



Ridge Split Procedure In The Placement Of Dental Implants Using Sandwich Bone Augmentation Technique

Dr. Ritu Mohindra

Asst. Prof . Department Of Prosthodontics and Maxillofacial Prosthetics
Sardar Patel Post Graduate Institute of Dental and Medical Sciences, Lucknow

***Corresponding Author:**

Dr. Ritu Mohindra

Asst. Prof . Department Of Prosthodontics and Maxillofacial Prosthetics

Type of Publication: Original Research Paper

Conflicts of Interest: Nil

Abstract

Objective of the study:

Ever since the introduction of the concept of osseointegration, implants have gained significant ground in the field of dentistry. Osseointegration has been the ultimate goal for dentists. With aesthetics being the prima fascia concern, the functional aspect has to match up to the expected level of the patient. We need to find alternatives which not only satisfy the principles of surgical practice as far as healing is concerned but are time effective. Hence, the aim of the present study is to evaluate the width of the alveolar ridge and to illustrate the outcome of the operation using ridge split technique placement of implants using the CBCT.

Materials and methods:

Total of 30 patients with a complaint of missing maxillary or mandibular tooth/teeth was selected after thorough clinical, radiological and haematological investigation from the OPD of Department Of Prosthodontics and Maxillofacial Prosthetics, Sardar Patel Post Graduate Institute of Dental and Medical Sciences, Lucknow. All the cases underwent a ridge splitting procedure and implant placement in the narrow alveolar ridge. Peri-implant bone regeneration was assessed using cone beam computed tomography at the third month post-operative. Data were analysed using ANOVA test.

Results:

On comparison of the peri-implant bone regeneration pre- operative and post- operatively at 3 months, there was significant bone regeneration at the alveolar crest, the mid bucco-lingual crest and at the apex. The differences was significant at the apex and highly significant at the alveolar crest and the mid-bucco-lingual crest post-operatively.

Conclusion :

Results of the study confirmed that since the ridge splitting procedure uses a sequence of progressively increasing osteotome to create an osteotomy closely receptive to implant dimension, it can give a predictable outcome and results for placement of dental implants in atrophied ridges.

Keywords: CBCT; Osseointegration; Atrophied ridges; Ridge splitting procedure.

Introduction

The goal of modern dentistry is to restore the patient to normal contour, function, comfort, aesthetics, speech and health, whether by removing caries from a tooth or replacing several teeth¹.

Resorption of the alveolar ridge will be unavoidable and progressive if the teeth are lost. In the horizontal dimension, bone remodelling results in the reduction of the bucco-lingual width of the alveolar ridge and compromises the placement of dental implants². Characteristics bone volume changes after tooth loss

were evaluated in the anterior mandible by Atwood.³ The posterior edentulous mandible resorbs at a rate approximately four times faster than the edentulous mandible.⁴ There are various treatments to augment the deficient alveolar ridges such as on-lay grafts, guided bone regeneration and distraction osteogenesis and each of these processes have their advantages and disadvantages.

Ridge split procedure in the placement of dental implants is an effective way to correct the horizontal deformity of the ridge i.e. the bucco-lingual alveolar width deficiency as it allows gradual widening of the ridge thereby reducing the risk of fracture and dehiscence by the use of series of osteotomies that progressively increase in diameter.

Another reliable method for the augmentation of the alveolar ridge is GBR.⁵ The sandwich-bone augmentation technique exploits the properties of each of the materials to improve the reliability of the augmentation. According to Lee et al⁶ the sandwich bone augmentation creates an environment that mimics native bone thereby including two layers of bone graft that simulate the cancellous and cortical bone respectively and a barrier membrane that replicates the periosteum.

The placed implant with ridge splitting technique is covered with a split ridge (dense bone plate) and the healing furrow between the split plates is similar to that of the fractured bone.⁷

At least 3mm of residual ridge is required for this technique because cancellous bone must exist between cortical bone plates for bone expansion.⁸

Therefore, the study presented here aimed at evaluating the width of the alveolar ridge using CBCT and to illustrate the outcome of the operation using ridge splitting technique with sandwich bone augmentation in the placement of implants in narrow buccolingual alveolar ridges.

