OPTIMAL SITES FOR THE PLACEMENT OF MINI SCREWS IN POSTERIOR MAXILLA USING CONE BEAM COMPUTED TOMOGRAPHY CROSS SECTIONAL DESCRIPTIVE STUDY

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ABSTRACT

Objective: *Miniscrews have become popular in recent years where absolute anchorage is desired. Besides many advantages offered by them, miniscrews still show lack of stability. One of the main factors for failure has been reported to be the (2018) optimal sites for the micro implant placement. This study was aimed to determine the interradicular distances in posterior maxillary region using cone bean computed tomography by mapping of the mesiodistal dimensions on the maxillary buccal site.*

Materials & Methods: *A descriptive cross sectional study was conducted at the Orthodontic department Rehman College of Dentistry, Peshawar. 50 patients were evaluated using (CBCT apparatus (CS 9000) at 60 -90 kV). Linear Interardicular distances were measured from distal of canine to the mesial of 1st molar at three levels (alveolar crest, mid root and the apex) using CS 3D imaging software.*

Results: *Maxillary interradicular distances ranged from 1.00 mm to 6.20 mm. The distance tended to progressively increase from alveolar crest to apex and from canine to 1st molar. Greatest distance was found to be between 2nd premolar and 1st molar.*

Maximum distance was between 2nd premolar and 1st molar 3.60 mm, 5.10 mm, 6.20 mm at alveolar crest, mid root and apex level respectively. Minimum interradicular dimensions varied. At crest and mid root level it was found to be between canine and 1st premolar 1.20 mm and 1.00mm respectively. At the level of apex minimum distance measured was 1.20 mm between 1st premolar and 2nd premolar.

Conclusion: *Interradicular distance tended to increase from cervical line to apex and canine to 1st molar. Because of the greatest interradicular spaces between 2nd premolar and 1st molar, miniscrews of 1.2 to 1.6 mm diameter can safely be used.*

Keywords: *miniscrews, maxilla, posterior region.*

INTRODUCTION

Mini screws have become popular in recent years where absolute anchorage is desired. The clinical advantages offered includes patient compliance , small size, easy placement and removal , versatile placement , simple surgical procedure , and immediate loading.[1, 2] Despite these several advantages miniscrews may loosen and show lack of stability. Failure rate in literature has been reported to be 11 to 30 %.[3]

Stability of miniscrews depends on the mechanical interlocking and not on osteointegration. Mini implants are more stable in cortical bone than medullary bone.[4] Besides bone quality and quantity, insertion sites also play a key role in stability.[5, 6] Most common placement sites are the interradicular spaces

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between adjacent teeth , palate ,retromolar area and buccal cortical plate of both maxilla and mandible . Success rate in literature is reported to be 84 %.[7, 8]

The failure rate of orthodontic mini-implants has been proved to be affected by lots of variables including: Patient (age, site, bone quality & quantity), operator and orthodontic mechanics related factors. Despite many factors in a recent review no association was found between these factors and micro implant success.[7, 9]

Several studies have evaluated optimal locations for mini implant placement by using different methods like periapical radiographs, panoramic radiographs, computed tomography, digital volume tomography based on the cone-beam technique, and human cadaver skulls.[10, 8]

Kim studied inter radicular distances using cross sections of human jaws and found increase in the distance from anterior to posterior as well from CEJ to the apex. Safest zone for the placement of implants in maxilla was reported to be between 1st molar and 2nd premolar 5 to 6 mm from the cervical line.[11] Park used CT scans for his study and used narrower microimplant (diameter, 1.2mm) with a purpose to avoid root damage and more coronal implantt placement. Their results also determined greater interradicular distances between maxillary buccal segment between second premolar and the first molar[12] Chaimanee studied the safe zones for the placement of microimplants in different skeletal patterns using CBCT. They reported increase in the inter radicular spaces in maxilla from anterior to posterior and cervical region to apex more in Skeletal Class II than Skeletal Class III patterns.[13] Natildda Used CBCT for safe zone evaluation and reported increased interradicular distances at 10 mm above CEJ in maxilla in skeletal class II cases compared to skeletal class I.[10]

Microimplants are being used frequently for the absolute anchorage. The knowledge regarding the dimension and safe placement is scarce in our population. In the present study intra radicular distances in posterior maxilla were studied based on mapping of the dimensions using cone beam computed tomography (CBCT). Aim of the present study was to determine the safe zones for different dimensions of mini-implant placement based on inter radicular distances at different root levels. This site selection will also avoid discernable damage to the roots during placement.

