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A Cone Beam Computed Tomography study on the prevalence of typical aberrant canal morphology in the mandibular premolars of a Malaysian sub population

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Abstract

Background: The aim of this study was to evaluate the presence of Vertucci type V root canal morphology in mandibular premolars of a selected Malaysian subpopulation. **Materials and Methods**: Randomly selected full-size cone-beam computed tomographic images were collected from 810 patients (Gender: 41.9% male and 58.1% female, Ethnicity:19.3% Malay, 59% Chinese and 22.7% Indian). The prevalence of mandibular premolars with Vertucci type V morphology was assessed based on gender and different ethnic groups and statistical analysis was done using SPSS version 12.0 software using the chi-square tests, Odds ratio and its 95% confidence interval were calculated. All the statistical tests were two sided, and the level of significance was set at 0.05. **Results**: Among 810 patients, 26.5% had Vertucci type V root canal morphology. 18.3% of mandibular 1st premolar and 9.8% of mandibular 2nd premolar had Vertucci type V root canal morphology. On assessing the association between gender, ethnicity and Vertucci type V root canal morphology in the mandibular premolars, it was seen that in the mandibular 1st premolar, the odds of having vertucci type V root canal morphology were significantly higher in Chinese compared to Malay, odds ratio 1.85 (95% CI 1.09, 3.14) with P value 0.021.In mandibular 2nd premolar, the odds of having vertucci type V root canal was significantly lower in male than in female, odds ratio 0.58 (0.35, 0.94) with P value 0.027.**Conclusions**: This

cone-beam computed tomographic study showed an overall prevalence of 26.5% of Vertucci Type V morphology in mandibular first and second premolars in the Malaysian subpopulation.

Keywords: Cone beam computed tomography (CBCT), Vertucci Type V, Mandibular premolars, root canal morphology.

Introduction:

The complex and intricate nature of the root canal has been extensively researched and documented[1,2]. A definite comprehension of the morphology is important for clinicians to locate and identify all the canals to efficiently clean, shape, and obturate the canal space in three dimensions[3].

Mandibular premolars have long been associated with complex anatomical aberrations, making them one of the most arduous teeth to manage endodontically, especially when present with multiple roots or canals[4]. The narrow accessibility to canals, inconspicuous nature and apical third variations are factors that further test the clinicians skill[3].

Recent imaging techniques have delivered a finer perception of the mandibular premolar anatomy and their variations. Intraoral and panoramic imaging only provide a two-dimensional view missing significant three-dimensional findings, which could lead to canals that are non-negotiated. Currently, micro–computed tomographic (micro CT) imaging has been used extensively for anatomic studies, enabling non-invasive assessment of the root canals 3-dimensionally[5,6,7]. However, these studies are invitro analysis, time-consuming, and the results were based mainly on relatively small sample sizes. Cone-beam computed tomographic (CBCT) imaging has been proved to be a useful tool for the assessment of variations in tooth morphology. CBCT provides images in the axial, sagittal, and cross-sectional planes, in addition, panoramic images and three-dimensional reconstructions are also available[8]. Furthermore, ethnic variability, sex and origin of patients can be taken into consideration in investigations in vivo, as they are recorded in the medical history, and other pre-existing data are also available. The data availed from CBCT scans can be benefited for morphologic evaluations of the root canal and classifications[9].

The most common representation of mandibular premolars is a single root and a single canal. and studies have concluded that canal configurations may vary significantly with respect to ethnicity, race, and sex.[10.11.12] However, in the last decade, many case reports have been published where mandibular premolar post-treatment flareups have increased and one of the prime aetiologies for the same was the presence of Vertucci Type V canal which the clinician was not aware of or neglected.[13] Literature search reveals, only one study by Pan et al. [14] has been done regarding the root canal morphology of the permanent teeth in Malaysian population. Therefore, the rationale for conducting this study is to perceive the prevalence of vertucci type V canal morphology in mandibular premolars and its association with gender and ethnic variations, in patients reporting to Melaka Manipal Medical College, Melaka, Malaysia.