AIM :

The aim of the present clinical study is to analyse the width of the resorbed alveolar ridge using ridge splitting procedure in the placement of dental implants using sandwich bone augmentation technique.

OBJECTIVE:

To evaluate the width of the alveolar ridge and to illustrate the outcome of the operation using ridge split technique placement of implants using the CBCT.

METHODOLOGY

Source of Data:

Patients who are selected have partial edentulism associated to horizontal ridge resorption in either the maxillary or mandibular arches and require replacement by dental implants were included in the study.

Patients were selected from:

1. Those reporting to the from the OPD of Department Of Prosthodontics and Maxillofacial Prosthetics, Sardar Patel Post Graduate Institute of Dental and Medical Sciences, Lucknow
2. Patients reporting to the dental OPD of Sardar Patel Post Graduate Institute of Dental and Medical Sciences, Lucknow
3. Satellite centres associated with Sardar Patel Post Graduate Institute of Dental and Medical Sciences, Lucknow

4. Inclusion criteria :

1. Horizontally insufficient maxillary and mandibular ridge (3mm- 5mm buccolingual width)
2. Presence of a narrow edentulous maxillary or mandibular alveolar ridges (at least 1-3 teeth missing)
3. Patient age between 20-60years.
4. Patient with good systemic health.(ASA-I)

Exclusion criteria:

1. History of radiation therapy in the head and neck region.
2. Uncontrolled systemic diseases such as diabetes mellitus, hypertension, hyperthyroidism etc.
3. Poor oral hygiene with active periodontal disease.
4. Heavy smoker
5. Alcohol abuse
6. Pregnancy

7. Severe bruxism
8. Chemotherapy for treatment of malignancy
9. Bisphosphonate therapy

Criteria for evaluation:

Clinical examination -

1. Clinical photographs- pre-operative, intra-operative and post-operative.
2. Pre-operative, periapical radiograph and CBCT.
3. During follow up - Base line radiograph were taken immediately after implant placement, which serves to compare the bone healing (in the form of bone density) in the follow up radiographs. Follow up is done after 3 months.
4. The clinical parameters which were recorded were:
 1. The simplified oral hygiene index.(OHIS)
 2. Measurement of the width of the alveolus assessed using Vernier caliper.
 3. Probing depth around the implant at four sites- mesial, distal, buccal and lingual.
 4. Implant mobility
 5. The absence or presence of any infection around the implant.

Pre-operative assessment:

General and systemic conditions (uncontrolled diabetes mellitus, hypertension, hyperthyroidism) were evaluated (by using routine hematological, microbiological, and biochemistry investigations) to know their fitness to undergo the surgery.

The radiological investigations which were carried out to determine the dimension of the alveolar bone were:

- i. Intra-oral periapical radiograph (IOPA) – to determine the angulation of the implant placed(immediately after the implant placement) and to evaluate the amount of bone formation around the implant (3 months post-operative)
- ii. Orthopantomogram(OPG) – to determine the angulation of the implant placed(immediately after the implant placement) and to evaluate the amount of bone formation around the implant (3 months post-operative)

- iii. Cone Beam Computed Tomography(CBCT) – to determine the amount of bone formation along the buccal and lingual aspect of the implant site (3 months post – operative)

1. A case sheet was designed for this study to record the case history.
2. All patients were informed about the nature of the study and written informed consent was taken after the patients were explained about the need for the procedure.
3. Extra-oral and intra-oral photographs were taken.
4. The implant system used was ADIN DENTAL IMPLANT SYSTEMS
5. Clinical assessment of the patients were done on first day, third day , seventh day and third month post operatively for
 - i. Pain
 - ii. Swelling
 - iii. Infection
 - iv. Wound break down/soft tissue dehiscence
 - v. Cover screw exposure
 - vi. Implant mobility
6. The clinical parameters recorded were at the end of 3 months:
 - i. The simplified oral hygiene index
 - ii. Probing depth around the implant at four sites- mesial, distal, buccal and lingual,
 - iii. Implant mobility
 - iv. Absence or presence of infection around the implant.

