ORIGINAL ARTICLE

A prospective study of the Various Categories of Crown to Root Ratio of Premolars by Using Cone Beam Computed Tomographic Images in Peshawar Population

HASEEB AHMAD[1], UMAR NASIR[2], MAHWISH ZEB[3], ASMA ALI[4], ASFANDYAR QURESHI[5], SANA NAEEM[6]

[1]Lecturer, Department of Oral Biology, Peshawar Dental College Peshawar
[2]Assistant Professor, Department of Oral Biology, KMU-IDS Kohat
[3]Assistant Professor, Department of Forensic Medicine & Toxicology, Women Medical & Dental College Abbottabad
[4]Assistant Professor, Department of Oral Biology, Bacha Khan College of Dentistry Mardan
[5]Senior Lecturer, Department of Physiology, Ayub Teaching Hospital Abottabad
[6]Assistant Professor, Department of Oral Biology, Frontier Medical and Dental College Abottabad
Correspondence to Dr. Haseeb Ahmad, E-mail: drhaseeb333@gmail.com Cell: 0333-9273916

ABSTRACT

Background: Cone beam computed tomography (CBCT) has gained worldwide acceptance in the field of dentistry, because it provides definite images in the form of slices of single roots which can accurately measure the crown and root lengths of all the teeth including premolars. Crown and root lengths have its applications in surgical extrusion and crown lengthening in cases of tooth wear.
Aim: To document the frequency of crown-root ratio (using CBCT images) in longitudinal section of the premolar teeth.
Study design: Descriptive cross-sectional study.
Place and duration of study: Department of Radiology, Khyber College of Dentistry and Hospital, Peshawar and Department of Radiology, Sardar Begum Dental College and Hospital Peshawar from 1st January 2020 to 30th June 2020.
Methodology: One hundred and thirty five patients of both the genders were selected by obtaining there CBCT images. A written informed consent was taken from the patients or their attendants through concerned dentist who advised CBCT. Data of crown root ratio of premolar teeth were recorded in the form of categorical variables (crown and root length).
Results: The mean age was 29.64±4.47 years. The highest frequency of patients was of 28(14.8%) years and 29(17%) years. There were 87(64.4%) males while 48(35.5%) females.
Conclusion: There is significant difference of crown root ratio between the premolars of maxilla and mandible and the right and left quadrants of both arches.
Key words: Cone beam computed tomography (CBCT), crown-to-root ratio (CRR), Premolar

INTRODUCTION

Dentists have evaluated many tooth anatomical specifications to determine the prognosis of individual teeth, such as crown-to-root ratio (CRR), root canal morphology, number of canals and number of roots, the degree of bone-loss, probing depth, bifurcation area involvement, tooth mobility, root structure, pulp involvement and occlusal relationship[1].

The CRR is defined as "the physical relationship between the portions of the tooth root embedded within the alveolar bone as compared to the portion of the tooth crown outside the alveolar bone determined radiographically". Tooth with higher root portion supported by alveolar bone is better able to bear the unfavorable lateral forces and hence determines the success of dental prosthesis, specifically in which premolars act as abutment tooth[2].

Conventional periapical radiographs have been commonly used for evaluating root canal morphology and crown root ratio[3]. A periapical radiograph provides a two-dimensional image of a three-dimensional object and hence there is always a chance of missing minute information and measurements. Sometimes, anatomical structures, such as shallow vault of the palate or an overlap by the maxillary sinus, makes it difficult in observing the actual root canal morphology as well as it affects the calculation of crown root ratios[4].

Cone beam computed tomographic technique can be used to study the crown root ratios of premolars in different populations.[4] Cone beam computed tomography provides an accurate three-dimensional image of the crown and root of teeth and is considered to be the best in-vivo method for assessment of the root and canal morphology[5]. In various studies CBCT-based measurements showed a great deal of agreement that there is no sufficient difference between males and females. According to a study done on Korean patients, which included 672 subjects, (141 men and 531 women; mean age, 27.2±7.7 years) (who underwent

CBCT examinations during various dental treatments) the mean C/R ratios varied from 1.1 to 1.2 for maxillary incisors and from 1.3 to 1.4 for mandibular incisors in males and females respectively[6].

