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DENTAL IMPLANT;

OBJECTIVE EVALUATION OF BONE WIDTH AND HEIGHT AT PROSPECTIVE DENTAL IMPLANT SITES USING CONE-BEAM COMPUTED TOMOGRAPHY.

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ABSTRACT… Objectives: To measure the average bone width and bone height in the posterior edentulous spans in the mandible as well as to evaluate bone quality and anterior extension of the Inferior alveolar nerve to assess possibility for dental implant placement. **Study Design:** Cross-sectional study. **Setting:** Armed Forces Institute of Dentistry, Rawalpindi – Pakistan. **Period:** July 2017 to Oct 2017. **Method:** Bone height, width and anterior extension of inferior alveolar nerve was assessed using CBCT images from the hospital database. Bone quality was categorized as hard, moderately hard or soft based on clinician's tactile sensations. **Results:** Average bone width of 6.12 ±1.51 mm and average bone height of 13.56 ± 2.43 mm was found among the study subjects. "Soft" bone quality was found most prevalent in the posterior mandible. Anterior extension of the Inferior alveolar nerve was visible in 14% of subjects only. **Conclusion:** Variations in the bone width, height and density endorse the importance of a site-specific bone tissue evaluation prior to implant installation.

Key words: Alveolar Ridge, Cone Beam Computed Tomography, Dental Implants.

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INTRODUCTION

Replacement of missing teeth using dental implants has become the most reliable and popular treatment modality.[1] Use of dental implants has increased dramatically over the last twenty years and it is expected to amplify further in future.[2] Successful placement of a dental implant requires adequate occluso-apical height, mesio-distal length and bucco-lingual width of alveolar bone at the prospective site of placement.[3] However, following tooth loss, alveolar bone undergoes remodeling with resultant changes in its dimensions.[4] As a result, a patient may present with deficient bone height and width, precluding placement of dental implants.[5]

The prospective dental implant site needs to be evaluated both clinically and radiographically in terms of its quality and quantity.[6] Conventional radiographic techniques such as periapical, bitewing and panoramic view have been traditionally used for evaluation of implant sites but being two-dimensional, they allow only a limited analysis.[7] Moreover, image distortion and superimposition of structures compromises the accuracy of these techniques.[8]

With the advent of 3-dimensional sectional imaging modalities such as computed tomography (CT) and cone-beam computed tomography (CBCT), the three-dimensional anatomy of the bone can now be visualized at submillimeter resolution pre-operatively.[9,10] These modalities not only help to avoid superimposition and distortion errors but also allow measurements to be made in planes of space not available or accurately depicted in

conventional radiographs.[11,12] They can also be used to fabricate surgical guides for accurate and guided implant placement.

CBCT has recently been declared as the diagnostic imaging modality of choice for treatment planning with dental implants.[13] It is now cost – effective and allows imaging with lesser exposure to harmful radiations. Owing to its advantages, the use of CBCT images for pre-operative assessment for prospective implant placement has been on the rise. CBCT allows optimal selection of dental implant length and diameter for residual ridges of varying dimensions and avoid unintentional measurement errors that may lead to treatment failure.[14,15] Different studies have been carried out to evaluate ridge height and width using CBCT in various populations.[5,16] It appears that both bone width and bone height tend to vary among subjects of different ethnicity and race. The aim of this study, therefore, was to measure the average bone width and bone height in the posterior edentulous spans in the mandible of Pakistani population. It also aimed to assess bone quality in posterior mandible as well as anterior extension of the Inferior alveolar nerve (IAN) to evaluate the possibility for implant placement. The knowledge will help the clinicians in better planning and execution of dental implant therapy.

