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CBCT ANALYSIS OF ALVEOLAR BONE DIMENSIONS IN MANDIBULAR POSTERIOR TEETH: A PRELIMINARY STUDY

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ABSTRACT

OBJECTIVES: Extraction of mandibular posterior teeth followed by immediate implant placement is considered as an optimal technique of immediate prosthetic rehabilitation. The analysis of alveolar bone dimensions with Cone Beam Computerized Tomography prior to implant placement is a prime determinant in treatment planning. Hence this preliminary study was conducted to analyze the alveolar bone dimensions in dentate mandibular posterior teeth to evaluate the available bone which can be utilized for immediate implant placements.

MATERIALS AND METHODS: Retrospective data of 200 cases of full volume CBCT was procured from Riyadh Elm University (REU) database and reviewed for eligibility. A total of 10 cases were included in the study. Scans were assessed for thickness of buccal and lingual walls at 4mm below the CEJ (MP1) and at midroot level (MP2). Alveolar width was assessed at most coronal point on alveolar bone (BW1) and at superior border of mandibular canal (BW2). The height was be calculated by measuring the vertical distance between BW1 and BW2. Data was tabulated and statistically analyzed using unpaired t-test.

RESULTS: The results of our study indicates that dimensions of buccal and lingual bone walls of all teeth at MP1 and MP2 in PM1, PM2 and M1 were statistically significant. Also only the 1st premolar (PM1) showed statistical significance with regard to dimensions at BW1 and BW2.

CONCLUSION: The present study highlights the need for further studies with larger samples which can impact the immediate implant success rates in mandibular posterior teeth.

KEYWORDS : Alveolar bone thickness; Immediate implant; Immediate prosthetic rehabilitation; Fresh Extraction; Mandibular bone dimensions; Implant planning.

1. INTRODUCTION:

In Dentistry, the most prevailing disease conditions which affects the quality of life due to functional impairment are caries and periodontitis, which are progressive and result in early tooth loss if not intervened with adequate treatment. The concept of immediate implant placement in Dentistry is gaining much importance and is proposed that it would maintain bone volume and improve the esthetic treatment outcomes.[1] Analyses of available alveolar bone matched with implant dimensions are of prime importance for its success.[1,2] These bone changes can be analyzed using cone beam computed tomography (CBCT). Mandibular posterior teeth are most common sites of implant placement[3]. CBCT can provide dimensional accuracy of available bone in a proposed implant site apart from evaluation of bone changes, virtual implant placement with safe distance from vital structures which are critical determinants for implant success[4]. Hence this study is focused on assessing the alveolar dimensions in dentate posterior mandible as it the most common site of implant placement.

2. MATERIALS AND METHODS

This preliminary study was conducted in Riyadh Elm University using Retrospective full volume CBCT data of 200 cases, procured from the University database after ethical committee/IRB approval [RC/IRB/2018/1063]. The 200 cases were screened and the final sample consisted of 10 cases satisfying the inclusion and exclusion criteria. The measurements were done as follows and the data collected was analyzed using unpaired t-test.

INCLUSIVE CRITERIA:

I. Age 18 to 40 years
II. Dentate mandibular arches
III. No pathologies of mandibular molar

EXCLUSIVE CRITERIA:

I. Missing/extracted maxillary tooth
II. Medically compromised conditions including Systemic diseases like Diabetes, Osteoporosis, prolonged hypertension, Bone diseases or any other conditions compromising the bone quality
III. Any pathology involving the mandibular molar.

MEASUREMENTS:

MPI (Measurement at Point 1) in mm: Thickness of the buccal and the lingual walls 4mm apical to CEJ; MP2 (Measurement at Point 2) in mm: Thickness of the buccal and the lingual walls at Midroot level (Figure 1); BW1(Bone Width at Point 1) in mm: Alveolar crest width at the most coronally detected buccal bone; BW2 (Bone Width at Point 2) in mm: Alveolar crest width at the superior border of inferior alveolar canal; H(Alveolar Bone Height) in mm i.e, Vertical distance between BW1 and BW2 which is shows distance from mandibular canal to alveolar crest region (Figure 2).

