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BONE EXPANDERS FOR IMMEDIATE IMPLANT PLACEMENT: STUDY OF RIDGE EXPANSION

Dr. Manjunath Vijapur [1]

[1]MDS., Associate professor, Dept of maxillofacial surgery, KIMS Hubli

Email: dr.Manjunathbijapur@gmail.com

Dr Shruthi Rangaswamy[2]

[*] (Corresponding author)

[2*] Professor ,Department of Oral and Maxillofacial Surgery

Rajarajeshwari Dental College and Hospital, Ramohalli cross, Mysore road,

Bangalore-560 056

E-mail: drshruthir@yahoo.co.in

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Abstract

AIMS AND OBJECTIVES: Aim of this study was to assess the use and efficacy of lateral bone expansion screws. Also to evaluate the retention of labial plate thickness after implant placement with bone expansion technique by CBCT.

MATERIALS AND METHODS:

A total of 13 patients with inadequate alveolar width (2.5mm to 5mm) and with adequate bone height were included in the study. A total of 17 implants were placed immediately after ridge expansion. Gradual expansion of alveolar ridge was carried out in stepwise manner with increasing diameter of expansion screws. Minimal or no peri-implant warming had occured during expansion which was again favourable for immediate implant placement.

RESULTS:

Average pre-operative width was 3.88mm with 2.5mm being the least and maximum of 4.7mm. Mean post operative width was 5.87mm with minimum being 4.9mm and 6.5mm being maximum. Mean ridge expansion on an average of 1.90 mm was achieved by this technique which was statistically significant (p value 0.000).

Average pre operative ridge width on CBCT was 3.9mm. Average Post operative ridge width on CBCT was 5.80mm. Same measurements were again undertaken on CBCT at post 6 months, which showed mean ridge width of 5.71 mm.

The difference in ridge width was statistically analysed by repeated ANOVA which was very significant (p value 0.000). The difference in pre-operative and post 6 months ridge width was also analysed in same manner which is also significant (p value 0.000).

Clinical mobility at 3 months was found in 2 implants out of 17 placed by this technique. Overall implant success rate was 88.2% in our study following ridge expansion technique. Labial crestal resorption was measured on CBCT after 6 months. Mean resorption found was 1.41mm with minimum of 0.8 mm of resorption and maximum of 1.6mm. Average time duration for ridge expansion procedure was 9.71 minutes.

CONCLUSION:

We conclude that bone expansion screws can be used efficaciously in horizontally deficient alveolar ridge for immediate implant placement. This technique is minimally invasive, cost effective, allows controlled expansion of bone without fracture and can be used predictably with most commercially available implants.

Key words: Bone expansion, Residual ridge, Screw expansion.

INTRODUCTION:

Immediate implant placement after extraction is the state of art practice now. Lack of sufficient bone to place an implant at the functionally and aesthetically most appropriate position is a common problem. Thin alveolar ridges are challenging with narrow width and limiting the implant placement without bone graft. Following the extraction of teeth, the bony socket and adjacent soft tissue undergo a series of tissue repair processes. Histologic evidence of active bone formation at the bottom of the socket and bone resorption at the edge of the socket are seen as early as two weeks after tooth extraction, and the socket is progressively filled with newly formed bone until about six months[1].

Rapid bone remodelling subsides by this time but continuous bone resorption may persist at the external surface of the crestal area of the residual alveolar bone, resulting in considerable morphologic changes of the bone and overlying soft tissues over the years.[2] This happens after the extraction of teeth if the patient has been missing teeth for a considerable period of time.[3,4] Trauma and traumatic extractions also can lead to loss of labial bone and vertical height. There is a greater horizontal alveolar ridge reduction (29–63%) than vertical bone loss (11–22%) in first 6 months after extraction.[5](W. L. Tan)50% of crestal width is lost in a 12-month period post extraction.[6](L. Schropp) Placement of endosseous implants in atrophic ridges is often accompanied by various problems. During Implant placement there should be at least one millimetre of bony wall around implant. Various surgical widening techniques have been described, including lateral augmentation with or without guided bone regeneration (GBR), bone block grafting, onlay grafting procedure and alveolar distraction osteogenesis.[3, 4]