Surgical procedure of implant placement:

1. In all cases implants were placed under local anesthesia (2% Lignocaine hydrochloride with 1:2,00,000 adrenaline)
2. Skin preparation and isolation of the surgical field with barrier draping was accomplished.
3. All patients were advised to rinse with betadine mouthwash before the placement of implants intra-orally, thus disinfecting the mucous membrane.

4. Crestal incision given with No.15 blade after achieving adequate anesthesia.
5. Mucoperiosteal flap was reflected using Howarth's periosteal elevator minimizing the elevation of full thickness flap on the buccal side for adequate blood supply, followed by alveolar bone exposure.
6. Measurement of the width of the edentulous ridge was performed after full thickness flap elevation using a surgical Vernier caliper.
7. Implant site preparation was done with W&H Dental hand piece, Austria with external irrigation attached.
8. An initial osteotomy was made on the mid-crestal bone i.e. the creation of a 1-3mm deep seam along the length of the ridge at a speed of 1,200-1,500 RPM
9. Followed by progressive deepening of the split by simultaneously increasing the thickness and diameter of the ridge splitting chisels.
10. After establishing the initial ridge split, irrigated spiral drills were used to enlarge the implant osteotomy sites.
11. The narrow ridge was then split longitudinally via bone spreading chisel tapped lightly with a mallet.
12. . After the cortical plates were separated, a pilot drill was used to prepare the osteotomy for the final length of the implants to be placed.
13. The implants were then transferred to their respective osteotomy sites and firmly secured once they were fully seated in position.
14. Any intra-medullary bone collected during drilling procedures was mixed with and reconstituted with the patient's own blood.
15. The heme-reconstituted bone is then packed gently into the ridge split furrow using tissue elevators and amalgam condensers.
16. All implants placed were of tapered design endosseous implants with length ranging from 10-15mm and diameters from 3-5mm. followed by placement of the cover screws.
17. Immediate post-operative IOPA was taken to evaluate the alignment of the implant.

18. Mucoperiosteal flap was closed using 3.0 vicryl using simple interrupted suture technique.

Post – operative procedure:

1. Antibiotics (Cap. Amox 500mg T.I.D and Tab Metrogyl 400mg T.I.D for five days) and anti-inflammatory drugs (Tab. Aceclofen T.I.D for three days) were prescribed.
2. All Patients were given oral hygiene maintenance instructions.
3. Patients were checked for any pain/swelling/infection/wound break down/soft tissue dehiscence in the implant region on the first, third and seventh day post- operative days.
4. Patients were recalled after 15 days for suture removal.
5. Temporary removal prosthesis were given after ten days
6. Post-operative radiological analysis were done immediately post-operative (IOPA) and 3 months (IOPA, OPG and CBCT).
7. Healing abutments were placed after 3 months.
8. After two weeks the healing abutments were removed.
9. Permanent abutments placed and prosthesis given.

Duration of study:

A 3 months follow-up study with radiographic evaluation and CBCT was performed to assess the width of the alveolar ridge.

SAMPLE SIZE ESTIMATION

Pre split Mean width was $3.2=X_1$ Pre split SD of width was $3.2=S_1$

Post split Mean width was $X_2 = 5.57$ Post split SD of width was $X_2 = 0.49$ Pooled standard deviation $\sigma = 0.04$ $D=x_1-x_2=$ difference of means = 2.37

Sample size estimation was done with reference to "Amin Rahpeyma, Saeedeh Khajehahmadi, and Vahid Reza Hosseini. Lateral ridge split and immediate implant placement in moderately resorbed alveolar ridges: How much is the added width? Dent Res J (Isfahan). 2013 Sep-Oct; 10(5): 602–608."

A total of 30 implants were placed in 30 patients using ridge splitting procedure

Sample size estimation was done with reference to “Amin Rahpeyma, Saeedeh Khajehahmadi, and Vahid Reza Hosseini. Lateral ridge split and immediate implant placement in moderately resorbed

alveolar ridges: How much is the added width? Dent Res J (Isfahan). 2013 Sep-Oct; 10(5): 602–608.”

A total of 30 implants were placed in 30 patients using ridge splitting procedure.