Materials and methods:

This study was approved by the Institutional Ethical Review Board of Melaka-Manipal Medical College and ethical clearance was obtained. The sample size calculation was done with the Cochran's formula, and the recommended sample size was 809 with 95% confidence interval and 2.5% precision. Thus, a total of 810 full-size scans showing the entire length of the mandible, including all the root apices were retrospectively selected and analysed. The CBCT scans were acquired using Planmeca

Promax 3Ds (Helsinki, Finland) with a field of volume of 484 x 484 x 404 mm and a voxel size 200 µm. The radiographs were accessed from the archives of Oral Medicine and Oral Radiology Department, Melaka-Manipal Medical College, Melaka and were evaluated for a period from June 2014 to July 2019. The radiographs were viewed using Romexis software (Version 3.0.1 R). The study included the CBCT scans of Malaysian male and female patients having bilateral fully erupted permanent mandibular premolars with completely formed roots. Mandibular premolars which were root canal treated, fractured, heavily restored, having post endodontic restoration and artefacts in the images were excluded. (Figure 1,2,3)

All data were innominate. The data regarding the origin of the patients, ethnicity, and sex at the time of radiation exposure were known to ensure that all the patients were of Malaysian origin. The root canal anatomy of the mandibular premolars was assessed using the multiplanar reconstruction view which includes axial, coronal, and sagittal plane.

Two trained specialists evaluated the sample simultaneously and separately to achieve conformity. Inter-observer reliability test was carried out using Cohen's Kappa test. A final consensus was reached when the inter-rater agreement Kappa value was found to be within the substantial agreement (0.81–099). The prevalence of mandibular premolars with Vertucci type V morphology was assessed based on gender and different ethnic groups in the Malaysian subpopulation.

Statistical analysis

For data analysis, SPSS version 12.0 (SPSS Inc., Chicago, IL, USA) was used. For quantitative variables, mean and standard deviation (SD) were calculated and for categorical variables, frequency, and percentage were described. Chi-square test was used to determine association between gender, ethnicity and vertucci type V root canal morphology in the mandibular first and second premolars. Odds ratio and its 95% confidence interval were calculated. All the statistical tests were two-sided, and the level of significance was set at 0.05.

Results

The demographic characteristics of the patients attending clinic is shown in the **table1**. Among the patients, 41.9% were male and 58.1% were female. 19.3% of the patients were Malay while 59% were Chinese and 22.7% were Indian

Table 1: Demographic characteristics of the patients attending clinic (n = 810)

Variable	n (%)
Gender	
Male	362 (44.7)
Female	448 (55.3)
Ethnicity	
Malay	156 (19.3)
Chinese	470 (58.0)
Indian	184 (22.7)

Table 2 shows the prevalence of vertucci type V root canal morphology in the mandibular 1st and 2nd premolars. Among total patients of 810, 26.5% had vertucci type V root canal morphology. 18.3% of mandibular 1st premolar and 9.8% of mandibular 2nd premolar had vertucci type V root canal morphology. 85.11% of the patients had a unilateral prevalence and 16.2% patients showed a bilateral prevalence of Vertucci type V canal morphology.

Table 2: Prevalence of vertucci type V root canal morphology in the mandibular premolars of the patients attending clinic (n = 810)

Variable	n (%)
Mandibular premolars	
Present	215 (26.5)
Unilateral	183(85.11)
Bilateral	32(16.27)
Mandibular 1st premolar	
Present	148 (18.3)
Mandibular 2nd premolar	
Present	79 (9.8%)

Table 3 shows the association between gender, ethnicity and vertucci type V root canal morphology. Odds of having vertucci type V root canal morphology were lower in male than in female, odds ratio 0.73 (95% CI 0.54, 1.0) with P value 0.050 which was not significant. There was no significant association between ethnicity and vertucci type V root canal morphology. When compared to Malay, the odds of having vertucci type V root canal morphology were lower in Chinese, odds ratio 0.95 (95% CI 0.58, 1.56) with P value 0.833. However, odds of having vertucci type V root canal morphology was 1.45 times higher in Indian than Malay (95% CI 0.84, 2.53) with P value 0.182.

