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EVALUATION OF RIDGE SPLITTING WITH AND WITHOUT BONE GRAFT IN NARROW MAXILLARY ALVEOLAR RIDGE WITH SIMULTANEOUS IMPLANT PLACEMENT. (A CLINICAL STUDY)

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ABSTRACT

Objective: This study was designed to compare the clinical and radiographic outcomes of narrow maxillary ridge splitting procedure with and without bone graft with simultaneous implant placement. **Subjects and Methods:** Twenty patients (14 males and 6 females with a mean age of 57.2 ± 9.7 years) with horizontally deficient maxillary alveolar ridges less than 4mm and requesting the placement of dental implants were included in this study. The patients were divided randomly into two equal groups (Group I and Group II). In group I no bone graft was used while in group II, the inter-bony space between the buccal and lingual plates was filled with bone graft material. Evaluation of both techniques was carried out in terms of implant stability, horizontal bone gain and crestal bone changes. **Results:** Implant stability (ISQ) immediate post-operative as well as after two months; there was no statistically significant difference between the two groups. Ridge width (mm) pre-operatively, after one week as well as two months; there was no statistically significant difference between the two groups. Crestal bone changes (mm)_whether at the buccal or lingual sides, Group I showed a statistically significant decrease in crestal bone levels compared to Group II. **Conclusion:** Restoring adequate maxillary ridge width with simultaneous implant placement was successfully achieved by the ridge splitting technique performed either with or without bone graft. All the implants placed showed excellent level of stability in both groups after 2 months postoperatively.

KEYWORDS: Ridge Splitting, Implants, Bone Grafts

INTRODUCTION

A sufficient alveolar ridge height and width are required for successful insertion of a dental implant. Decreased horizontal width of the alveolar ridge can occur due to many factors such as atrophy, periodontal disease or trauma[1,2].

Restoring adequate horizontal bone width can be achieved through different techniques including ridge splitting, onlay bone grafting, distraction osteogenesis or a combination of two or more surgical procedures[3-6]. Ridge splitting provides many advantages when compared to other techniques used for horizontal ridge augmentation in terms of decreased treatment time, avoiding donor site morbidity, low cost, and minimal surgical complications [7, 8].

Ridge splitting is a procedure that separates the buccal and lingual plates of bone using surgical discs, chisels, osteotomes or piezotome. After ridge splitting, implants can be placed simultaneously in the same surgical procedure where the intra-bony defect between the 2 plates around the implants can be either filled with bone graft material or left to heal spontaneously without bone grafting [9-11].

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The most important factor affecting the clinical success of an implant and the time of loading is considered to be the primary implant stability [12]. Loading of the dental implants can be classified into immediate loading (within 1 week), early loading (1 week to 2 months) and conventional loading (more than 2 months) [1].

Osstell (Osstell AB Stampgatan 14, Goteborg, Sweden) is an electronic instrument designed to measure implant vibrations in response to resonance frequency analysis. The result of the measurement is the Implant Stability Quotient (ISQ) which conforms to the hardness of the connection between the bone and the implant [13, 14]. The ISQ values have been reported to be suitable indicators for immediate (ISQ ≥ 70) or early (ISQ = 40–70) loading of dental implants [15, 16].

In this study, ridge splitting with simultaneous implant placement was performed for 2 groups of patients. In group I, no bone graft was placed between the buccal and palatal plates of bone while in group II, bone graft was used to fill any gap found around the dental implants. Evaluation of both techniques was carried out in terms of implant stability, horizontal bone gain and crestal bone changes.

SUBJECTS AND METHODS

Twenty patients (14 males and 6 females with a mean age of 57.2±9.7 years) with horizontally deficient maxillary alveolar ridges less than 4mm and requesting the placement of dental implants were selected from the outpatient clinic of Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Cairo University. Any patient with vertical bone height less than 12 mm, psychological disorders or a systemic disease that jeopardize implant placement and/or the surgical procedure were excluded from the study. This study was approved by the Research Ethics Committee of Faculty of Dentistry, Cairo University.

Cone beam CT was done preoperatively to evaluate the ridge width and height (Fig. 1). The patients were divided randomly and equally into two groups. In the first group (Group I), ridge splitting with simultaneous implant placement was performed without using bone graft material. In the second group (Group II), the same procedure was performed followed by filling the inter-bony space with bone graft material (Bio-Oss® Geistlich-Switzerland).

