|| Print ISSN: 2589-7837 || Online ISSN: 2581-3935 ||

International Journal of Medical Science and Diagnosis Research (IJMSDR)

Available Online at www.ijmsdr.com

Volume 3, Issue 3; March: 2019; Page No. 10-16

crossref DOI: https://dx.doi.org/10.32553/IJMSDR/v3i3.03

EVALUATION OF BONE DENSITY AROUND IMPLANTS PLACED USING BONE EXPANSION TECHNIQUE: A ORIGINAL RESEARCH

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Conflicts of Interest: Nil

Abstract:

Placement of implants in the alveolar bone remains a challenge for most of the clinicians because of resorption of the residual ridge resulting in insufficient bone volume in one or more dimensions. In order to overcome this problem, Bone expansion technique by using osteotomes is incorporated for the narrow and resorbed ridges. The present study evaluates the variations in the pre operative and post operative bone density using CBCT between drilling technique and bone expansion technique at both buccal and palatal cortical plates at four different levels i.e. at crest, 3 mm below the crest, 6mm below the crest and at the apex and results have shown bone expansion technique is superior to drilling technique.

Keywords Bone density. Osteotomes. Bone expansion. CBCT

Introduction

Oral rehabilitation with implant-supported prostheses has been very successful in restoration of single or multiple missing teeth. Successful implant treatment depends on precise planning. Information on the height, width, morphology, and density of alveolar bone surrounding the proposed implant site is very critical for determination of the size of the implant and angle of placement.

Bone density is a key parameter for the predictability of successful implant treatment. It is a collective term referring to the mechanical properties, architecture and degree of mineralization of the bone matrix, chemistry and structure of the bone mineral crystals as well as the remodeling properties of bone.[1]. Determination of bone density is important to evaluate the statement of jaw bone at the potential implant site.[2]

Hounsfield value has been used to assess the bone density on the implants site, and the standard value of jaw bone density varies from one individual to other. The density of available bone in an edentulous site is a determining factor in treatment planning, implant design, surgical approach, healing time, and initial progressive bone loading during prosthetic reconstruction.[3]

Bone expansion can be defined as the manipulation of the bone to form a receptor site for an implant without the removal of any bone from the patient[4].

In 1994 summers presented the first cylindrical conical expansion osteotomes with gradual diameter escalation from one instrument to the next, where by the base of each instrument corresponds to the active portion of the next. This made it possible to insert the osteotomes within the maxillary bone and compress the latter thereby affording increased bone density for the preparation of beds of the same diameter as the required implant.[5]

The objective of the present study was:

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To compare the variation in pre and post operative bone density between two groups using CBCT.

Material and Methodology

Source of Data:

The cases were selected from patients coming to the department of Prosthodontics & Implantology having missing teeth in anterior region in maxilla. The study included patients irrespective of sex, age, socio-economic status. .A written consent from the patient will be taken in the prescribed form.

Material and methodology:

To conduct the study research committee and ethical committee clearance was obtained .Patient consent was also obtained for the study. Total of 10 implants (Indigenous single piece implants) were placed. Five patients aged between 25 and 60 years with two edentulous sites in maxillary arch who are eligible for implant placement were selected.

Inclusion criteria

Need for implant placement in the anterior maxillary site

- Patient aged between 25 and 60 years
- Edentulous sites free from infection.
- Sufficient alveolar bone volume at the implant site with minimum 4 mm width labio-lingually and minimum 12mm height.
- Divisions III bone quality.

Exclusion criteria

Insufficient bone quantity of less than 4 mm width and 12mm length.

- Poor oral hygiene
- Patients with specific systemic disease that contraindicate any implant placement. e.g. uncontrolled diabetes, uncontrolled hypertension, anemia, leukemia, osteoporosis, Paget's disease.
- Severe inter maxillary discrepancy.
- Patients with habit of tobacco chewing, smoking or chronic alcohol consumption.
- Patients with Para functional habits. e.g. bruxism.
- Patients with insufficient occlusal clearance for restoration in centric as well as eccentric excursions.
- Close proximity of vital anatomic structures to the proposed implant site.
- Radiation therapy to the head and neck region in the 12 months prior to proposed therapy
- Chemotherapy in the 12-month period prior to proposed therapy
- Uncontrolled periodontal disease, or an unwillingness to undergo needed periodontal therapy involving remaining teeth
- Severe psychological problems
- An unwillingness to commit to a long-term, post therapy maintenance program.