Clinical data

Table 1: Age distribution

AGE	NO. OF CASES	PERCENTAGE
20-29	22	73.3
30-39	8	26.7
TOTAL	30	100.0

The age range of patients was 20-39years, of which 22 (73.3%) belonged to 20- 29years and 8 (26.7%) belonged to 30-39 years (Graph 1).

Clinical data

Table 1: Age distribution

AGE	NO. OF CASES	PERCENTAGE
20-29	22	73.3
30-39	8	26.7
TOTAL	30	100.0

Table -2 : Sex distribution

SEX	FREQUENCY	PERCENT
MALE	18	60
FEMALE	12	40
Total	30	100

Table 3: Oral Hygiene Index Simplified

OHIS	NO.OF CASES	PERCENTAGE
GOOD	7	23.33
FAIR	19	63.33
POOR	4	13.33
TOTAL	30	100.00

Assessment of probing depth

Paired Samples Statistics

Probing Depth	Mean	N	Std. Deviation	Std. Error Mean
POST-OP (1.5months)	2.5667	30	.93526	.17075
POST-OP (3 months)	2.1667	30	.46113	.08419

Paired Samples Test

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
POST-OP (1.5 months) - POST-OP(3 months)	-.4000	.96847	.17682	-.03837	.76163	2.262	29	.031

On clinically evaluating the probing depth at the end of 1.5 months and 3 months, the data showed that there was no significance with a p-value of 0.031 (Graph 4).

Assessment of bone regeneration

The evaluation of peri-implant bone regeneration after placement of endosseous implants were assessed at 3 different points i.e. alveolar crest, the mid bucco-lingual crest and at the apex. This analysis was executed at the third month post-operative.

Table 4 : Comparison of peri-implant bone regeneration at the alveolar crest pre-operative and post-operative

Paired Samples Statistics

CREST	Mean	N	Std. Deviation	Std. Error Mean
PRE-OP	4.6160	30	1.06853	.19509
POST-OP	7.5000	30	1.37690	.25139

Paired Samples Test

CREST	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 PRE-OP - POST-OP	-2.884	.72528	.13242	-3.15482	-2.61318	-21.780	29	.000

On comparison of Mean ± SD values for buccolingual crest between the pre-operative and the post-operative months with using ‘unpaired t test’ the data was highly significant with a value of 0.000 (Graph 5)

Table 5 : Comparison of peri-implant bone regeneration at the mid buccolingual crest pre-operative and post-operative

Paired Samples Statistics

MID	Mean	N	Std. Deviation	Std. Error Mean
PRE-OP	6.7200	30	.93011	.16981
POST-OP	9.7100	30	1.27991	.23368

Paired Samples Test

MID	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
PRE-OP - POST-OP	-2.9930	1.3453	.24562	-3.49235	-2.48765	-12.173	29	.000

Table 6 :Comparison of peri-implant bone regeneration at the apex pre- operative and post-operative Paired Samples Statistics

APEX	Mean	N	Std. Deviation	Std. Error Mean
PRE-OP	9.6300	30	1.68116	.30694
POST-OP	11.6800	30	1.65121	.30147

Paired Samples Test

APEX	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
PRE-OP - POST-OP	-2.050	.56492	.10314	-2.26095	-1.83905	-19.876	29	.000

Fig 2: Measurements of preoperative and postoperative CBCT

OBSERVATIONS:

The mean ±S.D values at 3 points in implants with ridge splitting procedure showed an increase in bone regeneration at the 3months was statistically significant.

The data at 3 months shows a highly significant increase in bone regeneration at the alveolar crest and the mid-buccolingual crest and a significant increase at the apex.

According to Simon et al⁴⁹ (1992), they reported the split crest technique in 5 patients. They were able to gain 1-4mm of alveolar ridge width by a split ridge

crest technique and guided tissue regeneration at the same time. Scipioni et al⁵⁰ (1994) reported the ridge expansion technique. They installed 329 implants in 170 patients and found that the survival rate of implant over 5 years was 98.8%, which was similar to what we observed in our study.