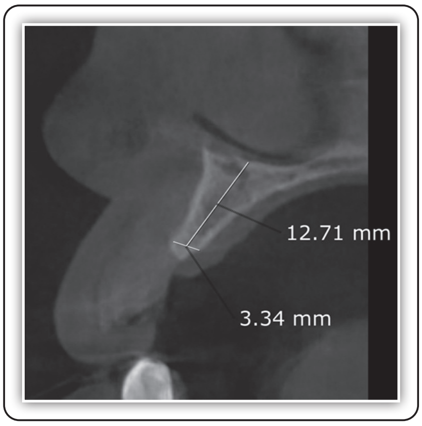

FIG (1) Cone beam CT showing a horizontal bone width of 3.34 mm and vertical bone height of 12.71 mm in the maxillary right lateral incisor region

All the surgical procedures were performed under local anaethesia (ARTINIBSA 40mg/0.01mg/ml, Inibsa Dental S.L.U, Barcelona, Spain) using local infiltration technique. A full thickness mucoperiosteal flap was performed with the crestal incision placed slightly palatal to the alveolar ridge to allow for full coverage of the implants at the end of the procedure.

Crestal osteotomy of the alveolar ridges in both groups was performed using a surgical disc along the edentulous span and ending 2 mm away from any adjacent teeth. Small chisels were used to extend the osteotomy apically ending 5 mm shorter than the imposed length of the dental implant used. Implant site preparation was performed using a Pilot drill of 2.0 mm diameter to the full length of the desired implant followed by sequential use of surgical osteotomes until reaching the required length and diameter of the implant used (Fig. 2, 3).

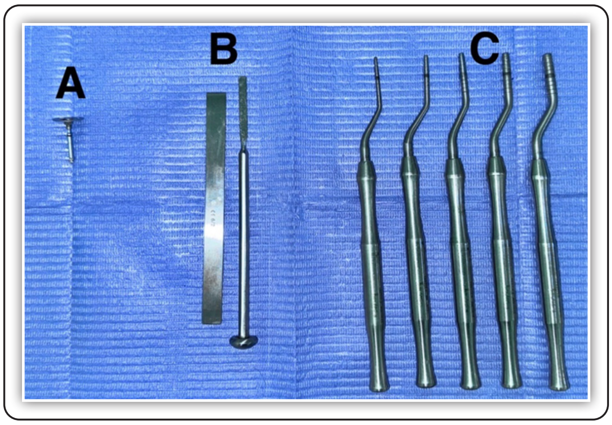

FIG (2) Showing the instruments used for ridge splitting and implant site preparation including surgical disc (A), small chisels (B) and bone osteotomes (C)

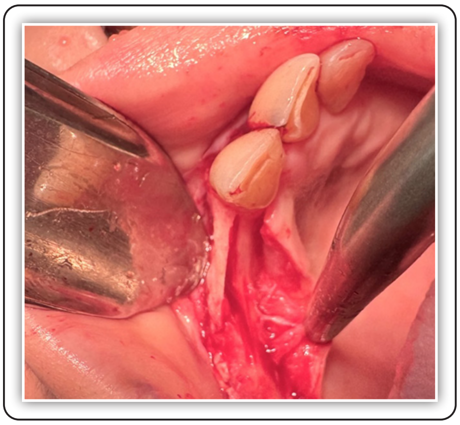

FIG (3) Showing maxillary alveolar ridge splitting prior to implant site preparation

Dental implants (TRI Dental Implants Int, Switzerland) of a same size 3.75 mm diameter and 11.5 mm length were used for all the cases in both groups. Implants were inserted into the prepared site flushing occlusally with the crest of the ridge. In group I no bone graft was used while in group II, the inter-bony space between the buccal and lingual plates was filled with bone graft material after implant placement (Fig. 4, 5).

Primary implant stability was assessed using Ostell device (Osstell AB Stampgatan 14, Goteborg, Sweden) followed by scoring of the labial periosteum and wound closure using 4-0 vicryl sutures (Assut Assucryl PGA, Switzerland) (Fig.6).

All patients were instructed to take antibiotic Augmentin 1000mg, one tablet twice daily for one week, paracetamol (500mg orally) for pain alleviation whenever needed, cold packs for 6-8 hours after the surgery and chlorohexidine mouth rinsing for 15 days.

