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Original Article

Lateral ridge split and immediate implant placement in moderately resorbed alveolar ridges: How much is the added width?

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ABSTRACT

Background: Lateral ridge split technique is a way to solve the problem of the width in narrow ridges with adequate height. Simultaneous insertion of dental implants will considerably reduce the edentulism time.

Materials and Methods: Twenty-five patients who were managed with ridge splitting technique were enrolled. Thirty-eight locations in both jaws with near equal distribution in quadrants received 82 dental fixtures. Beta Tricalcium phosphate (Cerasorb®) was used as biomaterial to fill the intercortical space. Submerged implants were used and 3 months later healing caps were placed. Direct bone measurements before and after split were done with a Collis. Patients were clinically re-evaluated at least 6 months after implant loading. All the data were analyzed by Statistical Package for Social Sciences (SPSS) software version 11.5 (SPSS Inc, Chicago Illinois, USA). Frequency of edentulous spaces and pre/post operative bone width was analyzed. Paired *t*-test was used for statistical analysis. Difference was considered significant if *P* value was less than 0.05.

Results: Mean value for presplit width was 3.2 ± 0.34 mm while post-split mean width was 5.57 ± 0.49 mm. Mean gain in crest ridge after ridge splitting was 2 ± 0.3 mm. Statistical analysis showed significant differences in width before and after operation (($P < 0.05$). All implants ($n = 82$) survived and were in full function at follow up (at least 6 months after implant loading).

Conclusion: Ridge splitting technique in both jaws showed the predictable outcomes, if appropriate cases selected and special attention paid to details; then the waiting time between surgery and beginning of prosthodontic treatment can be reduced to 3 month.

Key Words: Atrophic ridge, dental implant, ridge splitting

INTRODUCTION

Tooth loss in permanent dentition occurs gradually during years of the life. Replacement of missing teeth with dental implant procedures is one of the greatest advances in dentistry. 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 has still remained challenging. For correction of defective ridges some solutions presented including: Onlay lateral ridge bone grafting,[1] horizontal osteodistraction,[2] and Guided bone regeneration techniques.[3] Lateral ridge split technique is a way to solve the problem of the width in narrow ridges with adequate height.[4] Simultaneous insertion of dental implants will considerably reduce the edentulism time. Dental implant placement in atrophic ridges with deficient ridges with onlay bone grafting techniques (Autografts/allografts) need some time between bone grafting and dental implant insertion (3-6 month) and there is always the possibility of bone graft failure.[4,5] Crest split augmentation technique with simultaneous implant insertion will reduce the time as well as the

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surgical procedures. Bone compression and increase in trabecular density are other advantages of this technique.[6] Survival rate of implants inserted in ridge split alveolar ridges is reported between 86% and 97%.[7,8] Biomaterials or autogenous bone are used as interpositional grafting in this technique.[9] Membranes do not necessarily increase the outcomes with this technique.[10] The patients' acceptance rate for this technique is very high due to its low morbidity and shorter time intervals in comparison with autologous onlay bone grafting.

MATERIALS AND METHODS

This study was conducted on 25 patients in 38 locations that received 82 dental implants. After clinical and radiographic examinations of edentulous regions in both jaws, anterior or posterior segments with 3-4 mm width at crest region were chosen (the minimal accepted length of remaining bone was 10 mm) [Figure 1]. All patients had preoperative Cone Beam Computer Tomography scans (CBCT). Patients had good general health conditions without active periodontal diseases. Patients who had each of the conditions including systemic diseases that influence wound healing like diabetes mellitus, the need for simultaneous sinus lifting or inferior alveolar nerve lateralization, a thin ridge that does not widened apically, and enlarged maxillary incisive foramen were excluded from the study. A total number of 25 patients with the above conditions participated in study. All the data were analyzed by Statistical Package for Social Sciences (SPSS) software version 11.5 (SPSS Inc, Chicago Illinois, USA). Frequency of edentulous spaces and pre/post operative bone width was analyzed. Paired *t*-test was used for statistical analysis. Difference was considered significant if P value <0.05. This study was approved by the research deputyship of Mashhad University of Medical Sciences regarding methodological and ethical issues. A written consent was obtained from each individual after introducing the aims and procedures of the study and answering their questions.