Laboratory Investigations Blood analyses were done for each patient to assess the health status

Diagnostic phase All the relevant medical and dental history has been taken.

Diagnostic Cast and wax-up two sets of diagnostic impression were made using irreversible hydrocolloid with perforated stock tray. A diagnostic wax –up was done. Proposed site of implant placement was marked on the diagnostic wax-up in the relation to the central fossa of the waxed up tooth.

Radiographic stent A radiographic stent was fabricated on the diagnostic wax-up using auto polymerzing acrylic resin to locate the site of implant placement intraorally for pre-operative. radiographic evaluation using CBCT.

Pre operative Radiographic Evaluation

Pre operative radiographic evaluation was done by using Cone beam computerized tomography machine,

STUDY DESIGN

A total of 10 implants were placed in 5 patients. Pre operative density and bone width were evaluated by using CBCT. Two implants were placed in each patient with two different techniques drilling and bone expansion technique. Postoperative density was measured by CBCT after 24 hours of implant placement.

Implant surgery Routine pre –surgical protocol was followed for every patient.

Sterilization protocol was strictly followed during the entire process of surgery.

OSTEOTOME TECHNIQUE

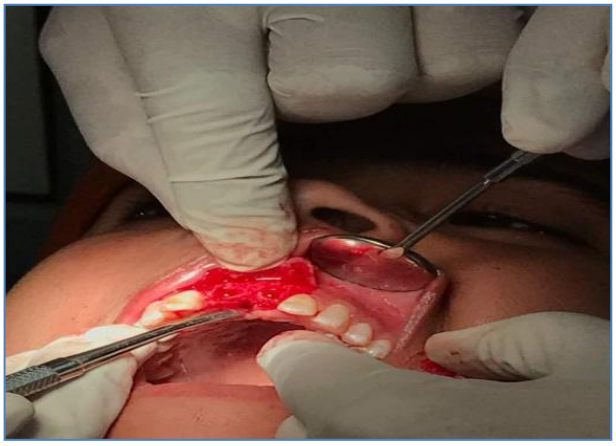
A. STAGE 1 SURGERY: SURGICAL IMPLANT PLACEMENT

- The peri-oral facial area was painted with 5% betadine followed by sterile draping of the patient.
- Oral cavity was rinsed with 0.2% Chlorhexidine gluconate for 30 second before surgery. This significantly reduced the oral microbial count and maintained a reduced level for an hour or more.
- Surgical area was anaesthetized using appropriate nerve blocks with 2% lignocaine hydrochloride with 1:100,000 adrenaline.
- Crestal incision was given on edentulous space.
- Trapezoidal flap was reflected with wider base. (On proximal end relieving incision was given at the angle of 450).
- The mucoperiosteal flap was reflected using a periosteal elevator, avoiding harm to the papillae and any other traumatic manipulation.
- After flap reflection the optimal implant location was decided pre-surgically by pre-treatment imaging modalities and was reaffirmed with the pre-surgical prosthetic guide template & the site was then marked with a surgical round bur.
- A low speed, high torque hand piece and copious irrigation were applied to prevent excessive thermal injury to bone. External and internal irrigation with sterile saline directed through the drills were used.
- After marking the site, the pilot drill (D-2.0 mm) was put to use for creating a osteotomy site of the appropriate depth for implant placement. It is indexed with various markings corresponding to the desired implant lengths.
- When appropriate depth was reached with the pilot drill, the implant depth probe was used for tactile perception of intact bony plates&/or any perforations & the confirmation of desired osteotomy depth. Once desired depth was confirmed, paralleling pin was placed to check the proper alignment of the implant with adjacent teeth & opposing occlusion. After confirmation of depth & angulation, a 2-mm osteotome was placed against the opening of the osteotomy, and a surgical mallet was used to give two firm taps to the end of the osteotome handle. The osteotome was then left in position for at least 2 minutes to enable the bone to yield and adjust to the slightly expanded ridge contours. The osteotome was then turned in a reverse direction and pulled out of the bone. Care was taken not to force the osteotome in a buccal or lingual direction; otherwise a complete fracture of the plates may occur. This procedure was repeated until the osteotome was driving to the desired depth. Each time the osteotome was tapped with the mallet; both the buccal and lingual aspects of the ridge were supported by thumb and index finger of the operator to brace the bone and help prevent fracturing. The Implant site was generously irrigated with sterile saline to remove any residual bone chips/other residue following preparation.
- The same procedure was repeated using a 2.5-mm diameter osteotome. If further expansion could not be performed, a 3.3-mm diameter implant was placed. If any microfracturing or cracks in labial cortical plate had occurred while expansion during osteotomes, care was taken to avoid displacing the fractured pieces and to ensure that they remain on the periosteum. If the further expansion could be accomplished, a 3.3-mm diameter osteotome was slowly driven into place, utilizing the above describe technique and a 3.75-mm implant placed.
- The implant was removed from the sterile vial using the implant mount and placed directly into the osteotomy site. Contamination by touching the implant with instruments made of a dissimilar metal or by contact with soft tissue, cloth or even surgical gloves was avoided.
- The implant was then screwed into the prepared site with manual pressure and aided with the implant mount.
- Following which, the implant mount was removed and hex driver was placed into the