FIG (4) Showing implants inserted in the splitted ridge in the region of the maxillary right lateral incisor and canine

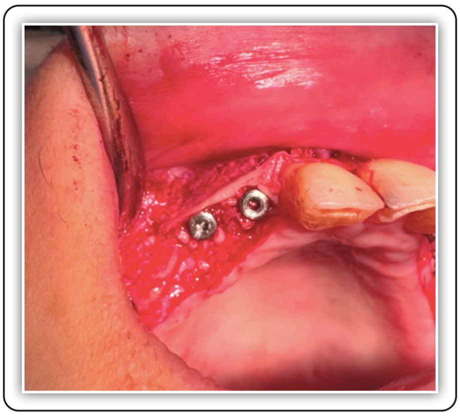

FIG (5) Showing the bone graft material used for filling the space between the labial and palatal plates of bone around the dental implants in group II

FIG (6) Showing suturing of the surgical site

Postoperative evaluation:

1- Clinical evaluation

Implant stability quotient (ISQ) was measured two months postoperatively using Osstell device and was compared to the values obtained immediate postoperatively.

2- Radiographic evaluation (Fig. 7)

a. Crestal ridge width was measured 1 week and 2 months postoperatively using cone beam CT and compared with the preoperative values.

FIG (7) Cone beam CT after 2 months postoperatively showing horizontal bone width of 6.1 mm and decrease in labial crestal bone height by 0.5 mm and decrease in palatal crestal bone height by 0.4 mm

b. Crestal bone level was measured from the implant shoulder to the crest of the ridge in the cone beam CT performed after 1 week and 2 months postoperatively. The difference between the two readings obtained was recorded as the change in the buccal and lingual crestal bone levels.

Focal trough of the cone beam CT was adjusted at the same position in the three planes to establish equalization of readings in the radiographs obtained

Statistical Analysis

Numerical data were explored for normality by checking the distribution of data and utilizing tests of normality (Kolmogorov-Smirnov and Shapiro-Wilk tests). All data showed normal (parametric). Data were presented as mean and standard deviation (SD) values. For parametric data, Repeated measures ANOVA test was used to compare between the two groups as well as to study the changes by time within each group. Bonferroni's post-hoc test was used for pair-wise comparisons when ANOVA test is significant. Student's t-test was used to compare between changes in bone width and crestal bone in the two groups. The significance level was set at P≤0.05. Statistical analysis was performed with IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.

RESULTS

Implant stability (ISQ)

a. Comparison between the two groups

Immediate post-operative as well as after two months, there was no statistically significant difference between group I and group II (*P*-value = 0.341, Effect size = 0.05) and (*P*-value = 0.446, Effect size = 0.033), respectively (Table 1) (Fig.8).

TABLE (1) Descriptive statistics and results of repeated measures ANOVA test for comparison between implant stability (ISQ) in the two groups and the changes within each group

Time	Group I (n = 10)		Group II (n = 10)		*P*-value	*Effect size (Partial Eta squared)*
	Mean	SD	Mean	SD		
Immediate post-operative	70.7	1.4	70	1.8	0.341	0.05
2 months	72.5	1.4	73	1.4	0.446	0.033
P-value	<0.001*		<0.001*			
Effect size (Partial Eta squared)	0.682		0.856			

**: Significant at P ≤ 0.05*

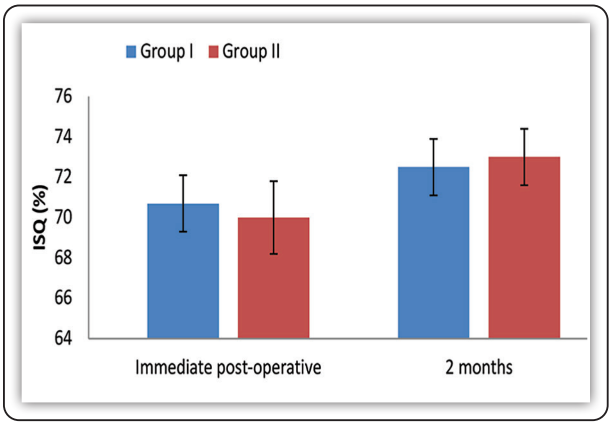

FIG (8) Bar chart representing mean and standard deviation values for ISQ in the two groups

b. Changes within each group

In both groups, there was a statistically significant increase in implant stability after two months postoperatively (*P*-value <0.001, Effect size = 0.682) and (*P*-value <0.001, Effect size = 0.856), respectively. (Table 1) (Fig.8).

Ridge width (mm)

a. Comparison between the two groups

Pre-operatively, after one week as well as two months, there was no statistically significant difference between group I and group II (*P*-value = 0.711, Effect size = 0.008), (*P*-value = 0.629, Effect size=0.013) and (*P*-value = 0.114, Effect size = 0.133), respectively

Changes within each group

In both groups, there was a statistically significant change in ridge width measurements by time (*P*-value <0.001, Effect size = 0.973) and (*P*-value <0.001, Effect size = 0.975), respectively. Pair-wise comparisons between time periods revealed that there was a statistically significant increase in ridge width after one week followed by a statistically significant decrease in ridge width from one week to two months. The mean ridge width measurement after two months showed statistically significantly higher mean value compared to pre-operative measurement (Table 2) (Fig.9).