Surgical technique

Under local anesthesia and after full thickness reflection of mucoperiosteal flap a trapezoid flap (crestal incision and two vertical releases) was reflected and the width of the bone directly measured with a Collis. Ridge split was applied

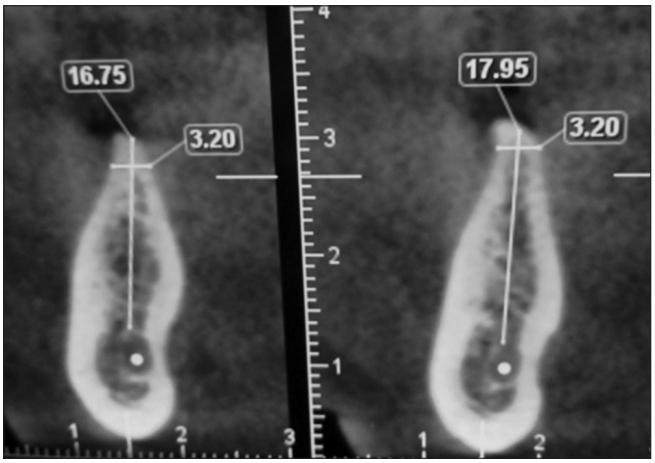

Figure 1: Ridge conditions suitable for ridge splitting: Buccolingual width between 3-4 mm, gradual increase from ridge crest toward basal bone and sufficient height of alveolar ridge

Figure 2: Fissure bur marking before beginning of osteotomy

Figure 3: Osteotome Obwegesser (8 mm width) was used in this study

with osteotome (8 mm/Obwegeser), after the crest being prepared with surgical fissure bur in straight

high speed handpiece [Figures 2 and 3]. One 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 will expand. Slight buccolingual movement of the osteotome increases the expansion. After obtaining adequate width a paralleling device is inserted in osteotomy site to prevent collapse of expanded cortical plates. With an implant insertion contrangle in low speed (slower than the usual speed for the specific region), the bur is inserted between the cortical plates; then the rotary movement begins while the bur is in the bone between the cortical plates. This inhibits damage to the cut edge of cortical plates (this technical note is more important in drilling with larger diameter implant burs). It is better that similar diameter implants is inserted in prepared sites [Figure 4]. Two unequal diameters lead to the small fixture loosening. Fixtures are selected from bone level systems and inserted the same level to the ridge crest. The space between cortical plates is then filled with biomaterial (Cerasorb®) [Figure 5]. In single fixture insertion, there was no need for biomaterial. Finally, cover screw was tightened and primary soft tissue closure was obtained. Three month later during second phase of surgery, healing caps were inserted. Two weeks after, they were delivered to Prosthodontist. A control radiography (OPG) or periapical was taken before second phase of surgery. The patients were followed up for at least 6 month after prosthetic treatment. In three patients, for whom cortical plate fracture occurred during surgery, the procedure was not continued. Biomaterials were inserted; fractured cortical plate was fixed with fine wire and 3 month later dental fixture insertion attempted. These patients were omitted from the study.

RESULTS

Demographic information of the patients is illustrated in Table 1. The patients aged from 16-78 years and 10.5% of them had edentulous space in anterior maxilla. Other quadrants (left lower, left upper, right lower, and right upper) had nearly equal values (21.1-23.7%). Inserted fixtures were from one to four in each site. Two implants insertion in ridge split sites was the most common (60%). Presplit mean width was 3.2 ± 0.34 mm (min 2.8 mm and max 4.2 mm). Post-split mean width was 5.57 ± 0.49 (min 3.7 mm and max 6.3 mm). The mean gain in crest ridge after ridge split was 2 ± 0.3 mm. Statistical analysis showed significant differences in width before and after operation ($P < 0.05$). After at least 6 month of follow up all implants (82 implants) survived and were functional.