implant internal hex & ratcheted with torque-controlled implant ratchet.

- Primary implant stability was assessed with the torque controlled ratchet. For delayed loading minimum torque is 35nm.
- The cover screw, provided with the implant package was then placed using hex-driver using finger pressure. At this point, implant was confirmed to be immobile, which re-affirmed primary implant stability.
- Alloplastic grafting material mixed with blood was placed over the implant site to facilitate bone healing.
- The flap margins were then repositioned & sutured tension free using non-resorbable 3-0 mersilk in interrupted fashion.

A post-operative IOPA radiograph with grid, without grid & OPG was taken to evaluate the implant angulation &position in relation to adjacent structures such as nasal floor and adjacent teeth.



A

B

C

D

E

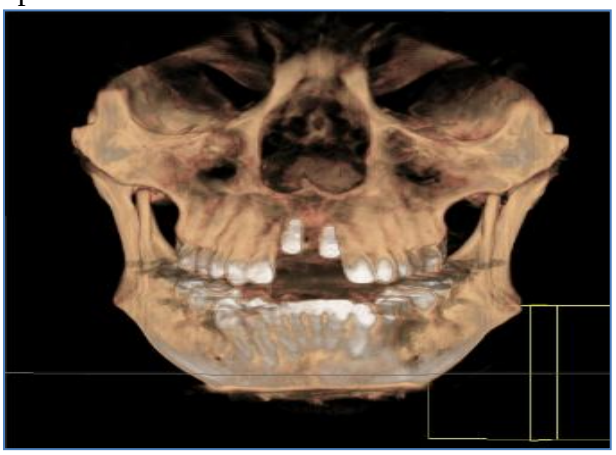
F

G

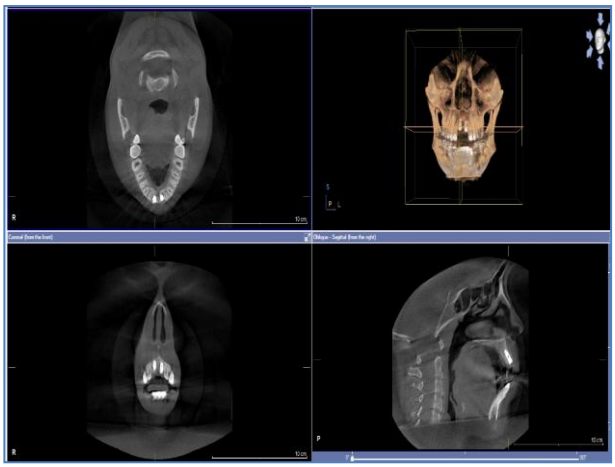
Figure 1(A,B,C,D,E,F,G): Clinical Pictures

Post –operative Radiological Evaluation of Bone Density in Hounsfield Units

After placement of implant in the designated implant locations post-operative CT scan was obtained at baseline under the similar pre-operative conditions.



A



B

Figure 2 (A,B):

Results The arithmetic mean & standard deviations were calculated for the requisite assessment intervals & for intra & inter group comparisons. All the values of different dental parameters at different time points are expressed in terms of MEAN ± S.D. respectively. The difference from baseline to 3 months, 3 months to 6 months was measured and its significance was assessed by paired' test.

- Comparative analysis of the raw data was performed with spss 16.0 statistical software. .
- P < 0.05 was considered to be statistically significant...

