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EFFECT OF ULTRASONIC RIDGE SPLITTING TECHNIQUE WITH SIMULTANEOUS IMPLANTS PLACEMENT INTO NARROW POSTERIOR MANDIBULAR ALVEOLAR RIDGE: A CLINICAL AND RADIOGRAPHIC STUDY

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ABSTRACT

The present study was designed to compare clinically and radiographically between the traditional methods and the ultrasound in ridge splitting technique (RST) with simultaneous implant placement into narrow posterior mandibular alveolar ridge. This study was carried out on 20 patients with partial edentulous narrow posterior mandibular alveolar ridge. Patients were divided randomly into two equal groups (group I was treated with RST with osteotome and simultaneous implant placement into their ridges associated with bone graft as a gap filler after splitting; group II was treated with RST by the ultrasound and simultaneous implant placement into their ridges associated with bone graft as a gap filler after splitting). Patients were evaluated clinically to assess probing depth and implant stability quotient, and radiographically to assess the alveolar ridge width and the marginal bone level measurement parameters at 3, 6, 9, and 12 months. The results of the present study showed no significant difference of postpartum depression and significant difference in implant stability quotient between the two groups at the second interval, and there was a superiority of the group ll in marginal bone level between the two groups at the different intervals with statistically significant difference, especially at the end of the observation.

Keywords: Implant, osteotome, ultrasonic ridge splitting technique.

INTRODUCTION

Consequent to tooth loss, resorption of alveolar bone height and thickness occurs as a result of physiologic healing[1]. Ridge healing patterns following tooth removal result in more rapid bone resorption on the buccal than on the lingual/palatal aspects of the ridge. Between 40-60% of labial bone is lost during the first 3 years and this lost continues at an annual rate of 0.25-0.5% thereafter[2].

The mandibular bone resorption patterns after tooth extraction may jeopardize correct implant placement with respect to position and angulation. Malpositioned implants may affect the emergence profile of the final implant restoration and generate functional and esthetic problems that would have a negative effect on implant long-term success rate[3].

Several methods have been described to augment the alveolar crest before or after implant placement to establish at least 1 mm bony wall around screw type implant. Various surgical widening techniques have been described, including lateral augmentation with or without guided bone regeneration (GBR) and horizontal distraction osteogenesis. Expansion of the existing residual ridge is another method and is referred as, bone spreading, ridge expansion, the osteotomy or ridge splitting technique[4].

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One advantage of ridge splitting over other ridge augmentation techniques such as bone grafting is that implants may be placed simultaneously, considerably shortening the treatment time. Unlike guided bone regeneration, which relies on bone forming over the exposed implant surface, ridge splitting repositions the cortical plates around the implant, then allowing bone to regenerate within the space between the expanded cortical plates[5].

Various tools and methods are described to achieve a sufficient mesio-distal vertical osteotomy (rotary burs, rotary diamond coated discs, oscillating saws, bone chisels) and immediate horizontal distraction of the narrow alveolar crest (cylindrical osteotomes, flat chisels, widening screws, horizontal distractors)[6,7], but there are several drawbacks for these tools because they demand alveolar crest-widths of a minimum of 4 mm and demand a very high level of surgical skills[8].

Therefore with the introduction of ultrasonic surgical instruments (Piezotomes) the applicability of the crest-split technique was narrowed down to crest-widths of 2 mm by the more bone-conserving primary osteotomy[9,10]. Some authors have claimed faster healing and less inflammation with piezoelectric bone cuts as compared to the classical methods[11,12].

Implant success rates in alveolar ridges split with piezoelectric surgical scalpel compare favorably to those placed in intact ridges[13]. The present study was a trial to compare between the classical methods and the ultrasound for ridge splitting technique with simultaneous implants placement into narrow posterior mandibular alveolar ridge

PATIENTS AND METHODS

Patients selection:

This study was carried out on 20 (13men and seven women; mean age of 34years) patients with partial edentulous narrow posterior mandibular ridge according to clinical examination and radiographic evaluation by cone beam computed tomography. An informed consent was obtained from all patients before carrying out any study procedures. All patients will be selected from those attending at the Out Patient Clinic, Oral and Maxillofacial Surgery Department, Faculty of Dental Medicine, Al-Azhar University, Assiut Branch.