However, these methods have limitations, including the need to harvest bone from intraoral or extra oral sites, which may lead to increased morbidity, the risk of exposure of the bone graft or membrane followed by infection, and an unpredictable rate of bone resorption after the reconstructive or regenerative procedure(s) and placement of implants.[7] Alveolar distraction has also been reported with complications like fracture of the transport segment during osteotomy, wound dehiscence due to unpredictable bone formation and ossification defects with early removal of distractors.[8]

Bone expansion in narrow alveolar ridge can be achieved by bone expansion screws, which widens the space between the two cortical bones. Bone expansion was first introduced by Summers in 1994.[10] It is a single-step technique in which creation of implant site begins using

smallest cylindroconical expansion screw. It is followed by successively increasing diameter from one expansion screw to the next so that base of each expansion screw corresponds to active portion of next screw. Gradual expansion of alveolar ridge occurs with stepwise increased diameter of expansion screws. Minimal or no peri-implant warming occurs during expansion which is again favourable for immediate implant placement. By this technique bone expansion is achieved till the desired dimension for the planned implant.[11]

This study was undertaken to assess the use and efficacy of bone expansion screws in horizontally deficient alveolar ridge for stable implant placement.Aim of this study was to assess the use and efficacy of lateral bone expansion screws. Also to evaluate the retention of labial plate thickness after implant placement with bone expansion technique by CBCT. We have also measured the horizontal ridge width after bone expansion is achieved.

MATERIALS AND METHODS:

A total of 13 patients with inadequate alveolar width and having sufficient alveolar height were included in the study. A total of 17 implants were placed in these 13 patients, which was evaluated clinically and radiographically over a span of six months.

INCLUSION CRITERIA:

Patients with alveolar ridge width inferior to the optimally planned diameter of the implant (2.5mm to 5mm) with adequate bone height were included in the study.

EXCLUSION CRITERIA:

Atrophic ridges less than 2.5mm with no interposition of cancellous bone between buccal and palatal and lingual plates or patients with co-existing vertical defect of bone were excluded. Patients having history of radiotherapy to the head and neck region or treatment with bisphosphonates were also excluded. Active periodontal disease involving residual dentition or patients with poor oral hygiene and lack of compliance were not enrolled for study.

For clinical evaluation following criteria were considered based on the criteria suggested by The International Congress of Oral Implantologists (ICOI) Pisa Consensus Conference (2007).

1) Pain :
2) Clinical Mobility :
3) Radiographic crestal bone loss analysed using CBCT.

TECHNIQUE:

The available vertical, mesio-distal and labio-lingual bone dimension was determined by cone beam computed tomography. All surgical procedures were performed under strict aseptic conditions. The written consent was taken from the patient.

Lignocaine HCL + 2% Adrenaline 1:2,00,000 was used as the local anaesthetic following which an incision was made over crest of the ridge. Full thickness mucoperiosteal flap reflection was performed to expose the alveolar ridge. Intraoperatively, crestal ridge width was assessed with Vernier caliper before expansion. Initial drilling was done with a spade drill slight palatally to the mid crestal region. The ridge expansion began using smallest cylindroconical expansion screw (size # one). It was gradually introduced with hand wrench and expansion was achieved till desired length of planned implant. It was followed by successively increasing diameter from one expansion screw to the next so that base of each expansion screw corresponds to active portion of next screw. By this technique bone expansion was achieved gently along the desired direction of implant placement.

Endosteal implants were introduced into the prepared site and evaluated for the primary stability. Crestal ridge width was again assessed clinically after ridge expansion and immediate implant placement with Vernier caliper. The reflected mucoperiosteal flaps were

sutured using 3.0 black braided silk suture material. Time taken for the operative procedure was recorded.
The patients were followed up on the 7th post-operative day and then on, 3rd and 6th month post-operative. The patients were evaluated by taking pre-operative CBCT, post-operative CBCT and postop 6 months CBCT. Assessment for pain and clinical mobility was done 3rd and 6th month post-operatively using Visual analogue scale.

