Original Research

Evaluation of Relationship between Bone Density Values and Implant Stability Parameters- In Vivo Study

Sowmya Reddy.G[1], Krishana Kishore.K[2], Hara Gopal,S[3], Asritha.S[4], Naga phanindra.M[5], Kavya sai sree.U[6]

[1,4,5,6]Postgraduate student Department of Prosthodontics, Sibar Institute of Dental Sciences
[2]Professor & HOD, Department of Prosthodontics, Sibar Institute of Dental Sciences
[3]Reader Department of Prosthodontics, crown & bridge including Implantology, Sibar Institute of Dental Sciences, Guntur

ABSTRACT:
The aim of the study was to explore the efficacy of bone density value derived from CBCT by evaluating its correlation with implant stability parameters including insertion torque value [ITV] and resonance frequency analysis [RFA]. A total of 20 patients in the age group of 20- 65 years attending department of prosthodontics, Sibar Institute of Dental Sciences were selected for the study during the period of 2017-2019 with either fully or partially edentulous region. Alpha bio Implant system was used in the present study. Patients were divided into two groups; Group-A and Group-B. In Group- A patients, 10 implants were placed in D1 bone density and in Group B, patients 10 implants were placed in D2 bone density. Osteotomy site was prepared, the implant with dimension 3.75×10mm placed in the osteotomy site. Implant was tightened by torque wrench during placement. Insertion torque values [ITV] were obtained. After placing resonance frequency was checked by osstell mentor. ISQ values were recorded. Implant stability increased as bone density increased. The present study was done to establish the relation between pre-surgical assessment of bone density values derived from CBCT and implant stability parameters and thus estimated the implant survival rate and loading protocol. Within the limitations of the study, bone density showed correlation with implant stability which means as the bone density increases implant stability increases. This suggests that bone quality is one of the factors that require evaluation preoperatively. In the present study the mean ITV and ISQ values were significantly higher in D1 group when compared to D2 group.
Key words: Bone density, primary implant stability, CBCT, Insertion torque, Resonance frequency analysis

Corresponding Author: Dr. Sowmya Reddy. G, Postgraduate student, Department of Prosthodontics, Sibar Institute of Dental Sciences, Guntur, Andhra Pradesh, India

INTRODUCTION:
The success of dental implant treatment is influenced by both the quality and quantity of available bone for implant placement and implant stability. Evolution of CBCT added remarkable changes/advances to the implant dentistry by its way of 3D evaluation which provides accurate measurements and reliable information about bone density, the shape of alveolus, height & width of proposed implant site. Assessing primary stability immediately after implant insertion is also an important prognostic marker for the success of dental implants. The contact between the implant and the bone is the principle determinant for primary stability which would be estimated by Insertion torque value [ITV] using torque wrench and Resonance frequency analysis [ISQ] using osstell mentor. Hence

34

this study is being performed to evaluate the presurgical site using CBCT for determination of bone density values and correlating it with implant stability parameters. This assessment would predict the prosthesis loading protocol.

Aims and Objectives:
The aim of the study is to explore the efficacy of bone density value derived from CBCT by evaluating its correlation with implant stability parameters including insertion torque value [ITV] and resonance frequency analysis [RFA].

- To assess the bone density values in the implant recipient site preoperatively.
- To assess insertion torque values [ITV] during implant placement.
- To assess resonance frequency analysis [RFA] immediately after implant placement.
- To compare the bone density values with ITV.
- To compare the bone density values with implant stability quotient [ISQ]
- To predict the possibility of immediate or early loading.

MATERIALS &METHODS:
A total of 20 patients in the age group of 20- 65 years attending department of prosthodontics, sibar institute of dental sciences will be selected for the study during the period of 2017-2019 with either fully or partially edentulous region.

INCLUSION CRITERIA
- D1 & D2 bone density
- Sufficient stable soft tissue architecture at edentulous sites
- Free from infection
- Patients willing to follow recommended plaque control
  Measures

EXCLUSION CRITERIA
- Uncontrolled diabetes
- Uncontrolled hypertension
- Bisphosphonates[6]
- Osteoporosis

RESULTS:

Table 1: Descriptive statistics

- History of radiation therapy in the past 1yr & radiation dosage above 50Gy[6].
- History of chemotherapy
- Alcohol and smoking
- Tooth extraction in implant recipient site <3 months ago
- Bone augmentation procedures before or during implantSurgery.
- Pregnant and Lactating women
- Under 16 yrs of age
- D3 & D4 bone density

Procedure
- A standardized presurgical CBCT image will be obtained and bone density will be assessed. *Misch bone density classification [Carl. E. Misch, "Contemporary Implant Dentistry", ed 2, St. Louis, 1999, Mosby Inc]*
- A surgical guide or stent is prepared
- After adequate local anesthesia with 2% lignocaine, a midcrestal incision will be given with a No.15 B.P blade. A mucoperiosteal flap elevated and bone will be exposed. A pilot drill of 2mm and sequential drilling will be done with a speed range of 800-1200 rpm.
- Once the osteotomy site is prepared, the implant with dimension 3.75×10mm will be placed in the osteotomy site. Implant will be tightened by torque wrench during placement. Insertion torque values [ITV] will be obtained [*Goswami MM, et al., Evaluation of dental implant insertion torque using a manual ratchet, Medical Journal Armed Forces India (2013)*].
- After placing resonance frequency will be checked by osstell mentor. ISQ values will be recorded [*www.osstell.com/scientific-forum*].The flaps will be approximated with sutures by No.3.o silk. And the recorded values will be correlated for a predictable outcome.