A study done on Korean population, the mean R/C ratios varied from 1.29 to 1.89 (male: 1.28-1.84; females: 1.31-1.94). In this study 99 panoramic radiographs were taken (50 males and 49 females aged 16-24 years) and a total of 2770 teeth (all permanent teeth) were analyzed. Crown and root length were measured with modified Linds measurement using PACS tools by two examiners in two separate sessions two months apart[3].

In another study conducted on Chinese population, all 25 extracted premolars were scanned (tooth scanning was performed by GE Explore Locus Micro-CT) and crown to root ratio was found to be around 0.95[7].

Another study was conducted on 72 patients who attended BAU (Beirut Arab University) dental clinics. CBCT records were obtained for healthy single rooted teeth i.e. incisors, canine and premolars. The maximum C/R ratio was 1.51 and the minimum C/R ratio was 0.3. The highest C/R was for incisors (0.67) and the lowest C/R ratio was for canines (0.53). Premolars had an intermediate C/R ratio of 0.63[2].

In another study the crown root ratios were calculated in Iranian population by Haghanifar et al[8], through panoramic radiographs. The crown and root lengths of teeth were measured by a digital calliper on panoramic radiographs. This study showed that the mean crown root ratio of premolars was considerably higher in females than in males.

In Finish population there was a study conducted by Hölttä et al[9] who compared the CRR of maxillary arch with mandibular and it was found to be having mean value of 0.56 to 0.40. The difference between CRR of maxillary and mandibular arch was determined to be non-significant (less than 0.05). A detailed descriptive statistics was performed for the C/R ratio of males and females and it was found that, second premolars had lowest C/R ratio as compared to first premolar. There was no significant difference of CRR among ethnicities[10].

MATERIALS AND METHODS

This descriptive cross-sectional study was conducted at Department of Radiology, Khyber College of Dentistry and Hospital, Peshawar and Department of Radiology, Sardar Begum Dental College and Hospital Peshawar from 1st January 2020 to 30th June 2020 and 135 CBCT images were analyzed. The sample was distributed according to the population visiting the two dental colleges of Peshawar on 1:3 basis. The major data (i.e. 3) was obtained from Khyber College of Dentistry while less data (i.e. 1) was obtained from Sardar Begum Dental College after approval from IRB of Peshawar Medical College. CBCT images of (target area: premolar region) both the genders, fully developed maxillary and mandibular premolars of subjects having age of 16 years and above (fully developed roots) were included. Fracture, tumor or any other pathology in the premolar region were excluded. A written and verbal informed consent was taken from the patients.

The patients went to the Radiology Department. CBCT images were taken through the CBCT units described later. The images directly transfer to the computer connected to the CBCT units. The data was then transferred to a folder already created in that computer for the date wise CBCT images. All the images obtained were examined in the software and measurements were taken. Reference points were taken on the highest point of the tip of buccal cusp of premolars and from that point to the CEJ and then from the CEJ to the root apex of the longest (buccal) root. A line was drawn between these points and lengths were automatically calibrated by the software. These measurements i.e. Crown to root ratios and their categories were recorded. Data of crown root ratio of premolar teeth were recorded in the form of categorical variables (crown and root length) and analyzed by SPSS-26. Chi-square test was used to compare the differences in these categories among gender, upper/lower arches and tooth position in quadrants. P-value ≤0.05 was considered significant.

RESULTS

The mean age was 29.64±4.47 range between 19-42 years. The highest frequency of patients was of 28 (14.8%) years and 29(17%) years. There were 87 (64.4%) male patients while 48(35.5%) female patients (Table 1).

The CRR`s of maxillary right first premolar was compared with the CRR`s of mandibular right first premolar in table 2. The most frequent CRR was 0.36 that was present in the maxillary right first premolar in 18 patients while in mandibular right first premolar this CRR value was present in 10 patients. The CRR value most common in mandibular right first premolar was of 0.4 that was found in 12 subjects while in maxillary right first premolar this CRR was found in 15 subjects. Both of these ratios were found to be in the ideal range of CRR. A statistical comparison for CRR was made between the premolars of maxillary and mandibular arch which revealed a significant difference $p<0.05$ (Table 2).

