical study was conducted according to the Helsinki Declaration guidelines and after the approval of the Ethical Committee of the Faculty of Dentistry, Mansoura University, Mansoura, Egypt (Approval No. A06090419). Fourteen patients were selected from the Outpatient Clinic of Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Mansoura University between September 2019 to May 2022, according to the following inclusion criteria: (1) Age of 18–45 years, (2) narrow edentulous ridges not less than 4-mm width and 12-mm height from the inferior alveolar canal, (3) enough keratinized tissue, and (4) mandibular arch with multiple edentulous spaces while exclusion criteria were patients with a systemic condition that affects bone healing, smoking, and pregnancy. According to the type of ridge expansion, patients were divided equally into group I (BS): Horizontal ridge expansion was done by the modified BS technique without using any bone graft material in seven patients, and group II (DO): Horizontal ridge expansion was done by DO technique using distractors in seven patients. All patients in both groups signed informed consent.

Preoperative Preparation

Blood tests comprising of complete blood count (CBC), bleeding time (BT), and international normalized ratio (INR) were conducted for all the participants. Cone-beam computed tomography (Cybermed Inc., Korea) (Figs 1A and 2A) were taken for preoperative T0 evaluation of horizontal bone width and distance from the inferior alveolar canal.

Surgical Procedures

Local anesthesia (Artinibsa 40 mg/mL with 1:100,000 adrenaline, Inibsa Dental SLU, Spain) was achieved using inferior alveolar, lingual nerve blocks, and buccal nerve infiltration for both groups, and all surgical steps were done under complete aseptic condition.

Stage I – Both Groups

Crestal and two vertical releasing incisions followed by full-thickness mucoperiosteal flap (FTMPF) elevation was done. The soft tissue flap was wider than the osteotomy lines. The osteotomy was performed (SATELEC – a company of ACTEON Group, France) using a splitting kit according to the sequence provided. Four osteotomy lines were done by C1, C2, and C3 splitting tips comprising two horizontal osteotomies, apical and crestal, and two vertical osteotomies connecting the apical and crestal osteotomies to form a cut that resembles a rectangle (Figs 1B and 2B). Crestal osteotomy was done on the alveolar crest of the edentulous segment, and the apical one was placed buccally (8–10 mm) away and paralleled to the crestal osteotomy.

For group I, the flap was repositioned and sutured with 4.0 non-resorbable polypropylene (Ghatwary Medical GMS, Egypt) in an interrupted manner and started stage II surgical protocol after 4 weeks.

Stage II – Group I

Crestal incision was done to expose crestal osteotomy only.[20] Bone expansion with the CS4, CS5, and finally with the CS6 tip was done (Fig. 1C) until the bone segment was completely separated from the alveolar bone, however, while it still attached to the mucoperiosteal flap. After achieving the proper width, the segment was fixed with a long self-tapping titanium screw 1.5-mm diameter and 7 or 9 mm in length (Fig. 1D). Gap was covered with non-resorbable membrane; expanded polytetrafluoroethylene (e-PTFE) (Bioss Biomaterials GmbH, Zossen, Germany) and edges of incision were approximated with 4.0 non-resorbable polypropylene (Fig. 1E).

While in group II, immediately after bone osteotomy was completed (stage I). Bone expansion with the CS4, CS5, and finally with the CS6 tip was carried out until the complete separation of the bone window. The separated bone segment was fixed on the horizontal distraction device using self-taping titanium screws 1.5-mm diameter and 2–5-mm length (Figs 2C and 2D). This was followed by hole preparation in the center of the separated bone segment to allow the distraction screw to touch the lingual plate. Closure of flap closed was done with 4.0 non-resorbable polypropylene after repositioning the distraction screw to its initial position and part protruding from the soft tissue (Fig. 2E).

After 7 days (latency period), the suture was removed, and the distractor was activated (0.5 mm/day)[21] until it reached the required horizontal bone width.