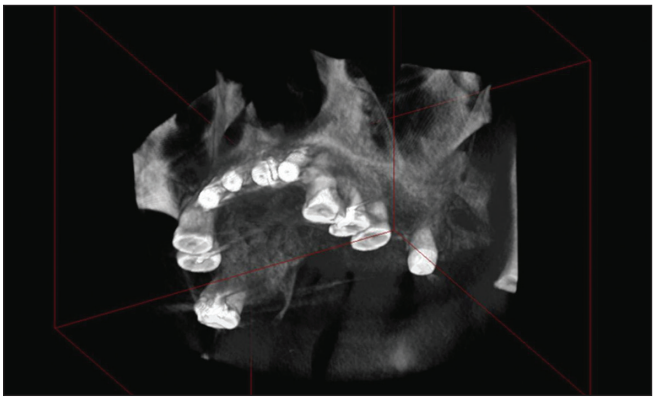

Figure 4: The same diameter implants are inserted at bone level

Figure 5: Intercortical space is filled with Cerasorb®

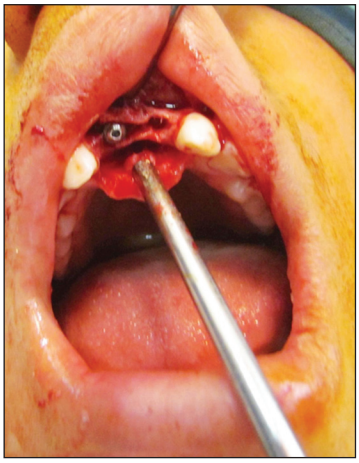

Figure 6: Greenstick fracture of buccal cortical plate

Table 1: Demographic information of the patients in this study

No	Sex	Location	Inserted fixture (S)	Age	Pre split BL-width (mean) mm	Post split BL-width (mean) mm
1	F	LLq	Two	56	3.1	5.2
2	M	LLq	Three	64	2.8	5.1
		LUq	Three		3.1	5.2
		RLq	Three		3.3	5.2
		RUq	Two		3.5	5.2
3	M	RUq	Three	65	3	5.3
		LUq	Three		3.1	5.2
4	M	LLq	Three	45	3.3	5.5
5	M	Maxillary C_i	Two	16	3.2	5.1
6	F	Maxillary incisors	Four	20	2.8	4.7
7	M	Central incisors	Two	24	3.2	5.3
8	F	RUq	Two	50	2.9	5.1
		LUq	Two		3.2	5.4
9	F	RUq	One	20	4	6.2
		LUq	One		4.2	6.3
10	F	Mandibular overdenture site	Two	65	3	5
					3	5
11	M	LLq	Three	67	3.3	5.7
12	M	Maxillary C_i	One	38	3.2	4.8
13	M	Luq	Two	62	3.1	5.2
		RUq	Two		3.2	5.4
		LLq	Two		3.5	5.5
14	F	RLq	Two	53	3.7	6
15	F	RUq	Two	52	3.1	5
		LUq	Two		3.2	5.1
16	F	RUq	Three	48	2.8	4.5
17	F	RUq	Two	62	3.2	5
		LUq	Two		3.5	5.5
18	F	RLq	Two	60	3.4	5.5
19	F	LUq	Two	47	3.8	5.7
20	M	LUq	Two	60	2.9	4.9
21	M	LLq	Two	21	3.5	6
22	F	RLq	Two	58	3.8	6
23	M	Mandibular overdenture site	Two	78	3	5
24	M	LLq	Two	61	3.2	4.9
		RLq	Three			
25	F	RLq	One	63	4	6

LLq: Left lower quadrant, LUq: Left upper quadrant, RLq: Right lower quadrant, RUq: Right upper quadrant, C_i: Central incisor, BL: Bucco-Lingual

Table 2: Modifications of lateral ridge split technique

Modification	Advantage	Reference
Osteoperiosteal flap (book flap)	Better marginal bone stability	[12]
Simultaneous with implant placement	Save time	[13]
One/two buccal bone release	Buccal cortical plate expansion in lower jaw	[14]
Membrane application	Benefits of GBR	[15]
I flap	Simultaneous width and height increase	[16]
Staged ridge splitting	Decrease the risk of malfracture in mandible	[17]

DISCUSSION

Ridge split technique in implant dentistry was introduced for the first time by Simion *et al.* in 1992.[11] Further modifications of this technique since 1992 are presented in Table 2.[12-17] It is also used for bone augmentation for orthodontic purposes.[18] Main concept of this technique relies on elasticity of the bone.[19] Greenstick fracture of cortical plates (buccal in maxilla and lingual in mandible) occurs in some patients [Figure 6]. Placement of bone substitutes in intercortical space (interposition bone grafting) has advantages of internal perfusion, prevention from

particle migration and displacement, omission of the need for donor site and fixation screw and reduction of graft resorbtion probability.[20,21] Simultaneous insertion of dental implants has advantages such as reducing waiting time from surgery to beginning of prosthetic treatment, requiring less amount of biomaterials, and preventing the collapse of distended buccal and lingual/palatal walls. For creating split between the cortical plates, different osseous surgical tools such as hand instruments (chisel and osteotome), rotary instruments (surgical bur in high speed handpieces), and piezosurgery instruments has been used successfully.[22,23] The bone apical to ridge split helps to gain primary stability of inserted implants therefore simultaneous need for sinus lifting (open or closed), insufficient space between inferior dental canal and ridge crest, or deep submandibular fossa would prohibit the application of this technique. Since after ridge splinting, there will be an increase in the width of the alveolar ridge crest primary soft tissue closure over the submerged implants and grafted biomaterials between them is the last and most important step in this technique that should be considered before beginning of the surgery.[24] The problem of soft tissue almost always occurs in upper jaw because of limited elasticity of palatal mucosa. A good solution for this problem is pedicle flap from palatal connective tissue.[25] The pedicle is based anteriorly in most cases [Figure 7]. This flap which has random pattern vascularity has other advantages over providing tensionless closure of soft tissue over grafted region. These include vertical augmentation of the soft tissue, providing keratinized tissue over split ridge, producing similar color with adjacent gingiva after epithelialization, and providing donor site with minimal morbidity [Figure 8].[26]

