Cone beam computed tomography (cbct) to assess bone density

INTRODUCTION

Implantology has witnessed an explosive growth during the last few years, from a technique practiced on the fringe of acceptability to one embraced by the mainstream dentistry and dental implants have emerged as a widely accepted form of teeth replacement. Implants are bio-acceptable materials with an inherent capacity to osseointegrate into the jaw bone to support a dental prosthesis to restore adequate function and esthetics without affecting adjacent hard and soft tissue structures. The Success of any implant procedure depends on a series of patient related and procedure dependent parameters, which include general health conditions, biocompatibility of the implant material, feature of the implant surface, surgical procedure and the quality and quantity of the local bone [1] . Careful recording and analysis of clinical and radiological information, interdisciplinary communication and detailed planning play an important role in determining the final successful outcome.

Bone density is a key factor to take into account when predicting implant stability [2] Clinical studies show greater implant survival in the mandible than in the upper maxilla, due to the bone characteristics. This survival is influenced by bone quality i. e. bone density [2] . The bone density is an important determining factor in implant treatment and can be assessed fairly using different imaging techniques [3] . The quality of bone in the proposed implant site in terms of relative proportion and density of cortical and medullary bone has frequently been assessed by using a grading scheme proposed by Lekholm and Zarb, which is applicable only to cross sectional

images. This classification system has been utilized worldwide because it is easy to use without considerable investment. Misch (2008) used computed tomography (CT) to objectively classify bone density into 5 types based on Hounsfield units (HU). This method allows for a precise and objective assessment of bone quality [2]

Several imaging techniques are currently available for presurgical and postsurgical examination, including devices developed specifically for dental implant imaging. Computerized tomograms are one of the best available radiographs for determining the bone quality. With the advancement of radiographic technology, computed tomography (CT), as well as cone- beam computed tomography (CBCT) are increasingly being considered essential for optimal implant placement , especially in the case of complex reconstructions [4] Unlike conventional two-dimensional radiographs, techniques like CBCT offer 3-D views of the mouth, face, and jaw from any direction. The cone beam configuration is ideal for the maxillofacial region because the dimensions of the beam allow for a panoramic view, sparing patients the radiation exposure of separate scans of the maxilla and mandible [5] . The overall advantages of CBCT are in its high resolution, potentially lower radiation dose and reduced cost compared with standard Computerized Tomography [2]

The past two decades have seen continual efforts by manufacturers, researchers and clinicians to improve the success of implant treatment outcomes through evolution in implant designs, materials and clinical procedures [6] . One such aspect is co-relation of available bone density with

primary implant stability. Primary implant stability denotes the stability of a dental implant immediately after placement. Implant stability can be evaluated objectively, noninvasively, and easily by the insertion torque test. [7] The insertion torque measurement technique, which records the torque after the implant has been placed, provides information on the local bone quality [8] . A High initial stability may be an indication for immediate loading with prosthetic reconstruction. A low primary stability following implantation, can cause the implant's mobility leading to failure. Bone density and implant stability are important factors for implant osseointegration, and has been widely demonstrated by several authors [3] . The insertion torque measurement technique, which records the torque during implant placement, provides information on the local bone quality. [1] A number of studies have shown the relationship between bone density based on CT and primary implant stability [9, 10] . However, there are few studies about the relationship between bone density estimated by CBCT and primary implant stability. The possibility of predicting the primary implant stability and bone quality during the pre-surgical assessment of the implant placement site may produce an implant treatment protocol with higher predictability. The bone density and Implant stability can be evaluated using CBCT and the insertion torque test which records the torque during implant placement and provides information of the local bone quality [6, 8] . Keeping in mind the aforesaid goals the present study was designed to compare and evaluate the relationship between the bone density estimated by CBCT and the primary implant stability of the dental implants by measurements of the insertion torque and to determine their correlation.