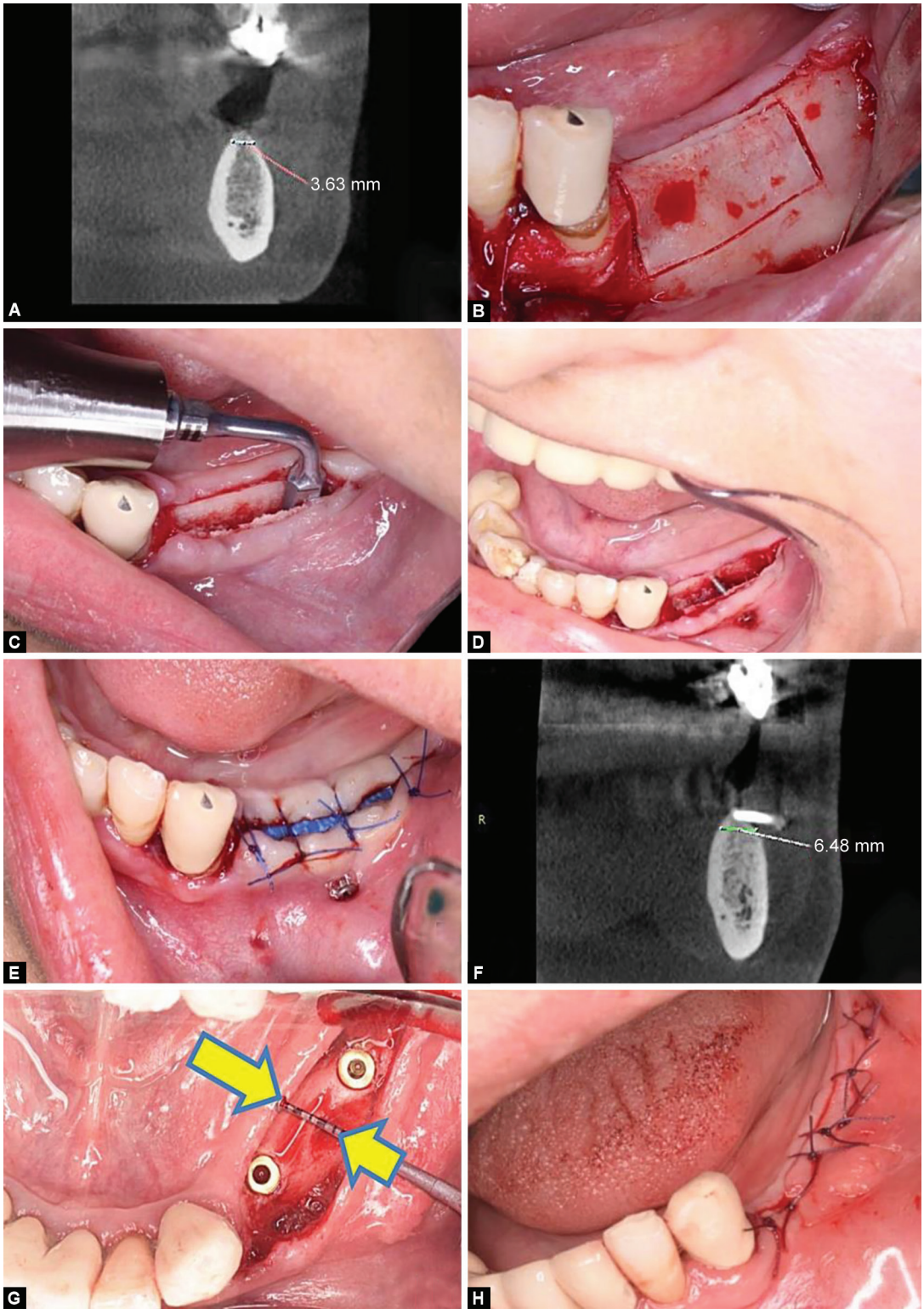
Postoperative Care

All patients were instructed to maintain optimal oral hygiene, and avoid chewing solid texture food. On day 1, ice packs were applied an over the skin area. Antibiotic course amoxicillin and clavulanic acid 1-gm tablets (GlaxoSmithKline Pharmaceuticals, Egypt) for 5 days after surgery, ibuprofen 400 mg (Brufen 400-mg tablets, ABBOTT, Egypt) as analgesic, 3 times daily, and 0.2% chlorohexidine gluconate solution (Listermix Plus mouthwash, SIGMA, Egypt) rinse daily was prescribed for 2 weeks. Finally, after day 10, the sutures were removed.