Inclusion and exclusion criteria:

Systemically healthy patients missing a multiple teeth in the posterior mandibular region and those with the crestal residual ridge width of at least 3 mm at the crest and 6 to 8mm at the base with sufficient vertical bone height provided that the recipient site of the implant should be free from any pathological conditions were included in the study. Whereas patients with dental history of bruxism, para functional habit, smoking habit, Pregnant or receiving contraceptive pills, and History of radiotherapy and chemotherapy were excluded.

Patients grouping and randomization:

Patients were classified randomly into the following equal two groups using the online software (https://www.randomizer.org):

Group I, ten patients with partial edentulous narrow mandibular ridge; treated by ridge splitting technique with classical tools (osteotomes) and simultaneous implant placement into their ridge.

Group P, ten patients with partial edentulous narrow mandibular ridge; treated by ultrasonic ridge splitting technique and simultaneous implant placement into their ridge

Surgical procedures

1. After local anesthesia administration, a bard parker blade No 15 was used to create a crestal mesio-distal incision and reversion of envelope flap “minimal booklet-flap”. The periosteum along the lateral cortices should remain intact to ensure blood supply to the underlying bone.

2. **In group I**, ridge split was applied with different size of osteotomes (4,6,8 mm), after the crest being prepared with surgical fissure bur in straight low speed hand piece half centimeter penetration of the osteotome blade in ridge crest would automatically expand the ridge. Since osteotome thickness increases from tip toward shaft further the osteotome penetrates, more the ridge would expand. Slight buccolingual movement of the osteotome would increase the expansion(Fig. 1).

   In group P, Using a piezosurgical device (Piezotome SOLO; Satelec Acteon, Bordeaux, France), a crestal corticotomy cut were made in the alveolar ridge. Then, this crestal corticotomy cut widened till the depth of splitting reached 8mm (Fig 2).

3. After splitting completed, preparation of the implant site was performed and the Superline or Narrow Ridge Dentium (Dentium, Seoul, Korea) implants were inserted until bone level (Fig.3) Then final wound closure was performed.

4. Standard postsurgical instructions and medications were given to the patients preoperatively and postoperatively for 7 days and chlorhexidine mouth rinsing was recommended for 15 days.

5. Sutures were removed after 10 days and all patients recurrently checked for any complications every 4 weeks.

6. After 6 months, the patients were called back for the second-stage surgery. Definitive abutments were tightened. The final prostheses made of porcelain were cemented with resin cement. (Fig 4)

FIG (1)

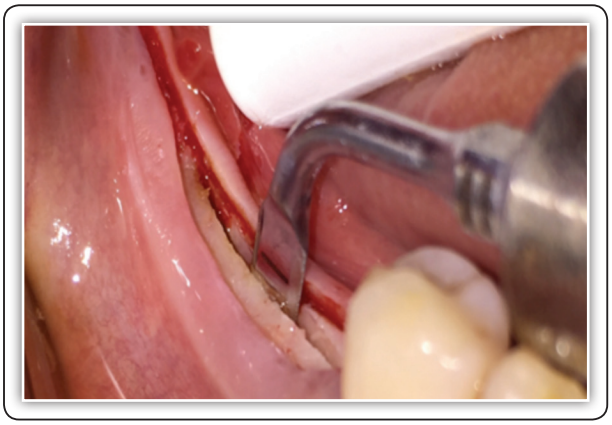

FIG (2)

FIG (3)

FIG (4)

Postoperative evaluation

Clinical evaluation

1. Probing depth (PD): It was measured as the distance from the crest of gingival margin to the bottom of the gingival sulcus at four sites around implants using aWilliams probe.
2. Changes in implant stability quotient (ISQ): By using Osstell, (Osstell ABStampgatan 14, Go¨ teborg,Sweden) primary stability was recorded immediately after implant placement and at 6 months for each implant.

Radiographic evaluation

1. Postoperative ridge width: It was measured and compared with preoperative cone beam computed tomography measurements.
2. Measurement of marginal bone loss (MBL): Implant MBL around the implant was evaluated at the day of the implant placement (immediate) and on the follow up visits at 3, 6, 9 and 12 months. Measurements were made mesially and distally for each implant.