Table 3: The association between gender, ethnicity and vertucci type V root canal morphology in the mandibular premolars

Variable	Vertucci type V root canal morphology		OR (95% CI)	P value
	Present n (%)	Absent n (%)		
Gender				
Female	138 (30.8)	310 (69.2	Reference	
Male	89 (24.6)	273 (75.4)	0.73 (0.54, 1.0)	0.050
Ethnicity				
Malay	25 (16.0)	131 (84.0)	Reference	
Chinese	72 (15.3)	398 (84.7)	0.95 (0.58, 1.56)	0.833
Indian	40 (21.7)	144 (78.3)	1.46 (0.84, 2.53)	0.182

OR = Odds ratio; 95% CI = 95% confidence interval; P value <0.05 is significant.

Table 4 shows the association between gender, ethnicity and vertucci type V root canal morphology in the mandibular 1st and 2nd premolars. In mandibular 1st premolar, the odds of having vertucci type V root canal morphology was lower in male than in female, odds ratio 0.90 (95% CI 0.63, 1.29), but it was not significant (P value 0.565). Moreover, the odds of having vertucci type V root canal morphology were significantly higher in Chinese compared to Malay, odds ratio 1.85 (95% CI 1.09, 3.14) with P value 0.021. Similarly, the odds of having vertucci type V root canal morphology were 1.58 times higher in Indian than in Malay (Odds ratio 1.58; 95% CI 0.86, 2.90) but it was not significant (P value 0.142). In mandibular 2nd premolar, the odds of having vertucci type V root canal morphology was significantly lower in male than in female, odds ratio 0.58 (0.35, 0.94) with P value 0.027. The odds of having vertucci type V root canal morphology was significantly higher in Chinese compared to Malay, odds ratio 4.08 (1.73, 9.62) with P value <0.001. But in Indians, the odds of having vertucci type V root canal morphology were lower than Malay (Odds ratio 0.99; 95% CI 0.32, 3.01) and it was not significant (P value 0.984).

Table 4: The association between gender, ethnicity and vertucci type V root canal morphology in the mandibular 1st and 2nd premolars

Variable	Vertucci type V root canal morphology		OR (95% CI)	P value
	Present n (%)	Absent n (%)		
Mandibular 1st premolar				
Gender				
Female	85 (19.0)	363 (81.0)	Reference	
Male	63 (17.4)	299 (82.6)	0.90 (0.63, 1.29)	0.565
Ethnicity				
Malay	19 (12.2)	137 (87.8)	Reference	
Chinese	96 (20.4)	374 (79.6)	1.85 (1.09, 3.14)	0.021
Indian	33 (17.9)	151 (82.1)	1.58 (0.86, 2.90)	0.142
Mandibular 2nd premolar				
Gender				
Female	53 (11.8)	395 (88.2)	Reference	
Male	26 (7.2)	336 (92.8)	0.58 (0.35, 0.94)	0.027
Ethnicity				
Malay	6 (3.9)	150 (96.1)	Reference	
Chinese	66 (14.0)	404 (86.0)	4.08 (1.73, 9.62)	<0.001
Indian	7 (3.8)	177 (96.2)	0.99 (0.32, 3.01)	0.984

OR = Odds ratio; 95% CI = 95% confidence interval; P value <0.05 is significant.

Discussion

The knowledge of the variations in root canal anatomy, proper evaluation of root and canal anatomy and the skill of adequate cleaning, shaping and obturation is important for a successful treatment.

Hess and Zurcher made the first initiative to document the internal and external complexities of the root canal anatomy[1] followed by Weine et al and Vertucci et al [1, 15.] Recently, Ahmed et al introduced a new classification on root canal morphology that could be reliable, accurate and simple for research and clinical practice [16]. However, the present study employs the Vertucci's classification as it is widely used and accepted by authors in the literature and textbooks despite the recent modifications[17]. Based on previous morphologic studies Vertucci Type V canal being the second most common canal pattern was chosen for the study[3].