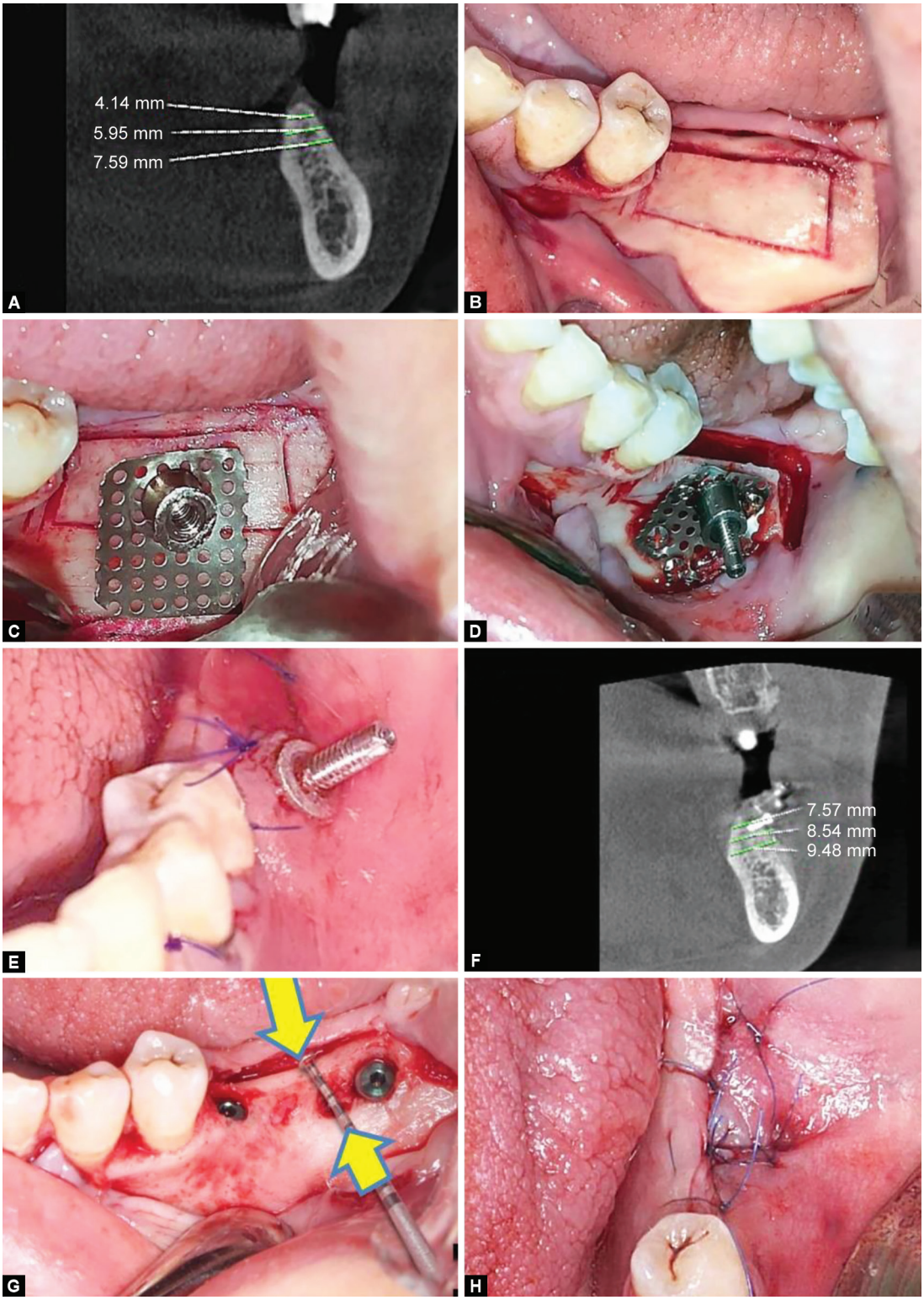
Evaluation

Radiographic Evaluation

Cone-beam computed tomography was taken for each patient to measure the horizontal bone width: Preoperative – T0; 3 months – T3; and 6 months postoperative – T6 (Figs 1F and 2F). Measurements of horizontal bone width were done between the buccal and lingual cortical plates at the center of an augmented area. The distance was measured in a cross-sectional cut at the level of 2, 4, and 6 mm from the crest.



