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Orginal Article

ASCERTAINMENT OF MAXILLARY BICUSPID ROOT AND ROOT CANAL MORPHOLOGY USING CONE BEAM COMPUTED TOMOGRAPHY, AMONG PATIENTS OF KHYBER PAKHTUNKHWA

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ABSTRACT

Objectives: *To determine the most common root canal configuration in maxillary first bicuspid (MFB) teeth using Vertucci's classification among patients visiting a tertiary care hospital.*

Materials and Methods: *This descriptive cross-sectional study was conducted from August 2023 to August 2024. CBCT images were obtained from the radiology department using a SCANORA 3DX scanner, with a 50x50 mm field of view and 200 µm resolution. Patients aged 12–40 years who met the inclusion criteria were enrolled. Data analysis was performed using SPSS version 22. Chi-square or Fisher's exact test was applied to assess statistical differences in Vertucci canal types between genders.*

Results: *A total of 246 patients were evaluated with a male-to-female ratio of 1:1.2 and a mean age of 28.02 ± 11.63 years. The prevalence of two-rooted MFBs was 54.3% on the left side and 59.9% on the right. Vertucci's Type IV canal configuration was the most common, observed in 72.2% of cases on both sides of the arch. The association between canal configuration and gender was statistically non-significant (p = 1.000).*

Conclusion: *Maxillary first bicuspids demonstrated bilateral symmetry in root number, with Vertucci's Type IV being the most prevalent canal configuration in both male and female patients.*

Key words: *Vertucci, Maxillary, Premolar, Roots, Canal*

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INTRODUCTION

The Vertucci classification is the most popular, straightforward, and reproducible categorization utilized to understand better roots and root canal anatomy and deviations that cannot be explained elsewhere[1,2].

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When this reproducible classification is paired with three-dimensional CBCT or CBVT imaging, the understanding and knowledge of changes in pulp canal architecture and surrounding structures improves even further[3,4]. A CBCT provides precise imaging with minimal radiation exposure and non-invasive assessment[5] allowing for the creation of detailed three-dimensional images of root canal morphology[6]. These modern imaging techniques improve diagnostic capacity in dentistry, allowing practitioners to comprehend better and identify oral disorders, resulting in improved treatment planning and prognosis[1,7,8].

Undergraduate and postgraduate students

and physicians require a deeper understanding of tooth morphology and structure[2]. Thus, both of the procedures as mentioned earlier, when paired with increased knowledge of changes in root canal morphology, will result in a satisfactory treatment outcome[9].

Maxillary first bicuspids (MFB) are an example of a tooth having a wide range of pulp canals and root numbers[3,4]. Understanding the anatomy of this tooth can be difficult, particularly because its roots are bifurcated, which has a substantial impact on pulp canal morphology[10].

Many studies on Maxillary first bicuspid configuration showed the predominance of two canals (51.3%) rather than one or three canals (29.3%)[7]. On the other hand several studies found a higher frequency of single-root canals (56,1%) than two or three-canals (21.2%)[8,9]. Other studies also derived sexual dimorphism in the variation of canal configuration of maxillary first premolar teeth in both arches[9,11].

Over the years, such wide-range variations in root canal configurations have been identified and resulted in the proposal of numerous classification systems and their modifications[1]. The clinical classification was given for the first time by studying root canal configuration in the mesiobuccal root of maxillary first molar by Weine FS et al. It was further elaborated by Vertucci's FJ in 1984 by including configurations also for three canals[12]. It is one of the most commonly used classifications in most of the studies. According to Vertucci's classification, root canals may exit apically through one or more than one apical foramen, depending upon the configuration[8,9].

The goal of this study was to determine the Vertucci's canal classification in Maxillary First Bicuspid (MFB) teeth, on both sides of the dental arch using three dimensional CBCT views, in patients visiting a tertiary care hospital in Khyber Pakhtunkhwa.