MATERIALS AND METHODS

A cross-sectional study was designed and carried out at Armed Forces Institute of Dentistry, Rawalpindi – Pakistan. Prior approval from AFID ethical committee was obtained. Based on previously published data[7], keeping confidence level (1-α) at 95, absolute precision (d) at 0.12, population mean (μ) at 2.11, population standard deviation (σ) 0.53, a sample size of 85 was calculated using WHO sample size calculator. Bone height, width and anterior extension of inferior alveolar nerve (IAN) was assessed using CBCT images taken through CBCT unit NewTom VGi® (Quantitative Radiology, Verona, Italy). The images were retrieved from the hospital database. The data was collected from January 2015 to January 2016. Following inclusion and exclusion criteria was used to select CBCT images:

Inclusion Criteria

1. Good quality CBCTs.
2. Medium density and contrast of images.
3. Patients with no clinically observable oral pathology in the oral region.
4. Both male and female patients were selected.
5. Partially dentate patients with 1-2 teeth missing in the posterior mandible.
6. Healing period of at least 3 months after tooth extraction.
7. Patients with good oral hygiene i.e. no plaque or calculus deposits.

Exclusion Criteria

1. Distorted or unclear images.
2. Patients with adjacent metallic restorations with scatter effects in CBCT images.
3. Long span edentulous area i.e. 3 or more missing teeth.
4. Patients with bony protuberances in the mandible.
5. Patients with active lesions in the mandible.
6. Patients with a history of trauma.

After appropriate selection of the samples, informed consent was obtained from the patients to use their radiographic images for the study. Two measurements were performed on each edentulous site. Buccolingual width was measured between the two most prominent reference points - one on the buccal aspect of the bone and the other on the lingual aspect. Bone height was measured between the crest of the alveolar ridge and the superior aspect of the inferior alveolar nerve canal. Images were also evaluated to see if anterior extension of IAN was visible or not.

Bone quality of the edentulous span was assessed clinically by two independent qualified clinicians and was categorized as being “hard”, “moderately hard” or “soft”. For inter- and intra-examiner reliability, about ten subjects were randomly chosen and assessed independently for bone quality twice by each clinician. There was good (0.82) inter-examiner agreement and excellent (0.98) intra-examiner agreement between the two clinicians.

Collected data was analyzed using SPSS version 21. Descriptive statistics were calculated. Qualitative variables like gender were presented as frequency and percentages while quantitative variables like alveolar ridge dimensions obtained by CBCT were depicted as mean ± SD. Post stratification Fisher's Exact test was used to evaluate the effect of gender on bone quality while the difference in mean bone width and height between males and females was compared using Independent Sample T - test. P value <0.05 was taken as significant.

RESULTS

Out of the sample of 85 individuals, 51 (60%) were males while 34 (40%) were females. Table-I illustrates the mean values of buccolingual width and bone height amongst the sample. A statistically significant difference in mean buccolingual bone width was found between males and females (P<0.001) whereas no significant difference for bone height between genders could be established (Table-I). Anterior extension of the Inferior alveolar nerve could only be appreciated in 12 subjects (Table-II). The most prevalent bone quality according to subjective evaluation in the mandibular posterior region was "soft" (Figure-1). However, association of bone quality with gender using Fisher's exact test was not found to be significant (P = 0.693).

Parameter	Minimum (mm)	Maximum (mm)	Mean ± SD	Mean ± SD (male)	Mean ± SD (female)	P value
Bone Width (bucco-lingual)	3.1	10.1	6.12 ± 1.51	6.61 ± 1.6	5.38 ± 1.01	< 0.001
Bone Height	6.1	19.8	13.56 ± 2.43	13.88 ± 2.49	13.07 ± 2.27	0.125

Table-I. Mean bone width and bone height in posterior edentulous region and its association with gender among the study subjects

Parameter	Visible on CBCT	Not Visible on CBCT
Anterior extension of Inferior Alveolar Nerve (IAN)	12 (14.12%)	73 (85.88%)

Table-II. Assessment of anterior extension of inferior alveolar nerve

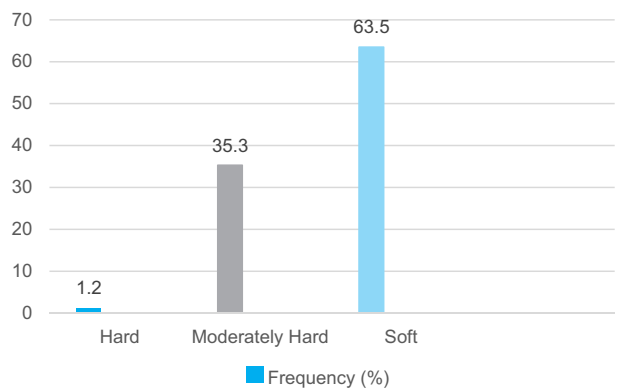

Figure-1. Frequency of bone quality encountered in mandibular posterior edentulous region

DISCUSSION

Appropriate patient history, clinical examination augmented with diagnostic cast and investigations are essential for adequate implant treatment. Every other patient presents with distinctive set of problems and treatment needs. The clinician must consider individual circumstances including anatomical, functional and aesthetic requirements so that a realistic, predictable and satisfactory result can be achieved.