Figs 1A to H: Modified bone splitting technique at mandibular right posterior side. (A) Preoperative CBCT cross section view (T0); (B) Four osteotomy lines; (C) Bone expansion with CS6 tip; (D) Segment fixed with titanium self-tapping screw; (E) Edge of incision approximation; (F) Postoperative CBCT cross-section view (T6); (G) Evaluation of clinical bone width and dental implant placement; (H) Sutures at surgical site



Figs 2A to H: Distraction osteogenesis technique at mandibular right side. (A) Preoperative CBCT cross-section view (T0); (B) Four osteotomy lines; (C) Adaptation of distractor; (D) Fixation of transport bone segment; (E) Distraction screw; (F) Postoperative CBCT cross-section view (T6); (G) Evaluation of clinical bone width and dental implant placement; (H) Sutures at the surgical site

Clinical Evaluation

- *Bone Evaluation:* Bone width was measured immediately after mucoperiosteal flap elevation, the bone width was evaluated (T0) by periodontal probe and after sixth postoperative (T6) (Figs 1G and 2G). Mucoperiosteal flap sutured with 4.0 non-resorbable polypropylene (Figs 1H and 2H).
- *Soft Tissue Evaluation:* Wound healing was evaluated by Landry index[22] preoperative at (T0) and 10 days postoperative (T1), 3 weeks postoperative (T2), 3 months (T3), and 6 months (T6).
- *Pain Evaluation:* Pain of each surgical step was evaluated at 3 days postoperative ($T0_A$), 10 days (T1), 3 week (T2), 3 months (T3), and after 6 months (T6) by using universal pain assessment tool (UPAT)[23] by using printed chart marked from 0 to 10 (0: no pain; 1–3: minor pain experienced; 4–6: moderate pain experienced; and 7–10: severe pain experienced).

Statistical Analysis

Data were analyzed using statistical package for social sciences (SPSS) software, version 20 (SPSS, IBM Inc., Chicago, IL, USA) 120. Shapiro–Wilk's test was used to indicate the normality of the data. Data were presented as mean standard deviation (SD) for continuous variable and number/percent for nominal variables. To test statistical significance in-between the groups, independent samples *t*-test was used for parametric data and Mann–Whitney test was used for non-parametric data. Fisher's exact test was used to compare nominal data. To compare results at different times within each group, dependent samples *t*-test was used for parametric data and related-samples Wilcoxon signed-rank test for non-materials and parametric data. The correlation between variables was done using Spearman's rank correlation coefficient. The values were considered significant when $p \leq 0.05$.

Results

Demographic Data

All the patients were females. Patient's ages ranged from 18 to 45 years, with a mean age of 31.43 ± 6.95 for group I and 32.71 ± 5.05 for group II. When comparing both groups, there was no statically significant difference between both groups $p = 0.699$ (Table 1).

Radiographic Evaluation

The mean horizontal bone width in group I was 5.27 ± 0.529 mm at T0, 7.60 ± 0.89 mm at T3, and 7.52 ± 0.79 mm at T6, while the mean horizontal bone width in group II was 5.19 ± 0.72 mm at T0, 7.06 ± 0.96 mm at T3, and 7.02 ± 0.79 mm at T6. When comparing both groups in different intervals, there was no significant difference observed ($p = 0.760$, 0.344, and 0.178) (Table 2). Conversely, there were statistically significant differences when comparing the interval time measurement in each group with $p < 0.001$ (Table 3).