3. RESULTS

A total of 64 teeth in the mandibular posterior region were analyzed for alveolar bone measurements out of which 17 first premolars, 17 second premolars, 14 first molars, 19second molars were present. The mean thickness of buccal bone plate at Point 1(MP1) were as 0.67mm, 0.69mm, 1.01mm and 2.95mm for first premolar, second premolar, first molar and second molar respectively with increase in thickness of buccal cortical plates from premolar to molar. The second molar had the maximum width of buccal cortical plate as seen in Figure 3. The mean thickness of lingual bone plate at Point 1(MP1) were as 1.62mm, 1.95mm, 2.32 mm and 2.31 mm for first premolar, second premolar, first molar and second molar respectively with increase in thickness of lingual cortical plates from premolar to molar; the first and the second molar with similar thickness (Table 1).

The mean thickness of buccal bone plate at Point 2(MP2) were as 0.96mm, 1.09mm, 1.41mm and 3.89mm for first premolar, second

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premolar, first molar and second molar respectively with increase in thickness of buccal cortical plates from premolar to molar. The mean thickness of lingual bone plate at Point 2(MP2) were as 2.43mm, 2.79mm, 2.78 mm and 2.59 mm for first premolar, second premolar, first molar and second molar respectively with increase in thickness of lingual cortical plates from 1st premolar to 2nd premolar. There was a decrease in lingual cortical thickness from the first molar to the second molar (Table 2).

There was statistically significant differences between the buccal and the lingual cortical plates at MP1 and MP2 for 1st premolar to 1st molar ($p<0.005$) (Table 3 and Table 4).

The mean alveolar bone width at Point 1(BW1) were 6.96mm, 7.58mm, 9.41mm, 9.75mm and at Point 2(BW2) were 8.64mm,8.93mm, 10.36mm, 10.85mm. An increase in mean alveolar width was seen from premolar to molar region both at BW1 and BW2; Whereas in case of alveolar bone height, there was a decrease in height from PM1 to M2 as 17.44mm,16.39mm, 15.37mm,14.20mm respectively(Table 5). Only for 1st premolar showed a statistically significant difference between the alveolar bone width at Point 1(BW1) and Point 2 (BW2) ($p<0.005$) (Table 6).

4. DISCUSSION

Dimensional alterations occur on the alveolar process after extraction of the tooth and during healing phase [5]. Once healing is completed, it is noted that there is comparatively more bone loss in the peripheral 1/3rd of the socket (the cortical plate) than that of the lingual aspect since the buccal wall is less in width than the lingual cortical plate[5,6,7,8]. This resorption of buccal bone exert great influence during implant placement and its success. Hence this loss of bone following extraction has to prevented/ compensated for the success of implant longetivity[5]. It was suggested and subsequently proved that implant placement in fresh extraction sockets (immediate implant) can help to recuperate from the bone loss[9].

One of the key determinants in the success of immediate implant therapy is the analysis of thickness of buccal bone wall since the extent of buccal wall reduction directly depends on thickness of the buccal cortical plates in the region of the tooth to be extracted[9,10]. According to Braut et al(2012), a minimum of 2mm of buccal bone thickness is required after implant bed preparation [4]. Whereas Grunder et al states that the thickness of bone dimension should be not be less than 4mm. If it is less then 4mm, the likeliness of buccal bone resorption resulting in recession of the gingiva is predicted to occur [9,10,11]. The placement of immediate implant may serve to preserves the alveolar bone dimension[12]. The coronal portion of the ridge often shows bony alterations following extractions[4,5]. Therefore MP1 is the most important aspect of studies with immediate implant placement. In our study we found that the mean thickness of buccal and lingual bone plate at Point 1(MP1) increased from premolar to molar except for the first and the second molar which had similar lingual cortical plate thickness at MP1 similar to the study by Kunte VR et al[10]. The mean thickness of buccal bone plate at MP2 also showed an increase in thickness of buccal cortical plates from premolar to molar which were consistent with the previous study[10]. The mean thickness of lingual bone plate at Point 2(MP2) had an increase from 1st premolar to 2nd premolar but the thickness reduced from 1st molar to 2nd molar. This reduction in lingual cortical thickness from the first molar to the second molar has to be further evaluated in larger studies. The differences between the buccal and the lingual cortical plates at MP1 and MP2 for 1st premolar to 1st molar ($p<0.005$) except second molars were statistically significant as reported by Kunte VR et al[10].