MATERIALS AND METHODS

Twenty out- patients with missing single/ multiple teeth who visited the Department of Oral & Maxillofacial Surgery, Dayananda Sagar College of Dental Sciences, Bangalore and who were suitable for implant rehabilitation were considered and taken up for the study. Patients with uncontrolled systemic/ psychiatric illness, previous history of undergoing radiotherapy or chemotherapy, pregnant patients, cases of post implant removal and implants placed in sinus lift and immediate extraction sites were excluded from the study.

pre-operative assessment: Patients selected based upon the above criteria underwent a thorough clinical examination, and the details were recorded using custom-made case proforma. A written informed consent was obtained from all patients and a standardized pre-surgical and surgical protocol was followed for all the patients. Pre-operative bone density of implant sites were evaluated using cone beam computerized tomographic scans. Bone density measurements were derived using 3DiagnoSys version 4. 1 Software (3DIEMME Bio imaging Technologies). 3Diagnosys® is a diagnostic imaging, analyses and 3D simulation software, tailored for the Clinician. 3Diagnosys® software helps to interact with the 3D-model of the Patient, which is obtained by importing TC/CBCT/RM images in DICOM format, in a simple and intuitive way. The tools included in this software are not bound to morphological reconstructions but are also able to extract from the DICOM data the densitometric values for a bone functional evaluation.)Pre-operative evaluation of bone height and bone width was done using Cone Beam Computed Tomographic scan and appropriate implants were selected to be

placed. The bone height and width measurements were achieved using the “ Carestream Dental Imaging Software v6. 13. 3. 3 CS imaging software”(Fov-15x9cm)” . All CBCT scans were obtained using the “ KODAK 9500machine” (10ma 90 Kvp, 200 micron resolution, 10. 9sec exposure, 605mgy per cm2).

STATISTICAL ANALYSIS

The statistical analyses were performed using SPSS version 16. 0 software (SPSS Inc., Tokyo, Japan). Spearman’s correlation coefficient (rs) was calculated to evaluate the correlation among density values and insertion torques. A value of P <0. 05 was considered to be statistically significant.

RESULTS

The density value ranged from 209. 91 to 667. 13Hu. The mean density value and insertion torque of all implants were 464. 69 + 135. 74 Hu and 49. 0 + 8. 20 respectively. There was highly significant correlation between bone density and insertion torque (rs 0. 89, P < 0. 001)

DISCUSSION

Over the last decade, there has been significant changes in reconstruction with dental implants. Rather than merely focusing on the tooth or teeth to be replaced, today’s implant practitioner considers a broad and complex set of interwoven factors before formulating an implant treatment plan [4.] Proper treatment planning comprises of pre – operative depiction and quantification of accurate

bone height and contour which can be established by radiographic examination. [11] The success of dental implants relies heavily on both the quality and the quantity of available bone for implant placement [3] . Studies have shown higher failure rates for implants placed in bone of poor quality and quantity. [3]

Bone density is a key factor to take into account when predicting implant stability [2] Clinical studies show greater implant survival in the mandible than in the upper maxilla, due to the bone characteristics. This survival is influenced by bone quality i. e. bone density [2]

The bone density is an important determining factor in implant treatment and can be assessed fairly using different imaging techniques [5] . The quality of bone in the proposed implant site in terms of relative proportion and density of cortical and medullary bone has frequently been assessed by using a grading scheme proposed by Lekholm and Zarb, which is applicable only to cross sectional images. This classification system has been utilized worldwide because it is easy to use without considerable investment. Misch (2008) used computed tomography (CT) to objectively classify bone density into 5 types based on Hounsfield units (HU). This method allows for a precise and objective assessment of bone quality [3]

Several imaging techniques are currently available for presurgical and postsurgical examination, including devices developed specifically for dental implant imaging. [12] They are used to visualize the internal anatomy of the jaws in 3-dimensional perspectives, including the proximity of nasal fossae,

neurovascular bundles, pneumatization of the maxillae, soft tissue morphology and bone quality. Computerized tomograms are one of the best available radiographs for determining the bone quality. Periapical and panoramic radiographs are the least viable options as the subtle changes between the different bone types can’t be quantified using them, also the lateral cortical plates tend to obscure the trabecular density . With the advancement of radiographic technology, computed tomography (CT), as well as cone- beam computed tomography (CBCT) are increasingly being considered essential for optimal implant placement , especially in the case of complex reconstructions [13] . Unlike conventional two-dimensional radiographs, techniques like CBCT offer 3-D views of the mouth, face, and jaw from any direction. [1] The cone beam configuration is ideal for the maxillofacial region because the dimensions of the beam allow for a panoramic view, sparing patients the radiation exposure of separate scans of the maxilla and mandible [14] . The overall advantages of CBCT are in its high resolution, potentially lower radiation dose and reduced cost compared with standard Computerized Tomography [15]

The past two decades have seen continual efforts by manufacturers, researchers and clinicians to improve the success of implant treatment outcomes through evolution in implant designs, materials and clinical procedures [2] . One such aspect is co-relation of available bone density with primary implant stability. Primary implant stability refers to the stability of a dental implant immediately after implantation. Implant stability can be evaluated objectively, noninvasively, and easily by the insertion torque test.