Clinical Evaluation

Bone width (horizontal bone expansion): Data for clinical horizontal bone width evaluation are represented in Table 4, which shows the different bone width means within each group with different interval periods T0 and T6 that represented statistically significant with $p < 0.001$ for both groups separately. In group I, bone width was 3.57 ± 0.313 mm at T0 and increased at T6 to 6.55 ± 0.395 mm, also for group II bone width was T0 4.0 ± 0.58 mm and increased at T6 to 6.52 ± 0.45 mm with statistically significant differences represented by $p < 0.001$ for both groups.

Table 1: Demographic characteristics of the studied groups

	Total	*Group I (BS group)*	*Group II (bone distraction group)*	*Test of significance*
Age/ years	32.07 ± 5.87	31.43 ± 6.95	32.71 ± 5.05	$t = 0.396$* $p = 0.699$**
Sex				
Female		7 (100)	7 (100)	

*t: Student's *t*-test; **Statistically significant; Parameters described as mean ± SD

Table 2: Comparison of radiological evaluation score average between studied groups

Average radiographic evaluation at	*Group I*	*Group II*	*Test of significance*
T0	5.27 ± 0.53	5.19 ± 0.72	$t = 0.313$* $p = 0.760$**
T3	7.60 ± 0.89	7.09 ± 0.96	$t = 0.988$* $p = 0.344$**
T6	7.52 ± 0.79	7.02 ± 0.79	$t = 1.16$* $p = 0.178$**

*t: Student's *t*-test; **Statistically significant Parameters described as mean ± SD

Table 3: Comparison of radiological evaluation score average change within each group

	Radiographic evaluation at	*Average*	*Test of significance (repeated measures ANOVA test)*
Group I: BS group	T0	5.27 ± 0.53	$F = 90.25$ $p < 0.001$*
	T3	7.60 ± 0.89	
	T6	7.52 ± 0.79	
Group II: Bone distraction group	T0	5.19 ± 0.72	$F = 48.9$ $p < 0.001$*
	T3	7.09 ± 0.96	
	T6	7.02 ± 0.79	

*Statistically significant

Table 4: Comparison of clinical evaluation score change within each group

	Clinical evaluation at T0	*Clinical evaluation at T6*	*Test of significance*
Group I: BS group	3.57 ± 0.313	6.55 ± 0.395	$t = 26.56$* $p < 0.001$**
Group II: Bone distraction group	4.0 ± 0.58	6.52 ± 0.45	$t = 8.73$* $p < 0.001$**

*t: Paired *t*-test; **Statistically significant; Parameters described as mean ± SD

When we compare between groups (see Table 5), there was no statistically significant difference $p = 0.883$ at T6 with a mean of 6.55 ± 0.395 mm for group I and 6.52 ± 0.45 mm for group II.

Soft Tissue Evaluation

Data evaluation of soft tissue healing are represented in Table 6, which shows the different soft tissue healing means comparison

Table 5: Comparison of clinical evaluation score between studied groups

Clinical evaluation	*Group I (BS group)*	*Group II (bone distraction group)*	*Test of significance*
T0	3.57 ± 0.313	4.0 ± 0.58	*t* = 1.73* *p* = 0.110**
T6	6.55 ± 0.395	6.52 ± 0.45	*t* = 0.151* *p* = 0.883**

**t*: Student's *t*-test; **Statistically significant; Parameters described as mean ± SD

Table 6: Comparison for soft tissue healing between studied groups and during follow up within each group

Clinical evaluation for soft tissue healing	*Group (BS group)*	*Group II (bone distraction group)*	*Test of significance*
Preoperative (T0)	4.86 ± 0.38	5.0 ± 0.0	*t* = 1.0* *p* = 0.337**
10 days (T1)	4.57 ± 0.53	4.29 ± 0.76	*t* = 0.816* *p* = 0.430**
3 weeks (T2)	4.71 ± 0.49	3.43 ± 0.98	*t* = 3.12* *p* = 0.009**
3 months (T3)	4.14 ± 0.89	2.57 ± 0.98[a]	*t* = 3.13* *p* = 0.009**
6 months (T6)	4.57 ± 0.78	2.57 ± 0.98[a]	*t* = 4.22* *p* = 0.001**
Average total	4.57 ± 0.24	3.57 ± 0.509	*t* = 4.69* *p* = 0.001**
Test of significance	*F* = 0.875 *p* = 0.386**	*F* = 41.49 *p* = 0.001**	