MATERIALS AND METHODS

A descriptive cross sectional study was conducted at the Orthodontic department Rehman College of Dentistry, Peshawar in year 2018. CBCT records of patients who presented to the department from 2018 who underwent CBCT for maxillary region were selected for evaluation. Informed consent was taken from the patients about the use of records in research or for academic activity. Ethical approval was taken from the committee.

49 patients were randomly selected those who met the following inclusion criterion; CBCT maxilla with permanent dentition and without any previous history of orthodontic treatment. Patients with any pathology, syndromes and impacted teeth other than 3rd molars were excluded from study.

The images were taken with CBCT apparatus (CS 9000) at 60 -90 kV, scanning time of 4 – 16 seconds and slice thickness of 0.15 mm. Sagittal view of the CBCT images was used and linear measurements on buccal sides of posterior maxilla from the distal of canine to the mesial of 1st molar were taken at three levels (alveolar crest, mid root and the apex) using CS 3D imaging software for this purpose. Fig 1(A, B, C)

RESULTS

CBCT volumes of 49 patients were analyzed. The volumes were obtained from 22 female patients mean age 27.86 years and 27 male patients whose mean age was 31.14 years. On 2 CBCT volumes measurements were recorded from distal of first premolar because the images did not capture the canine region. A total of 435 inter radicular measurements on the buccal side of the maxillary teeth were recorded. 141 measurements were taken from between canine and first premolar roots and 147 each from between 1st and 2nd premolar and 2nd premolar and 1st molar roots**.**

The descriptive statistics of the interradicular widths in maxillary posterior region are shown in (Table 1)**.**

Results of our study showed progressive increase of Inter root distances from canine towards the molar teeth horizontally (at crest, mid root and at the level

Table 1: The means and standard deviations of interradicular distances.

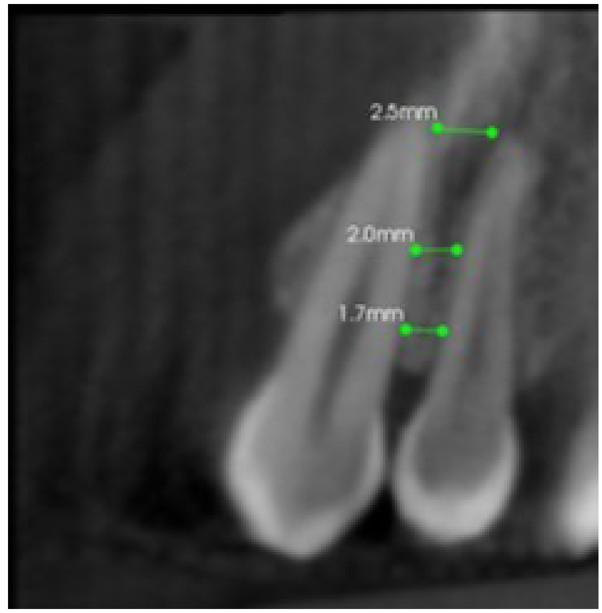
N 49		3&4	4&5	5&6
C	Mean	1.56.	1.94	2.43
	SD	0.25	0.33	0.50
	Min	1.20	1.40	1.60
	Max	2.30	2.90	3.60
M	Mean	1.89	2.50	2.96
	SD	0.37	0.44	0.88
	Min	1.00	1.70	1.60
	Max	3.20	3.90	5.10
A	Mean	2.45	2.80	4.13
	SD	0.60	0.79	1.15
	Min	1.30	1.20	2.00
	Max	4.70	4.80	6.20

Table 2: Gender, means and standard deviations of interradicular distances at different root levels.