It was observed that bone density in all patients ranged from 566 h u to 920 hu in mean bone density value of all patients at base level was 774.6±102.88 R.HU⁰

Table 1: shows the comparison of bone density between two group of implant placement techniques, drilling and bone expansion in

		Pre Op Bone Width	Post Op Bone Width	Change in Bone Width	Percentage Change	P value
At Crest	Drilling Group	620.21±70.22	451.40±51.70	-168.81±65.00	-26.83±3.99	0.001 (Significant)
	Bone Expansion	611.46±185.61	688.88±136.96	77.42±59.01	15.82±5.81	
3mm Below Crest	Drilling Group	640.08±76.38	467.27±72.47	-172.81±45.93	-27.09±6.78	0.001 (Significant)
	Bone Expansion	501.28±216.81	528.69±209.33	27.41±26.63	10.30±14.80	
6mm below the crest	Drilling Group	682.24±58.74	485.57±123.08	-196.67±83.00	-29.39±13.36	0.001 (Significant)
	Bone Expansion	624.51±118.12	681.55±136.71	57.03±40.45	9.19±6.92	
Apex	Drilling Group	760.35±71.50	521.01±138.60	-239.43±84.20	-32.21±13.64	0.001 (Significant)
	Bone Expansion	724.67±119.11	773.85±123.78	49.18±39.80	6.91±5.85	

The drilling group there (s-29.09) % reduction in bone density between pre-operatively and post-operatively time intervals as compared to Group II. Where there was increase in bone density by 15.82% and difference was statistically significant at p=0.00%

DISCUSSION

A precise evaluation of bone structure is essential before implant placement. Bone density was evaluated by CT technique to monitor bone density with increasing popularity during the past few years. Significant correlations between bone density on CT and implant stability were reported in previous studies. However, because of the disadvantages of this technique, such as high radiation exposure, the current literature has focused on the concept of using cone beam computed tomography (CBCT) for quantitative assessment of bone density. Recent previous studies showed significant correlation between bone density value from CBCT and implant stability parameters. -The present study evaluates the variations in the pre operative and post operative bone density values in HOUNSFIELD UNITS using CBCT between drilling technique and bone expansion technique at both buccal and palatal cortical plates at four different levels i.e. at crest ,3 mm below the crest ,6mm below the crest and at the apex. Comparison of bone density for both expansion and drilling technique by using CBCT has shown significant results in post operative bone density value. Post operatively drilling group had shown significant decrease in bone density in buccal as well palatal cortical plate around implant where as expansion group shows a significant increase in bone density on both buccal and palatal cortical plates.

GV K MOHAN REDDY, C.H VAMSI KRISHNA et al states that during the process of drilling, more amount of bone is removed due to incremental increase in drill size and hence creates more amount of separation between the trabecular spaces in Type III bone. But in bone expansion technique, only initial pilot drill is used to locate the implant location and subsequently osteotomes or bone expanders are used sequentially. This technique helps in condensing the bone and compressing the trabecular spaces there by, preserving the bone and consequently increasing the quality or density of bone. These results correlated with the studies conducted by Fanuscu et al. in cadaver bone where expansion technique resulted in notable changes in peri-implant bone architecture. Hence the increase in bone density will aid in better primary stability of the implant as the implant adheres to bone closely.

The significant decrease in bone density can be attributed to amount of heat generation and more amount of bone removal using drills, compared to expansion technique. The techniques for alveolar expansion and of the upper maxilla with compressive osseotomes lead to a 100% success rate after a 9-month follow-up of the implants and insertion of prostheses. Brunokonig JR shown that expansion technique offer some advantages over other techniques, such a being less invasive, requiring a shorter rehabilation time. According to them that the space created undergoes spontaneous ossification and the newly formed bone enables the consoliation of palate and the vestibule wall. This procedure enables bone formation in an optimally expanded space. In a histological study evaluating the new bone formed expanded areas, have high osteogenic activity was reveled.

The same success (100%) was achieved by Nedir et al, Deporter et al .100% success was also achieved by Demarosi et al in a case series with 22 patients(34 implants) during a period of observation after loading of the implants .

Summary and conclusion:

Bone expansion technique for implant placement has been shown to be predictable and successful in treating the maxilla with deficient alveolar bone width. This technique is superior to drilling technique for application in soft maxillary bone. In this study we concluded that:

- There was significant increase in bone density post operatively at four different levels in bone expansion group.

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