**t:* Student's *t*-test; **Statistically significant; *F*: Repeated measures ANOVA test; Similar superscripted alphabets in same column denote non-significant difference between studied readings during follow-up

for soft tissue healing between studied groups and within each group during the follow-up period as T0, T1, T2, T3, and T6. In the same group when evaluating soft tissue healing there were no statistically significant in group I with $p = 0.386$ while in group II there were statistically significant with $p = 0.001$.

Among groups, there were no statistically significant differences in T0 and T1 with $p = 0.337$ and $p = 0.430$, respectively. However, when comparing another interval period, there were statistically significant differences in T2, T3, and T6 with $p = 0.009$, $p = 0.009$, and $p = 0.001$, respectively. In general, there were statistically significant differences $p = 0.001$ when comparing the total average for group I with a mean of 4.57 ± 0.24 and group II with a mean of 3.57 ± 0.509.

Pain Evaluation

Data evaluation of pain is represented in Table 7, which shows the different means of comparison for pain between studied groups and within each group during the follow-up period after the surgical step at $T0_A$, T1, T2, T3, and after T6 postoperative.

Between groups, there were no statistically significant differences between both groups in $T0_A$ with a mean of 5.28 ± 1.11 for group I and 5.0 ± 0.0 for group II and $p = 0.510$ while in T1, T2, T3, and T6, there were statistically significant difference with means 3.0 ± 0.0, 0.0 ± 0.0, 0.0 ± 0.0, 0.0 ± 0.0 for group I while for group II, means were 5.57 ± 1.39, 3.0 ± 0.0, 2.57 ± 0.98, and 2.57 ± 0.98, respectively, and $p < 0.001$ and in general when comparing group I with average mean 1.66 ± 0.22 with group II with average mean 4.74 ± 0.55, there was a statistically significant difference with $p < 0.001$. Also, when evaluating pain in the same group there was a statistically significant difference in both groups with different interval periods with $p < 0.001$.

Table 7: Comparison of pain evaluation for soft tissue healing change during follow-up between both groups and within each group

Pain evaluation	*Group I (BS group)*	*Group II (bone distraction group)*	*Test of significance*
3 days ($T0_A$)	5.28 ± 1.11	5.0 ± 0.0	*t* = 0.679* *p* = 0.510**
10 days (T1)	3.0 ± 0.0	7.57 ± 1.27	*t* = 9.51* *p* < 0.001**
3 weeks (T2)	0.0 ± 0.0	5.57 ± 1.39	*t* = 10.55* *p* < 0.001**
3 months (T3)	0.0 ± 0.0	3.0 ± 0.01	*t* = 7.25* *p* < 0.001**
6 months (T6)	0.0 ± 0.0	2.57 ± 0.98	*t* = 6.97* *p* < 0.001**
Average	1.66 ± 0.22	4.74 ± 0.55	*t* = 13.75* *p* < 0.001**
Test of significance (repeated measures ANOVA)	*F* = 260.34 *p* < 0.001**	*F* = 210.77 *p* < 0.001*	

**t*: Student *t*-test; **Statistically significant, parameters described as mean ± SD *F*: Repeated measures ANOVA test; Similar superscripted letters in same column denote non-significant difference between studied readings during follow-up

In general, both techniques can increase the horizontal bone width with a slight difference in surgical steps and complications.

Discussion

In implantology, the atrophic alveolar process is a challenging issue for the clinician due to deficiencies in bone and attached mucosa.[24] Therefore, lateral bone augmentation procedures are necessary before implant placement. These modalities can use different augmentation graft materials such as xenografts, allografts, autografts, or bone substitutes, and GBR[25,26] as well as the use of specific techniques such as split ridge osteotomy or horizontal DO.[13]

This study aimed to compare the buccal bone width between the modified bone-splitting technique and DO at different interval periods for 6 months without adding bone graft.