The placed implant with the ridge splitting technique is covered with a split ridge (dense bone plate) and the healing of the furrow between the split plates is similar to that of fractured bone⁵¹. If primary closure of the flap is obtained over the furrow, a bone graft into the furrow is not necessary. In our study, intramedullary bone which was obtained during the

surgical procedure was mixed with the patient's blood and placed along the buccal cortical plates to enhanced stability.

A 3mm of the residual ridge is required for the ridge splitting technique because cancellous bone must exist between cortical bone plates for bone expansion⁵². Similarly, in our study, the Mean± Standard deviation pre-op at the alveolar crest, the mid-bucco-lingual area and at the apex were 4.6 mm, 6.72 mm and 9.63 mm respectively

Post-operatively, the Mean± Standard deviation at the alveolar crest, the mid- bucco-lingual area and at the apex were 6.2 mm, 9.9 mm and 9.67 mm respectively

No clinical complications during the healing period were reported in our study. Therefore, the clinical results from our case series could support the hypothesis within the limits of the study that primary implant stability, integrity of bone walls maintaining a firm blood clot and primary flap closure are factors sufficient to induce spontaneous bone healing in circumferential peri-implant bone defects not exceeding 3mm.¹³

Osseointegration around the implant sites

The coronal bone remodelling observed in our study showed narrowing of the crestal ridge in a bucco-lingual direction. The pattern of bone rearrangement could be induced by new bone apposition to fill the peri-implant defect and at the same time, by buccal and lingual bone resorption leading to a width reduction of the alveolar ridge. The osseointegration around the implant sites at three different points at the end of the 3 month shows that there a highly significant statistical value p value 0.000 using 'unpaired t test.'¹⁴

Assessment of probing depth

To maintain the vitality of the separated buccal bone plate through the ridge splitting procedure, an adequate blood supply is essential. If the blood supply from the buccal periosteum and the endosteal blood supply to the split buccal bone plate maybe unavoidable even though a bone graft is applied into the furrow areas. Thus, it is necessary to minimize the amount of full thickness flap on the buccal side in order for a successful clinical outcome. In order to evaluate the width expansion success, the assessment of marginal bone resorption is a proper measure. In our study, the assessment of marginal bone

dimension around the implant placed by the osteotome technique was done by bone sounding with a calibrated probe. The assessment was done after 1.5 months of the implant placement and on the 3 months. On clinically evaluating the probing depth, the data showed that there was no statistical significance with a p-value of 0.031. The success criteria of the Branemark implant was suggested to be that marginal bone loss is less than 1mm 1st year and thereafter less than 0.2mm marginal resorption annually.¹⁶

CONCLUSION:

Considering the results of this study, the ridge splitting technique is a predictable method to place implants at a narrow alveolar ridge. Based on the results obtained, the following conclusions can be drawn:

- Majority of the cases belonged to age range of 20-29 years.
- On evaluation of the clinical parameters OHIS and probing at the end of 1.5 months and 3 months was not significant which means that ridge splitting technique does not have an effect on oral hygiene indices.
- On comparison of the peri-implant bone regeneration pre-operative and post- operatively at 3month, there was significant bone regeneration at the alveolar crest, the mid bucco-lingual crest and at the apex.
- The differences was significant at the apex and highly significant at the alveolar crest and the mid bucco-lingual crest post- operatively.
- Results of the study confirmed that since the ridge splitting procedure uses a sequence of progressively increasing osteotome to create an osteotomy which is closely receptable to impant dimension, it can give a predictable outcome and results for placement of dental implants in atrophied ridges.

SUMMARY





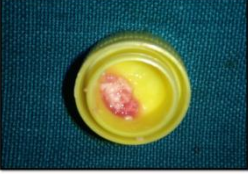



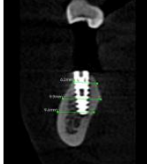


In summary, our results show that the bone-splitting technique used in rigid expansion osteotomy combined with sandwich-bone augmentation procedure, is an effective and reliable way to restore the atrophic alveolar ridge in the edentulous ridges. It increases the reliability of augmentation of the ridge

in the labio palatal/buccal dimension while it reduces the number of complications and shortens the course of treatment.

However, long-term follow-up with a larger sample is needed to assess the reliability of this approach.