In the present study, the mean bucco-lingual bone width in the posterior mandible (edentulous site) was found to be 6.12 ± 1.51 mm. Similar results have been reported by Alrahaimi et al.[5] who found a buccolingual bone width of 6.22 ± 1.96 mm in the premolar region and 6.51 ± 1.75 mm in the 1st molar region. Another similar study by Braut et al.[16] reported a range of buccolingual widths, ranging from 3.47 mm to 10.1 mm. However, the increasing width values were found just superior to the inferior alveolar nerve canal and not close to the crest. Since in the present study, site-specific measurements were not recorded, hence, only a general comparison of results can be carried out. Also, in the present study, a statistically significant difference in mean buccolingual bone width was found between males and females (P<0.001)

with greater width seen in males. These findings are endorsed by those of Braut et al.[16] who also reported significantly higher buccolingual bone width values in male subjects. Alrahaimi et al.,[5] on the other hand, did not find any effect of gender on bone width.

In terms of bone height, the present study found a mean bone height of 13.56 ± 2.43 mm in the posterior mandible. Contradictory to these findings, Alrahaimi et al.[5] reported a mean bone height of 15.19 ± 2.12 mm in the premolar region and 14.53 ± 2.34 in the 1st molar region. This suggests prevalence of increased bone height in the Saudi population as compared to the Pakistani population. In the study by Braut et al.,[16] bone height gradually decreased from the first premolar to the 2nd molar region. Mean bone height in the 2nd premolar region was found to be 13.32 mm which is comparable to the findings of the present study. The present study did not find any significant difference in terms of bone height between male and female subjects. Similar findings have been reported by Alrahaimi et al.[5] while Braut et al.[16] found significantly greater bone height in Swiss males than in Swiss females. These differences can be explained on the basis of difference in ethnicity and also by the fact that the researchers selected fully dentate patients for measurements.

In the present study, the most prevalent bone quality in the posterior mandible was characterized as "soft". Although this is not the most commonly used classification system, it seems rather practical for clinical evaluation of bone based on clinician's subjective evaluation. Such a classification system was put forward by Trisi and Rao[17] who also concluded that "hand feeling" can distinguish between two extreme bone qualities i.e. D1 and D4 but fails to distinguish between the intermediate qualities i.e. D2 and D3.

The present study also evaluated the anterior extension of IAN canal and found it visible in only 14% of the study samples. Studies reveal that visibility of mandibular canal decreases from the 3rd molar region to the region of mental foramen, the highest being in the 3rd molar region.[18] This is due to lack of definitive canal walls in the anterior region.[19] These findings are corroborated by those of Aslam et al.[20]

The present study has a few limitations to its credit. First, only partially dentate patients presenting to AFID were selected. Secondly, site-specific height and width were not evaluated, rather a mean value was calculated. Third, bone quality was only assessed in a subjective manner and not objectively. Despite these limitations, this study gives useful insight to quantitative evaluation of bone prior to implant placement. Its findings also build up on the epidemiological data pertaining to the local population. However, similar studies with larger sample size and a diverse sample must be carried out so that the results can be generalized to the population of the entire country.

CONCLUSION

Cone beam computed tomography (CBCT) provides excellent information to evaluate the morphology of the bone. Variations in bone width, height and density endorse the importance of a site-specific bone tissue evaluation prior to dental implant placement.

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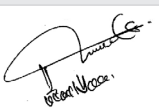
1	Mubashir Sharif	Study concept and design.	
2	Sajjad Hussain	Data collection and analysis + Writing.	
3	Ayesha Aslam	Manuscript writing.	
4	Syed Hammad Hassan	Critical revision.	
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