The CRR`s of maxillary right second premolar were compared with the CRR`s of mandibular right second premolar in table 3. The most frequent CRR was 0.38 that was present in the maxillary right second premolar in 16 patients while in mandibular right second premolar this CRR was less frequent and present in 8 patients. The CRR of 0.42 was found in mandibular right second premolar of 16 subjects while in maxillary right second premolar of this CRR was found in less subjects i.e. 10 subjects. Both of these ratios were found to be in the ideal range of CRR. A statistical comparison for CRR was made between the premolars of maxillary and mandibular arch which revealed a significant difference $p<0.05$ (Table 3).

Table 1: Frequency of genders (n=135)

Gender	No.	%age
Male	87	64.4
Female	48	35.6

Table 2: Comparison of maxillary right first premolar with mandibular right first premolar

Maxillary right 1st premolar	Crown Root Ratio of Mandibular Right First Premolar																					Total
	0.34	0.35	0.36	0.37	0.38	0.39	0.40	0.41	0.42	0.43	0.44	0.45	0.46	0.47	0.48	0.49	0.50	0.51	0.52	0.53	0.56	
0.34	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
0.35	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	5
0.36	0	0	5	3	0	2	0	1	0	1	0	3	0	0	0	0	2	1	0	0	0	18
0.37	1	0	2	1	0	2	0	1	1	0	1	0	0	0	1	0	1	3	0	0	0	14
0.38	0	1	1	0	0	0	2	1	2	0	1	0	1	0	0	0	0	0	0	0	0	9
0.39	0	1	0	5	0	0	1	0	1	0	0	0	0	2	4	0	0	0	0	0	0	14
0.40	0	1	2	0	1	0	0	0	4	2	0	1	1	0	1	0	2	0	0	0	0	15
0.41	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
0.42	0	0	0	0	0	2	3	3	2	2	0	0	0	0	0	0	0	1	0	0	0	13
0.43	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	3
0.44	0	0	0	0	0	2	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	4
0.45	0	0	0	1	4	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	7
0.46	0	0	0	0	0	0	4	0	0	0	0	3	1	0	0	0	0	0	0	0	0	8
0.47	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	4	0	1	0	0	0	6
0.48	0	0	0	0	0	1	0	0	0	0	2	0	1	5	0	0	0	0	0	1	0	10
0.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
0.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	4
0.51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Total	1	3	10	12	5	12	12	6	12	6	4	8	3	3	12	4	7	7	2	3	3	135

Table 3: Comparison of maxillary right second premolar with mandibular right second premolar

Maxillary right 2nd premolar	Crown Root Ratio of Mandibular Right Second Premolar																							Total
	0.25	0.30	0.32	0.33	0.35	0.36	0.37	0.38	0.39	0.40	0.41	0.42	0.43	0.44	0.45	0.46	0.47	0.48	0.49	0.50	0.51	0.53	0.60	
0.20	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2
0.30	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
0.32	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3
0.33	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
0.34	0	0	3	0	0	0	0	0	0	1	2	0	0	0	0	1	0	0	0	0	0	0	0	7
0.35	0	0	0	0	0	0	0	1	2	0	1	0	2	0	1	0	0	0	0	0	0	0	0	7
0.36	0	0	0	0	0	2	1	2	0	0	1	2	1	1	0	0	1	0	0	0	0	0	0	11
0.37	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	3
0.38	0	0	0	0	0	1	0	0	0	0	0	9	3	1	0	1	1	0	0	0	0	0	0	16
0.39	0	0	0	0	0	0	0	3	2	3	2	0	0	0	0	0	1	0	0	0	0	0	0	11
0.40	0	1	0	3	0	3	1	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	12
0.41	0	0	0	0	0	0	1	0	0	0	0	1	3	0	0	0	3	0	1	0	0	2	1	12
0.42	0	0	0	1	0	0	2	0	1	0	0	6	0	0	0	0	0	0	0	0	0	0	0	10
0.43	0	0	0	0	0	0	0	0	1	1	0	0	1	2	1	0	1	0	0	0	0	0	0	7
0.44	0	0	0	0	0	1	0	0	0	0	0	4	0	3	1	0	0	0	0	0	0	1	1	11
0.45	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	4	1	0	0	0	0	0	9
0.46	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	1	4
0.47	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2
0.48	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	4
Total	1	1	3	4	1	8	7	8	6	8	8	16	8	13	14	5	5	10	2	1	1	2	3	135