A problem mostly occurring in lower jaw is that cortical expansion is obtained by lingual displacement of lingual plates and buccal cortical plates will expand minimally, which could place inserted implants in more lingual position to the previous ridge crest [Figure 9]. Greenstick fracture of lingual plate will produce some bone spurs that irritate tongue. Corticotomy of a rectangular buccal segment and staged ridge splitting technique are two ways to overcome this problem.[23,27] Another consideration of this technique is the proximity of the osteotomy site near natural adjacent tooth. Close proximity increases the possibility of injury to the tooth root; therefore, dental fixtures are usually placed in a more distal position from natural teeth which could create prosthetic problems. Anterior maxillary region sometimes has the problem of enlarged incisive

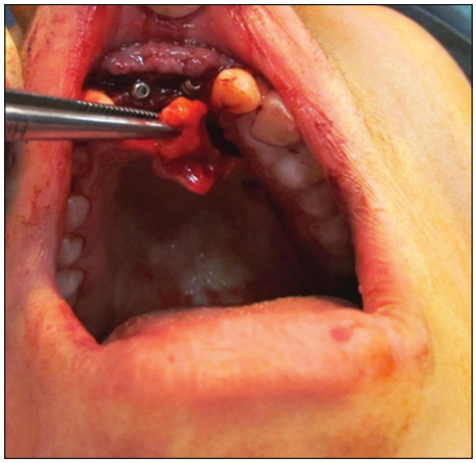

Figure 7: Pediculated connective tissue flap of palate (VIP-CT) covered the expanded alveolar ridge in anterior maxillary region

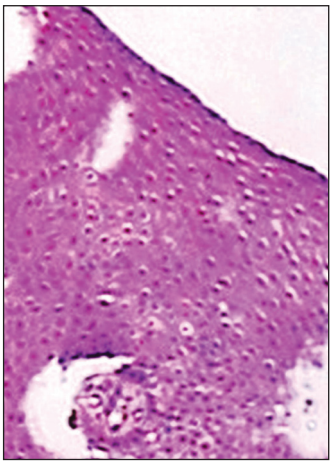

Figure 8: Histologic feature of epithelialized Vip-ct flap after 3 months (H and E, original magnication 100×)

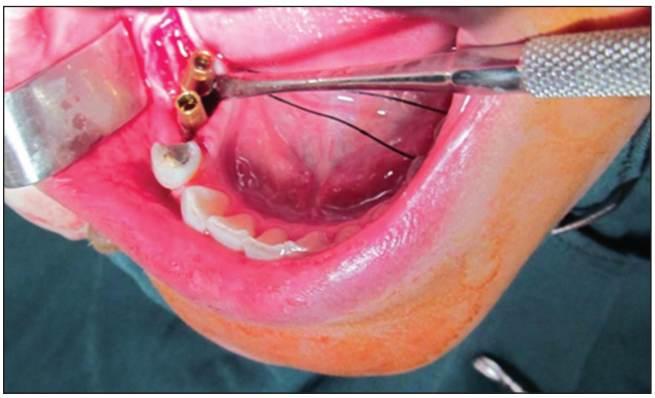

Figure 9: Lingual position of inserted fixtures at mandibular posterior region in comparison with lower dental arch

foramen in some patients that will inhibit simultaneous application of ridge split technique along with implant insertion.[28]

The recommended width of ridge for ridge splinting is 3-4 mm.[29] In our study, there were four patients with the ridge width lower than this amount. The patients were selected through preoperative CBCT. Difference between measured widths in CBCT with direct bone measurements after flap reflection was the reason. However, this technique successfully worked in these patients. Success rate of implants in the present study was 100% that may be due to good patient selection and automatic deletion of the patients in whom this technique was not appropriate (three patients with cortical bone fracture) which is consistent with other researches.[30,31] This denotes that if this technique is used properly and in a right situation, the result will be predictable. This technique could be more easily applied for younger patients. In old patients, elasticity of the bone is reduced and the expansion needs more detailed attention to the technical note. However, old age is not a concern and this technique was used successfully in these patients. In three young patients aged from 16-24 years, this technique was used to reconstruct anterior maxillary region after traumatic loss of anterior teeth. No case of mandibular incisor tooth loss replacement was present in our series. This study showed that the time interval between ridge splitting along with simultaneous implant insertion and the beginning of prosthodontic treatment could be reduced as low as 3 months which is shorter than other studies.[32]

CONCLUSION

Ridge splitting technique in both jaws will have the predictable outcomes, if appropriate cases selected and special attention is paid to details; then the waiting time between surgery and beginning of prosthodontic treatment can be reduced to 3 month.

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