This study also demonstrated the applicability and feasibility of Vertucci's classification system in maxillary first bicuspids using a three-dimensional CBCT view in the population of KPK.

The purpose of this study was to encourage Vertucci's classification at both the undergraduate and postgraduate levels to help students better comprehend the variance that influences the maxillary first bicuspid teeth.

MATERIALS AND METHODS

This descriptive study was conducted for one year (August 2023- August 2024), after the ethical approval from the Board of Advanced Studies and Research, (No.GU/2023/BASR/127) Sardar Begum Dental College Peshawar. All CBCT images were obtained from SBDC's Radiology department using a SCANORA 3DX scanner (Scanora 3DX, Soredex, Finland) once the patient met the exclusion criteria (already obturated tooth, chronic periapical granuloma, inflammatory cysts, pulp polyp, root caries, resorptions, calcifications/denticles) and inclusion criteria, which included an age limit of 12–40 years. For every image, the field of view (FOV) was 50x50 mm with a resolution mode of 200 µm, operational conditions of 90KVp/ 12.5mA current and a scanning time of 4.9 seconds. The voxel size of the Flat panel a-Si detector was 0.5mm. After being converted to DICOM format, the obtained data was exported into On Demand Cyber MEd's 3D application software to be analyzed and measured. The non-probability/ convenient sampling technique with an expected prevalence for the variations in the number of canals recorded in MFB teeth was 0.18[10] with a level of confidence of 95%, and a margin of error of 0.05, the sample size calculated was 246.

Using the software indicated above, the image of each tooth was cut in axial, coronal and sagittal planes to determine the number and topographic categorization of canals and apical foramen. The number of root canals was determined with an axial view. The apical foramen ending, bifurcation and canal variation in mesiobuccal and palatal canal were evaluated with coronal and sagittal views. The adjacent tooth, the cortical bone, and the lamina dura were removed in the following stage, leaving only the affected tooth. To increase the validity of the morphometric measurements, two external validities were included from Khyber College of Dentistry and Bacha Khan Dental College. Descriptive statistics was used to derive frequency, percentage and mean/standard deviation for all variables. Data was analyzed with the help of SPSS version 22. Fisher exact test was used to determine if there's a statistically significant difference in the prevalence of Vertucci types between male and female patients

with maxillary first premolars.

RESULT

Cone Beam Computed Tomography (CBCT) scans were analyzed to determine the root canal configuration of maxillary first bicuspids (MFB) using Vertucci's classification on both the right and left sides of the arch. A total of 246 patients were included, with a male-to-female ratio of 1:1.2 and a mean age of 28.02 ± 11.63 years (Table 1).

Among the scanned teeth, 53.6% were right-sided MFBs, while 46.4% were left-sided. Most MFBs exhibited two roots—59.9% on the right side and 54.3% on the left—followed by single-rooted teeth (38.6% right, 40.3% left). The prevalence of two-rooted MFBs was slightly higher in males (30.4% right, 28.9% left) compared to females (29.5% right, 25.4% left).

Regarding canal configurations, the most frequent type was Vertucci's Type IV, observed in 36% of cases on both the right and left sides. Type V was the next most common, found in 7.3% of right-sided and 4.05% of left-sided MFBs. Rare configurations included Type VI (0.4%) and Type VII (2.43%).

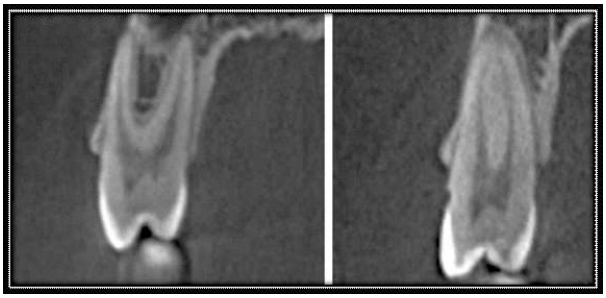

Fig 1: Maxillary first bicuspid coronal image obtained with CBCT. (A) First premolar with two roots, two canals and Vertucci's type IV classification (B) First premolar with one root, two canals and type II Vertucci's classification.