Radiographic assessment of the dental hard tissue and landmarks are usually done through panoramic radiographs, periapical and cone beam computed tomography[11]. Panoramic and periapical radiographs have many limitations while the CBCT has a higher level of accuracy. In this study a wide variety of premolars were observed having wide range of crown to root ratio in Peshawar population. The crown to root ratio of premolars of maxillary and mandibular arch was calibrated on the basis of CBCT. The premolar teeth of maxillary and mandibular arch were observed individually in this study and those of left and right sides were also observed to avoid tooth side and anatomical disparity. The CRR is a clinical parameter which is an important factor for determining the prognosis and survival rate of teeth experiencing alveolar bone support loss.

Volumen and de Dientes-Premolares[7] studied twenty-five premolars by using micro-computed tomography (micro CT) in vitro to build 3D models. The long axis and cemento-enamel junction of each tooth were determined and the crown-to-root ratios in terms of length, surface and volume was calculated. The relationship among length, surface area and volume of crown and root as well their ratios were analyzed. An average was obtained to be 0.65mm which as compared to the current study, lies in the acceptable range. In this study the teeth were evaluated on the basis of micro CT which has a disadvantage of being expensive as compared to CBCT and due to this reason large data could not be evaluated. The current study uses CBCT which is comparatively easy, cost effective and has low radiation dose.

Hölttä et al[9] conducted a study on the Finish population and the CRR was found to be having mean value of 0.56 to 0.40. The difference between CRR of maxillary and mandibular arch was determined to be significant (less than 0.05) which is also same as the current study. A detailed descriptive statistics was performed for the C/R ratio of males and females and it was found that, second premolars had lowest C/R ratio as compared to first premolar. This data is in accordance with that of other studies along with the current study.

Brin et al[12] conducted a study in which 257 teeth were included and their crown root ratios were determined. Premolars had the lowest CR ratio. The maxillary teeth exhibited a lower C/R ratio than the mandibular teeth. However, for the posterior region, the maxillary teeth had a slightly greater C/R ratio than the mandibular teeth. Stramotas et al[13] calculated the crown root ratios of premolars and it was found that, there is no significant difference between the ratios of the patients included in the study and carried out using panoramic radiograph.

In a study by Wang et al[10], the root crown ratios of premolars were calculated on the basis of panoramic radiographs it was found in the range of 0.55 to 0.45 in the maxillary arch while 0.55 to 0.43 for the mandibular arch. This showed no significant difference between the crown root ratios of the arches. In this study the genders were also compared and it was found that in both the genders the lowest crown to root ratios was of second premolars i.e. 0.40. Gender difference was found to be significant with higher ratio of females i.e. 0.54 as compared to males which was 0.51. In this study ethnic difference was also found to be significant.

In a study by Al-Jamal et al[14] on crown height and root length were determined of 1397 teeth, their CRR were calculated and compared. The CRR of males and females were compared and it was found that there was no significant difference between them. The CRR of first premolars was found to be 0.524 with standard deviation of 0.074 and the CRR of second premolars was found to be 0.517 with standard deviation of 0.086 respectively.

In another study by Haghanifar et al[8] calculated the crown root ratios in Iranian population through panoramic radiographs. This study showed that the mean crown root ratio of premolars was considerably higher in females than in males as compared to the current study done on Peshawar population in which there is no significant difference in C/R ratio among male and females.