TABLE (2) Descriptive statistics and results of repeated measures ANOVA test for comparison between ridge widths measurements (mm) in the two groups and the changes within each group

Time	Group I (n = 10)		Group II (n = 10)		*P*-value	*Effect size (Partial Eta squared)*
	Mean	SD	Mean	SD		
Pre-operative	3.05 ^{C}	0.34	3.1 ^{C}	0.24	0.711	0.008
1 week	6.23 ^{A}	0.27	6.3 ^{A}	0.36	0.629	0.013
2 months	5.93 ^{B}	0.29	6.18 ^{B}	0.38	0.114	0.133
P-value	<0.001*		<0.001*			
Effect size (Partial Eta squared)	0.973		0.975			

**: Significant at P≤0.05, Different superscripts in the same column indicate statistically significant change within group*

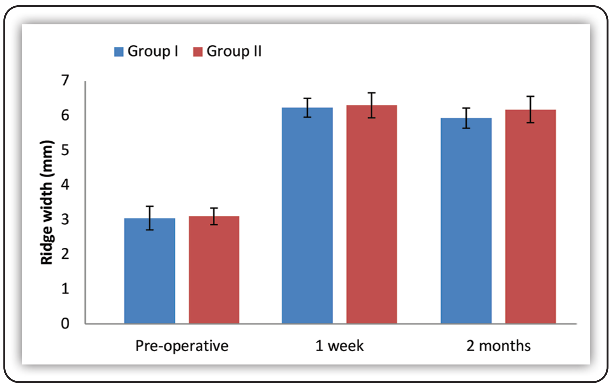

FIG (9) Bar chart representing mean and standard deviation values for ridge width measurements in the two groups

b. Comparison between amounts of increase in ridge width in the two groups

Increase in ridge width = Width (1 week or 2 months) – Width (Pre-operative)

There was no statistically significant difference between amounts of increase in ridge widths in the two groups after one week as well as after two month (*P*-value = 0.912, Effect size = 0.051) and (*P*-value = 0.239, Effect size = 0.544), respectively (Table 3) (Fig.10) .

Crestal bone changes (mm)

Whether at the buccal or lingual sides, Group I showed statistically significantly higher amount of crestal bone changes than Group II (*P*-value <0.001, Effect size = 4.818) and (*P*-value <0.001, Effect size = 4.511), respectively (Table 4) (Fig.11).

TABLE (3) Descriptive statistics and results of Student’s t-test for comparison between amounts of increase in ridge width measurements (mm) in the two groups

Time	Group I (n = 10)		Group II (n = 10)		*P*-value	*Effect size (d)*
	Mean	SD	Mean	SD		
1 week	3.18	0.44	3.2	0.35	0.912	0.051
2 months	2.88	0.39	3.08	0.35	0.239	0.544

**: Significant at P ≤ 0.05*

TABLE (4) Descriptive statistics and results of Student’s t-test for comparison between crestal bone changes (mm) in the two groups

Side	Group I (n = 10)		Group II (n = 10)		*P*-value	*Effect size (d)*
	Mean	SD	Mean	SD		
Buccal	-0.82	0.09	-0.37	0.09	<0.001*	4.818
Lingual	-0.72	0.1	-0.3	0.08	<0.001*	4.511

**: Significant at P ≤ 0.05*

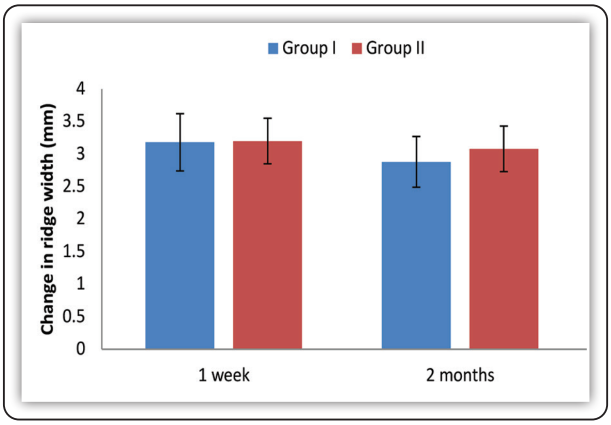

FIG (10) Bar chart representing mean and standard deviation values for amounts of increase in ridge widths in the two groups