Results:
This prospective clinical study included a total of 13 patients in which a total of 17 implant were placed. Patients were selected with inadequate alveolar bone width between 2.5 to 5 millimetres and adequate alveolar bone height. The criterion used for implant placement is at least 1mmof bone around the implant when in place[3]. Mean age for the patients enrolled for this study was 34.18 years with minimum age of the patient being 21 years and maximum being 55 years. 5 male patients and 8 female patients were included in which a total of 17 implant were placed.
Implant diameter ranged from 3.75mm to 5mm mm while implant length ranged from 10 mm to 13 mm.
The post-operative healing was uneventful in all 13 patients. No patients "dropped out" or missed their follow up visits. The follow up was for a period 6 months. Pre-operative and immediate post-operative ridge width was measured clinically by caliper. Pre-operative, immediate post-operative and 6 months post-operative ridge width was measured on CBCT.
Average pre op width was 3.88mm with 2.5mm being the least and maximum of 4.7mm. Mean post op width was 5.87mm with minimum being 4.9mm and 6.5mm being maximum.

1.Pre-operative, immediate post-operative and 6 months post-operative ridge width measurement on CBCT:

	N	Mean	Std. Deviation	Minimum	Maximum	'F' value	'p' value
Pre OP	17	3.900	0.5545	2.5	4.7	86.847	<0.001
Post OP	17	5.806	0.4308	4.9	6.6		
6 months	17	5.718	0.4319	4.9	6.5		

2. Pain score during the expansion by Visual Analogue Scale (VAS) of pain:

VAS	Frequency	Percent
0	11	64.7
1	5	29.4
2	1	5.9
Total	17	100.0

3.Clinical implant mobility after 3 months:

Implant mobility	Frequency	Percent
Present	2	11.8
Absent	15	88.2
Total	17	100.0

Discusssion:

Dental implants have now become an integral part of various treatment modalities. But it becomes difficult to place the implant when there is inadequate amount of bone. Following tooth loss, the most significant feature of the healing process is that the residual bony architecture of the maxilla and mandible undergoes a life-long catabolic remodelling. Knife-edge shape of the residual ridge is very common finding in the anterior segments of both the jaws, which is particularly challenging for implantology as the width of the crest is insufficient for insertion of endosseous implants.

The alveolar bone width should be sufficient to provide minimum 1mm bone width around the implant[3, 7].When the alveolar ridge is narrower than the optimally planned implant diameter, reconstruction of the ridge before implant placement is mandatory.

Ridge split is also described for thin ridges before implant placement. Ridge splitting involves the use of an osteotome and mallet which can induce greenstick fractures of the buccal cortical bone. In the ridge splitting procedure, discomfort to patients is often substantial because of malleting, and there is a risk of buccolingual bone fracture when excessive force is delivered[9].

Ridge expansion in narrow alveolar ridge can be achieved by bone expansion screws, which widens the space between the two cortical bones. It was originally reported by Summer in 1994[10]. The ridge expansion technique is a single-step technique for bony expansion using cylindroconical expansion screws with gradually escalating diameters, and immediately placement of the implants.

It allows more gradual widening of the ridge, with less risk of fracturing the cut segments. Heat has a detrimental effect on osseointegration, and the expansion technique produces less peri-implant warming of the bone and eliminates its loss during expansion. Again immediate placement of implant can offer advantage from aesthetic, biomechanical and functional point of view[7].

Studies by Cortes et al[11], Dermarosi[7] et al, Summers[10] and many others have shown successful results following this technique for narrow ridges. They showed that the advantages of ridge expansion over other techniques are reduced treatment time, lesser overall cost, no need of barrier membranes or bone graft material, no morbidity related to second donor site and controlled expansion of bone without fracture[7].

In present study we have obtained good results in mandible also with inadequate alveolar ridge width. Time duration for ridge expansion procedure was recorded which shows that average of 9.71 minutes was taken for the procedure with minimum of 8minutes and maximum of 15 minutes. Pain during expansion procedure was recorded by visual analogue scale (VAS) of pain on a score of 1 to 10. Only mild pain was observed with a score of 1 at 5 implant site and score of 2 at only 1 site. This suggests that ridge expansion can be done painlessly.