Gender-wise comparison of canal types showed a higher occurrence of two-canal configurations in males (right: 19.5%, left: 20.2%) than in females (right: 13.4%, left: 19.2%). However, statistical analysis using Fisher's Exact test revealed no significant association between gender and Vertucci canal type (p = 1.000) (Table 2).

Figure 1 presents a representative CBCT coronal image highlighting the number and morphology of root canals in maxillary bicuspids.

DISCUSSION

In the current study, a CBCT view of 0.5mm was also used to determine the most common canal configuration with the application of Vertucci's Classification for right and left sided MFB among both genders.

The mean age group for both genders was 28.02 ±11.63, which was the appropriate age to overcome the complications of pulp ageing like pulp stones and diffuse calcifications[12].

The study by Erkan et al[13] on the Turkish population examined 1438 teeth. There were 604 (42%) male teeth and 834 (58%) female teeth with M: F ratio of 2:1 aged 13 to 81 years. In line with the current investigation, substantially more women than men ($p<0.05$) did not correspond with our study. The ratio is contradictory as the sample size in Erkan's study 15 was much larger than ours. However, in the studies of Haider et al[14] and Alqedairi et al[15] the ratio was equal, similar to the present study.

In contrast to the study of Martins 16 the mean age group documented was 49.9±14.4 years for

Table 1: Gender and Age-wise Frequency Distribution of MFB

Age-Distribution of patient	The gender of the patient (n/%)		Total	
Right-side First Premolar	Male	Female		
10-20 years	9, 7.5%	14, 10.8%	23,9.23%	
21-30 years	44, 36.7%	47, 36.4%	91,36.5%	132, 53.6%
31-40 years	10, 8.3%	11, 8.5%	21,8.43%	
Left-side First Premolar				
10-20 years	7, 5.8%	10, 7.7%	17,6.82%	
21-30 years	36, 30%	31, 28.6%	73,29.3%	114, 46.4%
31-40 years	14, 11.6%	10, 7.7%	24,9.63%	
Total	120, 48.7%	126.51.3%	246. 100%	

Note: MFB. Maxillary First Bicuspid

females and 51.7±13.1 years for males. Although extreme pulp ageing might affect the canal configuration, this was the main reason to include the age group of 12-40 years in the existing study.

Vertucci's classification for the canal configuration was found to be non-significant among both genders in this study. This is in contrast to the findings of Asheghi et al[17] where they concluded the significant differences among both genders for Vertucci canal configuration. However, they conducted their study using a two-dimensional view rather than a three-dimensional CBCT view. The majority of premolars in the current study had two roots, followed by one root, according to the frequency distribution of the number of roots. Similar results were obtained in the research conducted by Asheghi et al[17] and Nazeer et al[18] Alqedairi et al[15]. They have reported a percentage of two-rooted maxillary premolars (range: 37.8%–75.1%) also congruent with the findings in the current study (32-66%). In contrast to 25.71% of single-rooted premolars, Karobari et al[19] observed that the incidence of the two-rooted maxillary first premolar was 73.41%. Thus, the facts and figures of the above studies were coherent to our study. Alternatively, the studies by Mashyakhy[20] on their populations have reported three-rooted first premolars (range: 0.9%–2.6%) when compared to 1.21% with our population, which might show ethnic differences. Similarly, several other studies[2,6,8] have reported three-rooted first premolars (range: 0.4%–3%) often similar to our findings. Gunduz[21] computed the number of canals in maxillary first premolars, which is consistent with the findings of our investigation. It was discovered that there were three canals (1.2-9.25%), two canals (85-96%) and one canal (2.1-17.7%). Similar to our analysis Yoza et al[22] other studies[2,11] included intriguing facts. They found that 94% of cases had two canals in maxillary first premolars. Nonetheless, Saber et al[23] investigations in the Spanish population revealed no statistically significant association between the number of canals and gender that contradicts with present study. Again, this fact can be correlated to ethnic variation for the number of roots worldwide. In maxillary first premolars of Saudi patients by Zubaidi et al[4] 88.5% of the right and left symmetry

Table 2: Frequency of root numbers, canal count, and Vertucci's canal configuration in MFB teeth on right and left sides of the Arch.