The mean alveolar width was seen to increase from premolar to molar region both at BW1 and BW2 which is consistent with the previous study[10]. The alveolar bone height as expected in accordance with the anatomy of mandible was seen to decrease from PM1 to M2 owing to the position of inferior alveolar canal. Statistically significant difference between the alveolar bone width at Point 1(BW1) and Point 2 (BW2) was noted only in 1st premolar which is not in accordance with the previous studies and has to be further evaluated in future studies[10]. This may be due to the small sample size that was evaluated. This is a critical distance (H) during implant placements to avoid perforation of inferior alveolar canal. In addition the location and extent of lingual undercut has also much importance and in such case, an off axial placement of implant with an angled abutment is the preferred procedure[4,13,14].

5. CONCLUSION

Our study highlights the importance of analyzing alveolar bone dimensions for facilitating immediate implant placement in favorable conditions. Further studies with larger a sample size is required to standardize the alveolar bone dimensions for apt treatment planning and bone augmentation prior to immediate implant placement. This can increase the implant success rates in mandibular posterior teeth.

AUTHORS COMMENT:

The present study was conducted as a preliminary study during summer research school program in Riyadh Elm University. Further follow up prospective study with large sample size has been proposed.

AUTHOR CONTRIBUTIONS

Author 1: Contributed to conception, design, data acquisition and interpretation, drafted and critically revised the manuscript
Author 2,3: Contributed to initial data acquisition and retrospective record analysis
Author 4,5,6: Retrospective record analysis

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

ETHICAL STATEMENT

The study protocol was approved by the Institutional Research Board Research at the Riyadh Elm University (RC/IRB/2018/1063).

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FIGURES

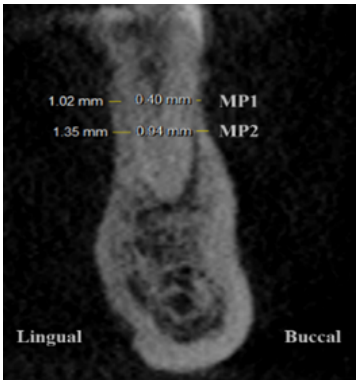

Figure 1: MPI (Measurement at Point 1) in mm: Thickness of the buccal and the lingual walls 4mm apical to CEJ; MP2 (Measurement at Point 2) in mm: Thickness of the buccal and the lingual walls at Midroot level

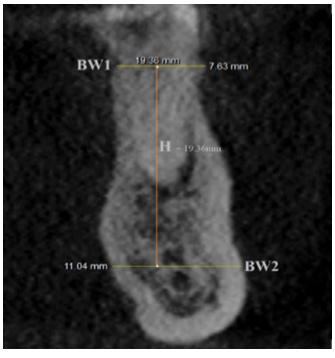

Figure 2: BW1(Bone Width at Point 1) in mm: Alveolar crest width at the most coronally detected buccal bone; BW2 (Bone Width at Point 2) in mm: Alveolar crest width at the superior border of inferior alveolar

canal; H(Alveolar Bone Height) in mm i.e, Vertical distance between BW1 and BW2 which is shows distance from mandibular canal to alveolar crest region

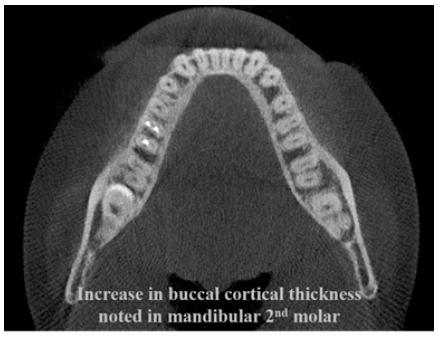

Figure 3: Increase in Buccal cortical thickness noted in mandibular 2nd molar region