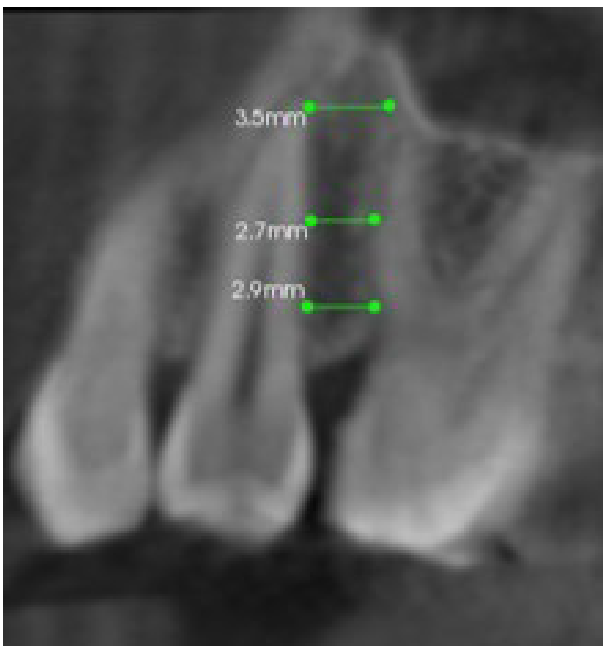
N 49		3&4		4&5		5&6	
		F	M	F	M	F	M
C	Mean	1.62	1.56	1.95	1.94	2.52	2.43
	SD	0.29	0.25	0.40	0.33	0.43	0.50
	Min	1.20	1.20	1.50	1.40	1.60	1.80
	Max	1.70	2. 30	2.60	2.90	3.60	3.60
M	Mean	1.95	1.89	2.50	2.50	3.08	2.96
	SD	0.44	0.37	0.47	0.44	0.88	0.88
	Min	1.50	1.00	1.90	1.70	1.80	1.60
	Max	2.40	3.20	3.50	3.90	5.00	5.10
A	Mean	2.56	2.45	2.9 2	2.80	4.18	4.13
	SD	0.69	0.69	0.7 8	.079	1.15	1.15
	Min	1.50	1.30	1.30	1.20	2.20	2.00
	Max	3.20	4.70	4.20	4.80	6.20	6.10

Patients	Age	3-4C N 47	3-4M N 47	3-4A N 47	4-5C N 49	4-5M N 49	4-5A N 49	5-6C N 49	5-6M N 49	5-6A N 49
N 49	29.67 (11.33)	1.56 (.25)	1.89 (.37)	2.45 (.60)	1.94 (.33)	2.50 (.44)	2.80 (.79)	2.43 (.50)	2.96 (.88)	4.13 (1.15)
Min	13	1.20	1.00	1.30	1.40	1.70	1.20	1.60	1.60	2.00
Max	56	2.30	3.20	4.70	2.90	3.90	4.80	3.60	5.10	6.20
Range	43.00	1.10	2.20	3.40	1.50	2.20	3.60	2.00	3.50	4.20

A



B



C

of apex). Similarly, the distances increased from the level of crest to the apex vertically. Maximum distances were found to be between 2nd premolar and 1st molar 3.60 mm, 5.10 mm, 6.20 mm at alveolar crest, midroot level and apex respectively. Minimum distance interradicular dimensions varied. At crest and mid root level it was found between canine and 1st premolar 1.20 mm and 1.00mm respectively. At the level of apex minimum distance measured was 1.20 mm between 1st premolar and 2nd premolar.