Statistical analysis:
Mann Whitney U test was used to assess correlation between Bone density, ITV and ISQ values

Variable	Bone Density	Sample (n)	Mean	Standard deviation	Range (Min-Max)	Standard Error
ITV	D1	10	49.5	1.58	5 (45-50)	0.50
	D2	10	40	10.54	25 (25-50)	3.33
RFA	D1	10	68.4	4.06	15 (62-77)	1.28
	D2	10	58.6	7.19	26 (40-66)	2.27

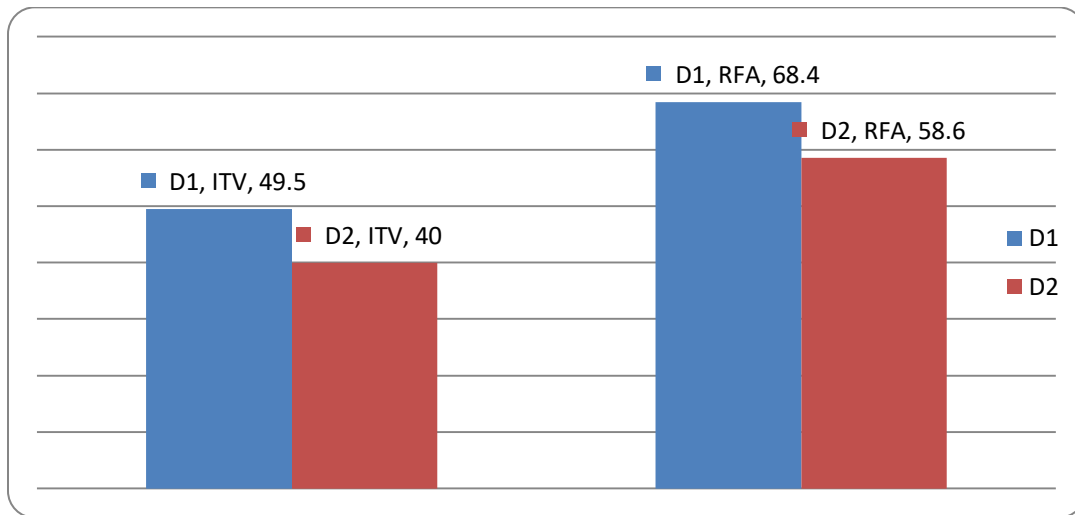Figure 1: Bar graph showing comparison of Mean ITR and RFA values between different bone densities

Table 2: Comparison of Mean ITR and RFA values between different bone densities

Variable	Bone Density	Mean (SD)	Mean rank	P value
ITV	D1	49.5 (1.58)	13.25	0.015*
	D2	40 (10.54)	7.75	
RFA	D1	68.4 (4.06)	15.05	0.001*
	D2	58.6 (7.19)	5.95	

Mann Whitney U test; P≤0.05 considered statistically significant; * denotes statistical significance

It was observed from this study that the mean ITV and mean RFA values were significantly higher in the D1 group compared to D2 group.

DISCUSSION

In the present study, CS3d software has been used to determine bone density preoperatively. Cone-beam computed tomography (CBCT) has achieved its importance in the last few years and has been widely engaged in dentomaxillofacial imaging. CBCT offers various advantages compared to traditional 2D radiography not just in terms of avoiding superimposition but also with its application in multiplanar reformation and face scan marking horizons in real-time imaging. This technique provides relatively high isotropic spatial resolution of osseous structures with a reduced radiation dose compared with conventional CT scans.

The present study was done to establish the relation between pre-surgical assessment of bone density values derived from CBCT and implant stability parameters and thus estimated the implant survival rate and loading protocol.

Implant stability plays a primary role in successful osseointegration, which is a prerequisite for the smooth functioning of dental implants. Implant stability was evaluated at two different stages: Primary and secondary. Primary stability was obtained from the mechanical engagement of the implant with the cortical bone. Secondary stability developed from regeneration and remodeling of the bone around the implant and was also affected by the primary stability. Measuring implant stability offers better guidance during implant loading.

Ajay Mahajan et al conducted a study to critically evaluate the available scientific data on the influence of insertion torque on implant success. This study includes data on insertion torque, such as primary stability, bone quality and quantity, implant design, and changes in bone-related to high or low torque. At the end of the study, it was found that most of the studies used an insertion torque ranging from 20-45 Ncm. A specific insertion torque value is still challenging to determine as the current evidence suggests the role of various other factors affecting insertion torque during implant placement.