Classification of PM1	Right PM1		Total	Left PM1		Total
	Men	Women		Men	Women	
1 No of Roots						
One Root	23, 17.4%	28, 21.2%	38.6%	21, 18.4%	25, 21.9%	40.3%
Two Roots	40, 30.4%	39, 29.5%	59.9%	33, 28.9%	29, 25.4%	54.3%
Three Roots	2, 1.1%	1, 0.75%	1.85%	1, 0.87%	0	0.87%
Total	**132, 100%**			**114, 100%**		
2 No of Canals						
1 Canal	19, 7.72%	13, 5.28%	13%	18, 7.31%	10, 4.1%	11.41%
2 Canal	33, 19.5%	48, 13.4%	32.9%	32, 20.2%	50, 19.2%	33.3%
3 Canal	13, 5.28%	3, 1.21%	6.49%	1, 0.41%	0	0.41%
4 Canal	2, 0.81%	1, 0.46%	1.27%	1, 0.40%	2, 0.81%	1.21%
Total	**132, 100%**			**114, 100%**		
3 Vertucci's Type						
Type I	1, 0.40%	2, 0.81%	1.2%	1, 0.40%	2, 0.81%	1.21%
Type II	4, 1.62%	3, 1.21%	2.83%	4, 1.62%	3, 1.21%	2.83%
Type III	3, 1.21%	5, 2.03%	3.24%	2, 0.81%	2, 0.81%	1.62%
Type IV	44, 17.8%	45,18.2%	36%	45, 18.2%	45, 18.2%	36%
Type V	9, 3.65%	9, 3.65%	7.3%	4, 1.62%	6, 2.43%	4.05%
Type VI	1, 0.40%	0	0.40%	0	0	0
Type VII	2, 0.81%	4, 1.62%	2.43%	0	0	0
Total	**132, 100%**		**1.000 2.279/ df=2**	**114, 100%**		**1.000 2.226/ df=2**

PM1 – premolar 1, significant value < 0.05; Fisher Exact test

was seen in the number of roots, and 77% in the canal pattern. These facts correlate well with the current study. The several Vertucci kinds seen in the canal configuration of maxillary first premolars were filed by Nazeer et al[18]. Vertucci's Type IV was present in over two-thirds (73.5%) of their population, almost similar to the current study. Additionally, they noted that the left side had a higher concentration of Vertucci Types III, IV, and V than the right showing arch asymmetry. This contrasts our study with no discernible difference between the arches' sides. The findings in the study of Zubaidai[4] were also similar. Olczak et al[23] found Type I accounted for 60.4% and Type IV made up 12.8%, in maxillary first premolar. This observation was dissimilar to the current study. This wide variation can be suggested due to ethnic and regional inequality regarding the canal configuration.

The Vertucci type distribution showed no statistical significance across gender or arch sides, but this is somewhat expected given small frequencies for rarer types. However, this do represent the limitation of the present study. It is thus recommended to conduct research for the distribution of these rare vertucci's types in MFB teeth, using CBCT in population of KPK to derive ethnic and regional variation.

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CONFLICT OF INTEREST
Authors declare no conflict of interest.
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AUTHORS' CONTRIBUTION

The following authors have made substantial contributions to the manuscript as under:

Conception or Design:	MA, A, NN, MN, NM G
Acquisition, Analysis or Interpretation of Data:	MA, A, NN, MN, NM G
Manuscript Writing & Approval:	MA, A, NN, MN, NM G

All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.