[16] The insertion torque measurement technique, which records the torque after the implant has been placed, provides information on the local bone quality. High initial stabilization may be an indication for immediate loading with prosthetic reconstruction. If primary stability is not high enough following implantation, the implant's mobility is high and can cause failure.

A number of devices and techniques have been developed to assess implant stability, including cutting torque resistance analysis, the reverse torque test, the insertion torque test, the mobility measurement test, and resonance frequency (RF) analysis [2] . Implant stability can be evaluated objectively, noninvasively, and easily by the insertion torque test and RF analysis. [17] The insertion torque measurement technique, which records the torque during implant placement, provides information on the local bone quality [1] . A number of studies have shown the relationship between bone density based on CT and primary implant stability . [9, 10] However, there are few studies about the relationship between bone density estimated by CBCT and primary implant stability. In a study conducted by Isoda k et al; The bone quality evaluated by specific CBCT showed a high correlation with the primary stability of the implants. [8] CBCT is one of the significant imaging modalities that can be used to assess the relationship between primary implant stability and bone density which can further give an insight into the prognosis of the implant treatment.

Implant stability can be evaluated objectively, non-invasively and easily by using the insertion torque test which records the torque during implant placement and provides information of the local bone quality [1] . Keeping in

mind the aforesaid goals the present study was designed to compare and evaluate the relationship between the bone density estimated by CBCT and the primary implant stability of the dental implants by measurements of the insertion torque. It also aims to determine the correlation between bone density and primary stability of implant by insertion torque value.

In all cases Implants were placed under local anesthesia. Different implant systems were used and all were root form implants. Surgical preparation and isolation of surgical field was accomplished according to standard operative protocols. A Crestal incision was placed and Mucoperiosteal flap was reflected and alveolar bone was exposed, and the implant placement site was identified by the marking made with the aid of the surgical probe. Osteotomy site preparation was done with a Reduction gear hand piece (1: 16/64) with an external Irrigation attached to the handpiece. Implant osteotomy was performed using standard sequential drill bits as per the dimensions of the implant. The osteotomy was proceeded till the desired depth as per the selected implants. The Implant was driven into the osteotomy site using the manual torque wrench till the final depth was reached. All Implants placed were of tapered design and their lengths ranging from 8 to 16 mm and diameters from 3-5 mm. After placing the implant, the implant stability was measured manually using the insertion torque test by a torque wrench with calibrations . The insertion torque reading was measured and recorded at the maximum torque resistance achieved. The cover screw over the implant was then placed and Flap closure was done. Post-operative OPG and IOPA was taken. Routine Antibiotics and anti-inflammatory drugs were prescribed along with oral

hygiene maintenance instructions. Patients were recalled for regular follow ups. Permanent prosthesis was given after 3 months .

SUMMARY & CONCLUSION

The study assessed the bone quality with density values obtained by cone beam computed tomography (CBCT) pre-operatively and determined their correlation with the insertion torque values recorded during the Implant placement procedure. From the observations and results obtained , We can conclude that, the present study demonstrates the relationship between the bone density values derived from Cone Beam computerized tomography (Hu), located in the maxilla and mandible , and bone quality according to the Lekholm & Zarb classification. The primary implant stability measured with the insertion torque test (ITV) depends on bone density values, bone quality and implant location. Implants Placed in location with higher bone density have more stability, and we can probably predict the implant insertion torque based on the bone density values (Hu) and the implant location. Finally, with higher bone density values (Hu) and higher primary implant stability measured in ITV values; Hounsfield units can be used as a diagnostic parameter to predict possible implant stability.

The results of our study indicate that CBCT can be used to assess the bone quality. Also attaining a good insertion torque and thereby enhancing the implant stability aids successful osseointegration and prosthetic rehabilitation. Hence CBCT can be used as a predictor diagnostic tool for implant success. We suggest that a larger number of patients with a larger

follow up might help a conclusive determining factor that pre-operative CBCT is a predictor for primary implant stability.