TABLES

Teeth	Cortical Plates	Minimum (mm)	Median (mm)	Maximum (mm)	Mean (mm)
PM1	Buccal Lingual	0.36 0.68	0.59 1.08	1.40 4.14	0.67 1.62
PM2	Buccal Lingual	0.40 0.87	0.64 1.56	1.08 4.26	0.69 1.95
M1	Buccal Lingual	0.64 1.37	0.95 2.20	1.51 3.76	1.01 2.32
M2	Buccal Lingual	0.77 1.45	2.44 2.23	6.57 3.41	2.95 2.31

MP1: PM1: 1st premolar, PM2: 2nd premolar, M1: 1st molar, M2: 2nd molar

Table 1: Thickness of buccal and lingual bone plates at Mp1

Teeth	Cortical Plates	Minimum (mm)	Median (mm)	Maximum (mm)	Mean (mm)
PM1	Buccal Lingual	0.57 0.88	0.92 2.19	1.91 5.63	0.96 2.43
PM2	Buccal Lingual	0.61 1.16	1.00 2.34	1.64 5.78	1.09 2.79
M1	Buccal Lingual	0.77 1.59	1.33 2.73	2.47 4.56	1.41 2.78
M2	Buccal Lingual	0.71 1.31	4.26 2.69	7.71 3.40	3.89 2.59

PM1: 1st premolar, PM2: 2nd premolar, M1: 1st molar, M2: 2nd molar

Table 2: Thickness of buccal and lingual bone plates at Mp2

Teeth at MP1	Buccal (Mean ± SD) (mm)	Lingual (Mean ± SD) (mm)	p-value
PM1	0.67 ± 0.24	1.62 ± 1.09	0.001
PM2	0.69 ± 0.23	1.95 ± 1.19	0.000
M1	1.01 ± 0.33	2.32 ± 0.72	0.000
M2	2.95 ± 1.96	2.31 ± 0.57	0.222

Table 3: Dimensions of buccal and lingual bone walls of all teeth at Mp1

SD: Standard Deviation; (p<0.05 significant)

Teeth at MP2	Buccal (Mean ± SD) (mm)	Lingual (Mean ± SD) (mm)	p-value
PM1	0.96 ± 0.33	2.43 ± 1.31	0.000
PM2	1.09 ± 0.317	2.79 ± 1.32	0.000
M1	1.41± 0.51	2.78 ± 0.75	0.000
M2	3.89 ± 2.15	2.59 ± 0.54	0.031

Table 4: Dimensions of buccal and lingual bone walls of all teeth at Mp2

Teeth	Minimum (mm)	Median (mm)	Maximum (mm)	Mean (mm)
Bone width at Point 1(BW1)				
Pm1	5.82	7.02	8.09	6.96
PM2	5.60	7.57	9.66	7.58
M1	7.38	9.54	11.35	9.41
M2	7.87	10.20	12.13	9.75
Bone width at Point 2(BW2)				
PM1	4.34	9.15	12.42	8.64
PM2	4.82	9.37	12.53	8.93
M1	7.51	10.57	12.62	10.36
M2	8.05	10.85	13.76	10.85
Height (H)				
PM1	15.24	17.42	19.93	17.44
PM2	14.50	16.19	19.36	16.39
M1	12.19	15.69	19.04	15.37
M2	11.27	13.69	18.17	14.20

SD: Standard Deviation (p<0.05 significant)
Bw1: bone width at most coronally detectable alveolar bone,
BW2: Bone width at the superior border of inferior alveolar canal
H: Height between BW1 And Bw2

Table 5: Alveolar bone width and height of mandibular posterior teeth.

Teeth	BW1 (Mean ± SD) (mm)	BW2 (Mean ± SD) (mm)	p-value
Pm1	6.96 ± 0.57	8.64 ± 2.15	0.004
PM2	7.58 ± 0.93	8.93 ± 1.19	0.026
M1	9.41± 1.37	10.36 ± 1.74	0.122
M2	9.75 ± 1.46	10.85 ± 1.65	0.047

Table 6: Dimensions of BW1 and BW2 for all teeth (p<0.005 significant)

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