Average pre-operative width was 3.88mm with 2.5mm being the least and maximum of 4.7mm. Post operative ridge width was measured after ridge expansion and implant placement. Mean post operative width was 5.87mm with minimum being 4.9mm and 6.5mm being maximum. A similar study done on 21 cases for ridge expansion had mean pre operative ridge width of 3.7mm with minimum of 3mm and maximum width of 4.8mm. Mean post operative ridge width was 6.2mm with minimum of 5.5mm and maximum width of 7.2mm[11].Mean ridge expansion on an average of 1.90 mm was achieved by this technique which was statistically significant (p value 0.000).

Average pre operative ridge width on most constricted portion of alveolar crest recorded on CBCT was 3.9mm with

minimum being 2.5mm and maximum being 4.7mm. Post operative ridge width on CBCT was found to be a mean of 5.80mm with minimum being 4.9mm and maximum being 6.6mm. Same measurements were again undertaken on CBCT at post 6 months, which showed mean ridge width of 5.71 mm with minimum of 4.9mm and maximum of 6.5mm.

The difference in ridge width was statistically analysed by repeated ANOVA which was very significant (p value 0.000). The difference in pre-operative and post 6 months ridge width was also analysed in same manner which is also significant (p value 0.000). The difference in immediate post operative and post 6 months is not statistically significant (p value 0.852). This means that ridge width was maintained after expansion by this method.

Mean gain in ridge width after expansion showed by CBCT measurement was 1.906 mm. This data substantiates the clinical measurements of ridge width gain by caliper. This Mean expansion achieved in present study is consistent with the data of similar studies done on non-traumatic ridge expansion and implant placement[11].

Labial crestal resorption was measured on CBCT after 6 months. Mean resorption found was 1.41mm with minimum of 0.8 mm of resorption and maximum of 1.6mm.A study had reported the mean value of labial bone resorption was 1.32 ± 0.86 mm in dental implants placed in adequate ridge width[12]. Our results are consistent with literature after following this ridge expansion technique.

Clinical mobility at 3 months was found in 2 implants out of 17 placed by this technique. Out of this 2 patient one patient had aggressive periodontitis because of which patient had under gone full mouth extraction and was considered for implant placement after wound healing took place. We think compromised host factor could be one of the reasons why implant did not take up.

Overall implant success rate was 88.2% in our study following ridge expansion technique.Various studies have been conducted for evaluating success following ridge expansion technique show promising results. Dermarosiet al[7] showed the success rate of 97% whereas Cortes et al[11] reported 100% of success rate following ridge expansion technique. However these authors had used particulate mineralized grafts in selected cases. We have not used any mineralized graft intra operatively during the procedure.

The present study shows that the simultaneous implant placement following ridge expansion technique with bone expanders is a successful method in narrow atrophic ridges and provides a significant replacement of other bone grafting techniques which are more invasive and traumatic.

It allows more gradual widening of the ridge, with less risk of fracturing the cut segments. Heat has a detrimental effect on osseointegration, and the expansion technique produces less peri-implant warming of the bone and eliminates its loss during expansion. Again immediate placement of implant can offer advantage from aesthetic, biomechanical and functional point of view.

It also has the advantages like reduced treatment time, lesser overall cost, no need of barrier membranes or bone graft material, no morbidity related to second donor site and controlled expansion of bone without fracture[7].

Limitations of this study are that ridge expansion cannot be carried out in very thin atrophied ridge (less than 2.5mm) with no interposition of cancellous bone. In absence of adequate bone height ridge expansion cannot be considered.

CONCLUSION:

We conclude that bone expansion screws can be used efficaciously in horizontally deficient alveolar ridge for immediate implant placement. Expansion achieved by

bone expansion screws is retained over a period of 6 months. Time required for ridge expansion is minimal that is around 10 minutes.

No complications were observed during ridge expansion procedure in present study. Labial crest resorption over a period of 6 months is minimal which is comparable with normal endosteal implant placement. This technique is minimally invasive, cost effective, allows controlled expansion of bone without fracture and can be used predictably with most commercially available implants.

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