Distances measured were greater for males than females at different root levels Table 2

Values are mean (SD)

3-4 Canine to 1st premolar **C** crest level

4-5 1st premolar to 2nd premolar **M** mid root level

5-6 2nd premolar to 1st molar **A** apex level

DISCUSSION

In present study CBCT was used to evaluate inter radicular distances of the maxillary posterior teeth. The distances recorded were from the distal of canine to the mesial of 1st molar at three vertical levels (alveolar crest, midroot and apex). Inter radicular space increased as the vertical distance from the crest increased. Maximum distance recorded was 6.20 mm between 2nd premolar and 1st molar at the level of apex. Conical shape of the roots might be the reason for this increase in the space towards the apex. Greatest width of the root is at the cervical level and it decreases progressively until it narrows down to the apex.[14] As a result, more space is available between the roots of adjacent teeth , at a greater vertical level from the alveolar bone crest.

This pattern was not observed in all measurements. In certain cases, inter root space decreased from crest to the mid root level before increasing again at the level of apex. This was seen between canine and 1st premolar. The distance measured at the crest, mid root and apex was 1.20, 1.00 and 1.30 mm respectively. Canine has the longest root which bulges out in the middle in certain cases which decreases the inter radicular space. Similarly, inter root space, at the level of apex was even less than that recorded at the crest. 1.20 mm at apex and 1.40 and 1.70 mm at crest and mid root respectively, between 1st and 2nd premolar. This might be due to apical root curvature in either mesio distal or bucco lingual directions, especially in premolar and molar regions.

The results of present study were similar to the previous studies. Park and Cho used CBCT images and evaluated CBCT inter radicular space, cortical bone thickness and alveolar process width at three vertical levels from cemento enamel junction (CEJ) (5, 7, and 9 mm). They found Inter radicular distance increased from crest to the apex both in the maxilla and mandible and also from anterior to posterior region. In maxilla distance was greatest between 2nd premolar and 1st molar and least between 1st and second molar[12] thickness of cortical bone, and alveolar process width at prospective microimplant placement sites in order to understand both safety and stability aspects of microimplant placement by using cone-beam 3-dimensional volumetric images. Methods: Initial 3-dimensional images of 60 adult patients (30 men, 30 women; mean age, 27.1 years-Similarly Poggio et al evaluated CBCT volumetric scans maxilla and mandible to measured mesiodistal and the buccolingual distance for each interradicular space, at four different depths from the alveolar crest, ie, at 2, 5, 8, and11mm they found the greatest greatest mesiodistal interradicular space between the first molar and second premolar, at five to eight mm from the alveolar crest At 11 mm the roots become narrower because of sinus.[15] Hu et al analyzed cross sections of human jaws in, and resin blocks were produced by dehydrating the jaws . they also reported increase inter radicular distances were also measured by image analysis system. The inter root distance increased from anterior to posterior teeth and from cervical line to the apex. The greatest inter root distance was between 2nd premolar and 1st molar.[11] Similarly M. Fayed et al reported highest mesiodistal distances, both buccally and palatally, between the second premolar and the first molar (4.05 and 6.75, respectively).they used cut off values from cervical margin at 2 , 4 and 6mm them they didn't take values above 6mm because of soft tissue restrictions.[16]

In another study Heins and Wieder used decalcified specimens of maxilla to evaluate inter root distance. Smallest distance was reported to be between between 2nd premolar and 1st molar at cervical and middle third and between 1st and 2nd molar at the mid root level.The results of this study are contrary to the present study, probably due to the deformation of the tissues during decalcification process.[17]

In present study we measured distances on sagittal view of right maxilla using CBCT. In future studies the levels from the alveolar crest can be taken numerically to determine the exact location. Also the measurements can be taken from the cervical line instead of alveolar crest because of the chances of resorption at the crestal region.[16] Recording distances from both sides and using cross sectional views for comparison could yield better results.

CONCLUSION

- The interradicular distances increased progressively from anterior to posterior and cervical level to apex at all three levels.
- Microimplants dimensions 1.2 to 1.6 mm can safely be placed between 2nd premolar to 1st molar in maxillary posterior region

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