In the present study, the mean primary stability insertion torque values in D1 bone density were 49.5, and D2 bone density was 40. This shows that the mean ITV was significantly higher in the D1 group compared

36

to the D2 group.

Lars senner by et al stated that the resonance frequency analysis technique evaluates implant stability as a function of the stiffness of the implant-bone interface and is influenced by factors such as bone density, jaw healing time, and exposed implant height above the alveolar crest. Studies designate that implants with high implant stability quotient values during follow-up examinations are successfully integrated, while low and decreasing implant stability quotient values may be a sign of ongoing implant failure and marginal bone loss.

In the present study, the mean primary stability values measured using RFA in D1 bone density were 68.4, and D2 bone density was 58.6. It was observed that the mean RFV was higher in the D1 group compared to the D2 group.

Fuster et al conducted a study to determine bone density value in implant sites using cone-beam computed tomography (CBCT) and to determine possible correlations between age, gender, insertion torque measurements, and resonance frequency analysis (RFA) values. They concluded that bone density measurements using presurgical CBCT might be helpful as an objective diagnostic tool. These values, in conjunction with RFA values and insertion torque measurements, can provide the dentist with an accurate assessment of bone quality and may be especially useful where poor-quality bone is suspected.

Limitations

1. The main limitation of the present study was a smaller sample size.

2. The present study utilized a unified surgical procedure with a single type of implant design. Further studies are required to determine the effects of surgical techniques and implant design, especially the condensing-osteotome method, on primary implant stability.

3. The correlations between follow-up measurements of ISQ and density value from CBCT also need to be addressed.

Potential Risks and Benefits:

The potential risks are comparatively negligible in this study. In this study patient will be exposed to radiation only once as well FOV (Field of view) required is smaller for single implant placement thus radiation exposure is very minimal. Accurate pre-surgical assessment of bone density values, using CBCT and relating with implant stability parameters will provide a better chance for successful implant outcome.

CONCLUSION:

Within the limitations of the study, bone density showed a correlation with implant stability. As the bone density increases, implant stability increases. This suggests that bone quality is one of the factors that require evaluation preoperatively.

In the present study, the mean ITV and ISQ values were significantly higher in the D1 group when compared to the D2 group.

However, based on available literature and present study evaluation, pre-surgical assessment of bone density values derived from CBCT and implant stability parameters can be considered to estimate the implant survival rate.

REFERENCES:

1) Ikusmi N. &Tsutsumi, S. (2005) Assessment of correlation between computerized tomography values of the bone and cutting torque values at implant placement: a clinical study. The International Journal of Oral & Maxillofacial Implants 20: 253–260.

2) Young-Dai Song,DDS, PhD1/Sang-Ho Jun,DDS, MSD2/Jong-Jin Kwon, DDS, PhD3.Correlation Between Bone Quality Evaluated by Cone-Beam Computerized Tomography and Implant Primary Stability; Int J Oral Maxillofac Implants 2009;24:59–64

3) Roze, J., Babu, S., Saffarzadeh, A., Gayet-Delacroix, M., Hoornaert, A. &Layrolle, P. (2009) Correlating implant stability to bone structure. Clinical Oral Implants Research 20: 1140–1145

4) Isoda K , Ayukawa Y , Tsukiyama Y , Sogo M , Matsushita Y , Koyano K . Relationship between the bone density estimated by cone-beam computed tomography and the primary stability of dental implants; Clinical Oral Implants Research 2011, 23(7):832-836

5) FarizSalimov,UfukTatli,MehmetKurkc,MuucahideAkoglan,HalukOztunc,¸Cemkurtogl.Evaluation of relationship between Preoperative bone density values derived from cone beam computed tomography and implant stability parameters: a clinical study; Clin. Oral Impl. Res. 25, 2014, 1016–1021

6) Gómez-de Diego R[1], Mang-de la Rosa Mdel R, Romero-Pérez MJ, Cutando-Soriano A, López-Valverde-Centeno A. Indications and contraindications of dental implants in medically compromised patients: update. Med Oral Patol Oral Cir Bucal. 2014 Sep 1;19(5):e483-9.

7) Herekar M, Sethi M, Ahmad T, Fernandes AS, Patil V, Kulkarni H.A correlation between bone (B), insertion torque (IT), and implant stability (S): BITS score. J Prosthet Dent. 2014 Oct;112(4):805-10.

8) Masahiro Wada* , Yasutane Tsuiki, Tohru Suganami, Kazunori Ikebe, Motofumi Sogo, IkuhisaOkuno and Yoshinobu Maeda Wada et al. International Journal of Implant Dentistry (2015) 1:3.

9) Turkyilmaz, I., Tumer, C., Ozbek, E.N. &Tozum, T.F. (2007) Relations between the bone density values from computerized tomography, and implant stability parameters: a clinical study of 230 regular platform implants. Journal of Clinical Periodontology 34: 716–722.

37