Statistical analysis: The data were collected, tabulated, and statistically analyzed by using the statistical package for the social sciences SPSS, version 17 for Windows (SPSS, Chicago, Illinois, USA).

RESULTS

During the period of the study, only three cases showed gingival wound gaps of 0.5 mm to 1 mm that were healed by secondary intention and had optimal epithelial covering by the end of third week postoperatively, while the majority of cases showed primary eventual soft tissue wound healing.

The changes in alveolar ridge width: The mean value of alveolar ridge width in group I was 3.619 mm ±0.612 preoperatively that increased to 6.697 mm±0.888 postoperatively. The mean value of alveolar ridge width in group II was 3.839 mm ±0.478 preoperatively that increased to 6.628 mm ±0.602 postoperatively. These changes showed that high statistical significant difference in comparing pre-operative versus post-operative alveolar ridge width in the two groups. When comparing between groups (Unpaired test); it showed no statistical significant difference between the two groups pre-operatively & post-operatively (table1).

Changes in implant stability quotient: Were recorded immediately after operation and at 6 month observation periods showed that high statistical significant difference at 6 month observation interval when compared to immediate observation period in the two groups. When comparing ISQ between groups, showed no statistical significant difference at immediate observation period. While it showed high statistical significant difference in comparing G II vs. G I at 6 month observation interval (table 2).

Changes in probing depth measurement: Showed that probing depth was increased gradually by the end of study in the two groups. Unpaired test, used for comparing PD between groups, showed statistically significant difference in the results of group II at the 12th month of the observation periods when compared with the other group. The accretion of probing depth in the two groups occurred but it still in acceptable range (≤ 3mm) (table 3).

Changes in marginal bone level: Showed gradual increase in marginal bone loss during all observation periods of the study in the two groups. In group I, the mean value of marginal bone level was 0.00mm ±0.00 immediately that increased to 1.480 mm ±0.216 after 12 months of implant placement. In group II, the mean value of marginal bone level was 0.00mm ±0.00 immediately that increased to 1.392 mm ±0.342 after 12 months of implant placement. When comparing GII VS. GI, it showed statistical significant difference during 3 month observation periods of the study and high statistical significant difference during 6, 9 and 12 month observation periods (table 4).

TABLE (1): Showing mean ±SD values of Pre-& post- operative alveolar ridge width (using CBCT) among studied groups, along with significance level using paired & unpaired t-test.

Follow up Periods / Studied groups	Pre O.		Post O.		Post Vs. Pre	
					Paired t-test	
	Mean ± SD		Mean ± SD		t	p
Group I	3.619±0.612		6.697±0.888		21.21	0.00**
Group II	3.839±0.478		6.628±0.602		18.12	0.00**
Unpaired t-test						
	Pre O.		**Post O.**			
	t	**p**	**t**	**p**		
GII Vs. GI	1.173	0.266	0.242	0.813		

Pre-& post- operative alveolar ridge measured by mm.

** Statistically significant: ($p < 0.05$).*

***High statistically significant: ($p < 0.01$).*

TABLE (2): Showing mean ±SD values of ISQ scores among studied groups immediately and at 6 months post-operatively, along with significance level using paired & unpaired t-test.

Follow up Periods / Studied groups	Immediate		6 month		6 month Vs. Immediate	
					Paired t-test	
	Mean ± SD		**Mean ± SD**		**t**	**p**
Group I	63.33±3.869		73.081.505		9.33	0.00**
Group II	63.08±4.420		75.50±1.834		11.11	0.00**
Unpaired t-test						
	Immediate		**6 month**			
	t	**p**	**t**	**p**		
GII Vs. GI	0.147	0.884	3.53	0.00**		

***ISQ**: implant stability quotient*

** Statistically significant: ($p < 0.05$).*

***High statistically significant: ($p < 0.01$).*

TABLE (3): Showing mean ± SD values of probing depth scores among studied groups at each evaluation period, along with significance level using paired & unpaired t-test.