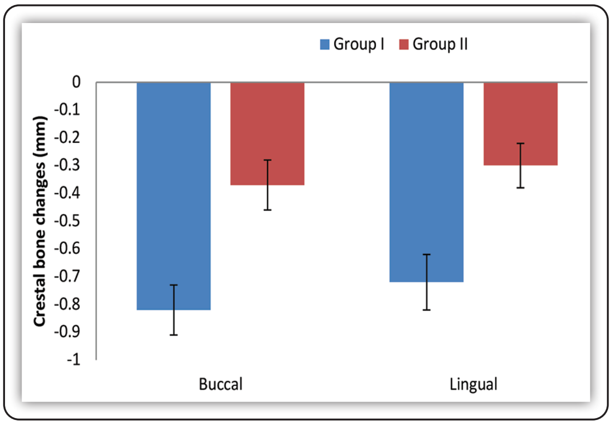

FIG (11) Bar chart representing mean and standard deviation values for crestal bone changes in the two groups

DISCUSSION

In the present study, ridge splitting was the technique of choice as it immediately increases the ridge width allowing for simultaneous implant placement in a one stage surgery avoiding any morbidity related to harvesting of autogenous bone graft. This agrees with other studies [17-20] reporting that the major advantages of ridge splitting is a shorter treatment time and low morbidity when compared to other techniques such as onlay bone grafting and guided bone regeneration.

In our study, the horizontal osteotomy was performed mesio-distally using a surgical disc at the center of the alveolar ridge and was terminated 2mm away from the adjacent teeth avoiding any damage to the roots or the periodontal ligaments. This is found to be in agreement with other authors[21-23] who recommended that at least 1mm of safety margin should be considered between the horizontal osteotomy and the neighboring teeth.

In the current study, the crestal osteotomy was propagated apically using small chisels to a depth of 5 mm shorter than the imposed length of the implant used to increase the primary stability of the dental implant. The depth of the crestal osteotomy was found to be variable among literature. Some authors [21, 22, 24, 25] recommended that the termination of the depth of osteotomy should be 3-5.5 mm shorter than the planned implant length based on the rationale that the un-splitted bone improves the primary stability. Other authors [23, 26] recommended that the depth of the osteotomy should be equal to or more than the length of the implant used as this will facilitate the expansion of the alveolar ridge. Throughout the literature, there is no recommended depth for the osteotomy and it is left to the clinician choice.

In this study, preparation of the implant site was performed initially with a pilot drill followed by a sequential use of osteotomes until reaching the desired diameter and length of the dental implant used. Our results showed excellent values regarding primary implant stability. This coincides with other authors reporting that using osteotomes provides greater implant to bone contact[27-29], accelerate trabecular bone formation[30] and preserves the remaining bone[31] when compared to the use of conventional drilling sequence.

Concerning the implant stability, our results showed a statistically significant increase in implant stability after two months in each group. Comparing the two groups, there was no statistically significant difference between the two groups immediate and after 2 months postoperatively. This agrees with the findings of Sim & Lang[32] and Nedir et al[33] who reported that primary implant stability with ISQ values ≥69 exhibit a slight decrease in stability during the first 4 weeks after which the stability increases gradually exceeding the initial values after eight weeks postoperatively. The authors reached a conclusion that the implant stability values over time are mainly dependent on the primary implant stability.

Our results showed a statistically significant increase in the horizontal bone width after 2 months postoperatively in each group, however, there was no statistically significant difference between both groups. This agrees with the study of Blus & Szmukler-Moncle[34] reporting that the initial mean value of the ridge width was 3.2 mm, whereas at the end of the surgery the final mean width was 6mm and after implant loading (at least 2 months for all implants) no implant failures were recorded in 3 years follow up period.

Chen et al[35] and Rahpeyma et al[36] reported that using bone grafts is usually necessary to achieve better outcomes concerning crestal bone loss through filling the peri-implant defects and augmentation of the surrounding tissues. This is found to be in agreement with our findings where a significant decrease of crestal bone level was found in group I when compared to group II. On the other hand, Chaves Netto et al[37] reported that the bone space generated between the buccal and palatal plates after splitting is considered a non-critical defect where leaving it without bone grafting will not preclude the filling and completion of bone healing around the dental implants.

CONCLUSION

Restoring adequate maxillary ridge width with simultaneous implant placement was successfully achieved by the ridge splitting technique performed either with or without bone graft. All the implants placed showed excellent level of stability in both groups after 2 months postoperatively. No significant difference concerning implant stability and horizontal bone gain was found between the two groups. However, more decrease in the crestal bone levels was recorded in group I compared to group II. Further measures and data can be collected later on after implant loading in both groups.

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