BIBLIOGRAPHY

1. Carl E. Misch. Contemporary implant dentistry ; Elsevier Mosby:2005.
2. Fei Teng, Qi Zhang, Mengchun Wu, Shrestha Rachana, Guomin Ou: Clinical use of ridge-splitting combined with ridge expansion osteotomy, sandwich bone augmentation, and simultaneous implantation. British Journal of Oral and Maxillofacial Surgery 2014.03.028.
3. Atwood DA: Postextraction changes in the adult mandible as illustrated by microradiographs of midsagittal sections and serial cephalometric roentgenogram. J Prosthet Dent 13:810-824,1963 .
4. Atwood DA: Some clinical factors related to rate of resorption of residual ridges. J Pros Dent 1962; 12:441-50.
5. Dahlin C, Simion M, Hatano N: Long-term follow-up on soft and hard tissue levels following guided bone regeneration treatment in combination with a xenogeneic filling material: A 5-year prospective clinical study. Clin Implant Dent Relat Res 2010;12:263-70.
6. Lee A, Brown D, Wang HL: Sandwich bone augmentation for predictable horizontal bone augmentation. Implant Dent 2009;18:282–90.13.
7. Suh JJ, Shelemay A, Choi SH, Chai JK: Alveolar ridge splitting: A new micro saw technique. Int J Periodontics Restorative Dent 2005;25(2):165-71.
8. Karoline Maria Reich et al: Atrophy of the Residual Alveolar Ridge Following Tooth Loss in a Historical Population. Oral Diseases, Wiley, 2010, 17 (1), pp.33.
9. Juodzbaly G, Raustia AM: Accuracy of clinical and radiological classification of the jawbone anatomy for implantation—A Survey of 374 patients. J Oral Implantol 2004;31:30-9.
10. Jaffin RA, Berman CL: The excessive loss of Branemark fixtures in type IV bone: A 5-year analysis. J Periodontol 1991; 62:2-4.
11. E. Zakhary et al: Alveolar ridge augmentation for implant fixation: status review Oral Surg Oral Med Oral Pathol Oral Radiol 2012;114(suppl 5):S179- S189.
12. Jae-Min Yoon et al: The long-term clinical stability of implants placed with ridge splitting technique 대한치과이식(임플란트)학회지 2011;30(1):1-8.a
13. Sergio Olate çlvaro Mar.n, Gonzalo Oporto; Daniel Farias & Mario Cant.n: Alveolar Ridge SplittinG for Implant Installation in Atrophic Sites Analysis of a Case Int. J. Odontostomat., 9(2):249-254, 2015.
14. Amin Rahpeyma ,Saeedeh Khajehahmadi, and Vahid Reza Hosseini: Lateral ridge split and immediate implant placement in moderately resorbed alveolar ridges: How much is the added width. Dent Res J (Isfahan). 2013 Sep-Oct; 10(5): 602–608.
15. Chiapasco,MD , Paolo Casentini, DDS, Marco Zaniboni, DDS: Bone Augmentation Procedures in Implant Dentistry Matteo. Int J oral maxillofac implants 2009;24(suppl):237–259.
16. Mario Santagat,; Luigi Guariniello, Alfredo D’Andrea; Gianpaolo Tartaro: A modified crestal ridge expansion technique for immediate placement of implants: A report of three cases Journal of Oral Implantology Vol. XXXIV/No. Six/2008.

		
<p>Photograph : Patient preparation</p>	<p>Photograph : Elevation of mucoperiosteal flap</p>	<p>Photograph: Narrow ridge split longitudinally via bone spreading chisel tapped lightly with a mallet.</p>
		
<p>Photograph 15: Separation of the cortical plates.</p>	<p>Photograph 16: Intra-medullary bone collected during drilling procedures</p>	<p>Photograph 17: Placement of dental implants with the intra-medullary bone collected</p>
		
<p>Photograph 18: Closure of the surgical site done</p>	<p>Photograph 19: Immediate post-operative OPG</p>	<p>Photograph 20: 3 months post-operative CBCT</p>
		
<p>Photograph 21: Placement of healing cap after 3 months</p>	<p>Photograph : Placement of prosthesis after 3 months</p>	