Follow up Periods / Studied groups	6 month		9 month		12 month		9 month Vs. 6 month		12 month Vs. 6 month	
							Paired t-test			
	Mean ± SD		**Mean ± SD**		**Mean ± SD**		**t**	**p**	**t**	**p**
Group I	2.146±0.198		2.333±0.268		2.625±0.226		3.45	0.01**	5.70	0.00**
Group II	2.000±0.354		2.271±0.225		2.421±0.249		3.77	0.00**	5.23	0.00**
	Unpaired t-test									
	6 month		**9 month**		**12 month**					
	t	**p**	**t**	**p**	**t**	**p**				
GII Vs. GI	1.246	0.226	0.618	0.543	1.873	0.036*				

** Statistically significant: ($p < 0.05$).*

***High statistically significant: ($p < 0.01$).*

TABLE (4): Showing mean ±SD values of marginal Bone loss scores among the two groups at each evaluation period, along with significance level using paired & unpaired t-test.

Follow up Periods	Immediate	3 months	6 month	9 month	12 month	3 month Vs Immediate		6 month Vs. Immediate		9 month Vs. Immediate		12 month Vs. Immediate	
Studied Groups						Paired t-test							
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	t	p	t	p	t	p	t	p
Group I	0±0	0.492 ±0.247	0.750 ±0.315	1.408 ±0.368	1.675 ±0.416	6.91	0.00**	8.25	0.00**	13.26	0.00**	13.95	0.00**
Group II	0±0	0.375 ±0.182	0.517 ±0.170	0.892 ±0.271	1.392 ±0.342	7.16	0.00**	10.55	0.00**	11.39	0.00**	14.08	0.00**

Unpaired t-test										
	Immediate		3 months		6 month		9 month		12 month	
	t	p	t	p	t	p	t	p	t	p
GII Vs. GI	--	--	2.244	0.05*	3.189	0.01**	5.568	0.00**	3.294	0.01**

Marginal Bone loss are expressed in mm.

** Statistically significant: ($p < 0.05$).*

***High statistically significant: ($p < 0.01$).*

DISCUSSION

Bone loss is an ongoing process following tooth loss affecting the mandible four times more than the maxilla[14]. Problem of resorbed ridges and the ways to add hard and soft tissue in defective sites to provide adequate height and width for appropriate implant insertion have still remained challenging[15].

To resolve this situation, alveolar ridge augmentation had been performed by many methods; guided bone regeneration, distraction osteogenesis, onlay block grafting and ridge splitting.

Ridge splitting is a procedure used to expand the narrow ridge bone by separating the buccal and lingual plates. Splitting of the alveolar bone longitudinally is performed using chisels, osteotomes or piezosurgical devices. The result is an increase of the horizontal ridge width, provided that the buccal and lingual cortical plates are not fused and some intervening cancellous bone is present, with adequate vascularity and stabilization of the mobile bone segment[16-18].

This clinical trial was designed to evaluate piezoelectric ridge splitting and compare between it and the traditional methods in narrow posterior mandibular ridges in twenty patients participated in the study for insertion of dental implants. They were evaluated clinically, radiographically and by RFA (ISQ).

Clinical as well as radiological results after 1 year revealed stable hard and soft tissue conditions with no soft tissue recessions or peri-implant bone loss in groups I and II, with superiority for groupII.

In the present study, intraoperative use of piezo surgery in osteotomy resulted in precise and easy controlled osteotomies that allowed successful implantation. This could be attributed to Vercellotti et al findings[17,19-22],

Who stated that the advantages are due to that the modulated ultrasonic frequency, which generates micro-vibrations of (60 – 200) mm/sec, cuts mineralized tissue exactly and smoothly while adjacent soft tissue and nerves remain unharmed and that peizosurgerys accuracy and selectively renders it superior to conventionally rotating instruments in operations where the area of interest is adjacent to nerves.

In the present study, ISQ measurement showed high statistical significant difference in comparing G II vs. G I at 6 month of observation interval. Whereas, MBL values showed that there are highly statistically significant differences during the 12-month interval when group II was compared with group I. These results can be explained by that the two groups didn't had the same technique that preserved soft tissue and blood supply at the distracted site. This study in agreement with Blus et al [23], that using the ultrasonic bone surgery (piezosurgery) to split the ridge crest and insert implant immediate in mandible.

CONCLUSION

From the results of the study, it can be concluded that the piezoelectric ridge osteotomy technique is a new effective and a promising procedure for ridge expansion especially in narrow posterior mandibular ridge without the risk of fracture because of excessive trauma. The implant success is very predictable in the piezoelectric technique than the traditional techniques because it takes place in protected and well vascularized environment.

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