Both techniques increase bone width for group I, two surgical stages, one for osteotomy and the other for expansion. In contrast, for group II, one surgical step followed by gradual expansion until reaches a suitable width. When comparing both groups, no statistically significant differences regarding the width of the buccal bone; these agree with Sethi and Kaus[11] and Lustmann et al.[10] who documented that techniques are similar in ridge expansion without interpositional graft.

However, the result of this study did not agree with Funaki et al.,[27] they compared the horizontal DO and BS method with bone graft, using an experimental dog model, and they reported that the average amount of bone gain in the DO group was significantly greater than that in the BS group.

The bone width in this study shows a clinical increase for both groups with statistically significant differences; group I clinical bone width mean was 3.57 ± 0.313 mm at T0 and was increased to 6.55 ± 0.395 mm at T6 and confirmed radiographically with a clear

increase at T6 with mean was 7.52 ± 0.79 mm in compared with T0 mean was 5.27 ± 0.529 mm. This results in an agreement with Agabiti and Botticelli[28] who evaluated 10 patients with a 2-stage atrophic alveolar ridge expansion and showed an increase in bone tissue. Clinically, the mean width of the buccal bone wall was 1.2 ± 0.2 mm and the gaps ranged between 2.8 and 3.2 mm and with CBCT, the alveolar bone crest width reached 6.8 ± 0.9 mm after ridge expansion.

That was confirmed by Korsakova et al.[29] who treated 18 patients with a horizontally atrophic posterior mandible with a modified two-stage split technique and concluded that the technique allowed for achieving the required bone in the posterior mandible.

Also, Tair[30] evaluated 16 edentulous mandibular ridges within 13 patients treated with a two-stage approach of RS, and lateral expansion with an average gain in width was 3.22 ± 0.97 mm.

While for group II, clinical bone width means was 4.0 ± 0.58 mm at T0 and was increased to 6.52 ± 0.45 mm at T6 and confirmed radiographically at T6 with a mean was 7.02 ± 0.79 mm compared with T0 mean was 5.19 ± 0.72 mm. This result was in agreement with Bulut et al.[24] who applied a distractor in a mandibular canine area and found an increase in bone width from 2 to 7 mm within concomitant an increase of soft tissue.

Also, Yamauchi et al.[31] treated a total of 12 patients with 13 sites that had severe loss of bone width and were treated with horizontal DO; the result was an increase in bone width at the end treatment period by 3.6 mm.

Regarding soft tissue healing evaluation, there was a statistically significant difference between both groups ($p = 0.001$), with an average mean of 4.57 ± 0.24 in group I and 3.57 ± 0.509 in group II. Regarding pain evaluation, there was an increase of pain in group II more than in group I and a decrease gradually at different interval periods with an average mean of 4.74 ± 0.55 and 1.66 ± 0.22, respectively, with statistically significant differences, and these may be due to the unique design of distractor which has activator screw that penetrated buccal mucosa and needed continuous activation during distraction phases and It also may be related to direct trauma to the check of the oral mucosa.

In this study, both groups did not show any significant post-operative complications such as infection paresthesia, dysesthesia, or severe unbearable pain during the follow-up periods. Only five cases in both groups showed minor complications (one in group I and four in group II).

All cases were managed correctly with no effect on horizontal expansion because these minor complications occurred after the consolidation period (6 months). Finally, all cases received dental implant sizes of 3.5 mm diameter in the premolar area and 4.1 or 4.8 mm in diameter in the molar area. Yamauchi et al.[31] had complications in some cases when treated with severe horizontal atrophy of a partially edentulous maxilla or mandible using horizontal DO.

The limitations of this study are its small sample size, short follow-up period, and histological bone specimen to confirm the quality of bone.

Conclusion

Both techniques seem useful as augmentation techniques for dental implant placement in a narrow alveolar ridge but need good practice experience. The modified splitting technique has fewer complications, less pain, and better soft tissue healing when compared with the DO technique.

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