Othman et al[15] reported the mean C/R of individual teeth in males was in the range of 0.61 to 0.38 while in females it was in the range of 0.63 to 0.38 and it was in the range of ideal to acceptable crown root ratio. In present study, which was done on Peshawar population the C/R ratios of premolars are also mostly in the ideal and acceptable C/R range so it is in accordance to the Malay study. Furthermore, in Malay study the C/R ratios of the genders, arches and quadrants were compared and there was no significant difference found which is in accordance to that of the current study.

CONCLUSION

Most frequently the premolars have Crown Root Ratio within the ideal and acceptable range. There is significant difference of Crown Root Ratio between the premolars of maxilla and mandible and the right and left quadrants of both arches, whereas, there is no significant difference of CRR of premolars among both genders.

REFERENCES

1. Novak KF. Determination of prognosis in Carranza's clinical periodontology. In: Newman MG, Takei H, Klokkevold PR, Carranza FA, eds. St. Louis: CV Mosby, 2014; 373-83.
2. Raslan M, Osman E, Segaan LG, Rayyan MM. Correlation between crown root ratio and periotest values in healthy single rooted teeth. Dent J 2015; 61(2321): 2327.
3. Yun HJ, Jeong JS, Pang NS, Kwon IK, Jung BY. Radiographic assessment of clinical root-crown ratios of permanent teeth in a healthy Korean population. J Advan Prosthod 2014; 6(3): 171-6.
4. Bulut DG, Kose E, Ozcan G, Sekerci AE, Canger EM, Sisman Y. Evaluation of root morphology and root canal configuration of premolars in the Turkish individuals using cone beam computed tomography. Eur J Dent 2015; 9(4): 551.
5. Tian YL, Liu F, Sun HJ, Lv P, Cao YM, Yu M, Yue Y. Alveolar bone thickness around maxillary central incisors of different inclination assessed with cone-beam computed tomography. Korean J Orthodont 2015; 45(5): 245-52.
6. Choi SH, Kim JS, Kim CS, Yu HS, Hwang CJ. Cone-beam computed tomography for the assessment of root–crown ratios of the maxillary and mandibular incisors in a Korean population. Korean J Orthodont 2017; 47(1): 39-49.
7. Volumen S, de Dientes-Premolares UEP. Crown-to-root ratios in terms of length, surface area and volume: A pilot study of premolars. Int J Morphol 2016; 34(2): 465-70.
8. Haghanifar S, Moudi E, Abbasi S, Bijani A, Mir APB, Ghasemi N. Root-crown ratio in permanent dentition using panoramic radiography in a selected Iranian population. J Dent 2014; 15(4), 173.
9. Hölttä P, Nyström M, Evälahti M, Alaluusua S. (2004). Root–crown ratios of permanent teeth in a healthy Finnish population assessed from panoramic radiographs. Eur J Orthodont 2004; 26(5): 491-7.
10. Wang J, Rousso C, Christensen BI, Li P, Kau CH, MacDougall M, Lamani E. Ethnic differences in the root to crown ratios of the permanent dentition. Orthodont Craniofac Res 2019;22(2):99-104.
11. American Dental Association Council on Scientific Affairs. The use of cone-beam computed tomography in dentistry: an advisory statement from the American Dental Association Council on Scientific Affairs. J Am Dent Asssoc 2012; 143(8): 899-902.
12. Brin I, Ben-Bassat, Einy S, Koyoumdjisky-Kaye E. Premature extractions of primary molars and the crown/root ratio of their permanent successors. ASDC J Dent Child 1991; 58(5):409-12.
13. Stramotas S, Geenty JP, Darendeliler MA, Byloff F. The reliability of crow-root ratio, linear and angular measurements on panoramic radiographs. Clin Orthodont Res 2000; 3(4): 182-91.
14. Al-Jamal GA, Hazza AM, Rawashdeh MR. Crown-root ratio of permanent teeth in cleft lip and palate patients. Angle Orthod 2010; 80(6): 1122-8.
15. Othman AA. Kihel M, Amara S. 1,3,4-thiadiazole and 1,2,4- triazole derivatives as potential antibacterial agents. Arabian J Chem 2014.