The present study investigated the prevalence of Vertucci type V root canal morphology of mandibular premolars in a Malaysian sub population. 810 patients were evaluated using CBCT scan images and results of the study revealed an overall prevalence of 26.5 % of Vertucci type V root canal morphology in the mandibular premolars which was well in accordance with study by Vertucci which was found to be 26% in mandibular premolars.[15]

Previous in vitro morphological studies have been done using clearing techniques, sectioning, and radiographic methods. Micro-CT imaging techniques used for Invitro evaluations of root canal anatomy offers higher resolution and more details concerning accessory root canals and

smallest isthmic structure[18]. However, these Invitro testing techniques are not enshroud by surrounding structures, aiding in generation of more accurate images. Hence most of these methods, cannot be applicable to clinical circumstances.

In the present study, Cone Beam Computerized tomography (CBCT) was used to evaluate the root canal anatomy as it produces a three-dimensional image which is not obscured or superimposed by the surrounding structures. The major advantage of CBCT is that it can be used clinically with considerably low radiation as possible[8]. Also, the sample preservation and three-dimensional data acquisition of multiple teeth using CBCT helps in overcoming the short comings related to the Invitro studies. Neelakantan et al[12] compared the accuracy of several morphological assessment techniques and reported that CBCT and peripheral quantitative CT are more accurate in identifying root canal systems compared to other techniques.

The Present study reported that 18.3% of the patients had at least one mandibular 1st premolar with Vertucci type V root canal morphology in Malaysian sub population. These results were in concordance with the previous studies done on Egyptian population (16.4%), Japanese's population (15.2%) and Indian population (17.39%) respectively. However, similar studies done on Iranian population (28.8%) and American population (24%) has shown a much higher prevalence in comparison to the current study [2,3,19,20,21].

Furthermore, current research revealed that 9.8% of the patients had at least one mandibular second premolar with Vertucci type V root canal morphology. In contrary to previous studies done on Iranian population (22%) and Indian population (17.5%) showed a higher prevalence. Previous studies done on Polish population (2.5%) and Chinese population (1.69%) revealed lesser prevalence in mandibular second premolars comparatively[22,23,24,25].

The present study evaluated Vertucci type V root canal morphology in Malaysian population and found that higher incidence of Type V pattern in mandibular 1st premolar (18.3%) compared to mandibular second premolars (9.8%). The results of the present study were in accordance with the previous epidemiological studies which also reported maximum variation in mandibular first premolars. Similar results were observed in a study by Pan et al done on Malaysian population which also reported higher prevalence of type V canal pattern in mandibular first premolar (15.6%) compared to mandibular second premolars (0%)[14].

Although the results comparing mandibular first and second premolar were in accordance with the previous study by Pan et al[14], higher Incidence of Type V canal pattern in mandibular second premolar was observed in the present study, this may be related to the larger sample size which allowed for a more accurate comparison of values and a smaller margin of error.

There is limited information in literature regarding the influence of gender/ethnicity on root/canal anatomy. However, few studies, showed the females having a higher predilection of two canals in mandibular first premolars, whereas in mandibular second premolars males showed higher likelihood of extra canals [26,27]. Sert and Bayrili [28] reported higher incidence of two or more canals in females compared to males. However, other studies disregarded the same[28]. Although the results of the present study suggested higher prevalence of type V canal pattern in females than in males but there was no statistical significance present between the genders.

In the current research on studying the association between gender, ethnicity and Vertucci type V root canal morphology in the mandibular 1st premolars, it was observed that Vertucci type V root canal morphology was significantly higher in Chinese compared to Malay and Indian patients. In mandibular 2nd premolar, the presence of Vertucci type V root canal morphology was significantly lower in male than in female and significantly higher in Chinese compared to Malay and Indian patients.

Since, the association of gender and ethnicity with the prevalence has been studied, the number of patients has been studied rather than the number of teeth, this may relate to a higher prevalence compared to the previous studies[3]. Trope et al[11], Sabala et al[29], and Amos et al[30] also reported morphologic variations based on number patients than number of teeth as these variations are not typically bilateral in 100% of the cases. Also, studies in which number of teeth were taken into consideration reported prevalence values higher than normal which cannot signify the relative incidence of variation within the population[31].

A thorough comprehension of the morphological complexities of human teeth is important for an increased treatment outcome. A detailed preoperative clinical assessment [4] and unforeseen changes in radiographic density of the root canal space, sudden narrowing or a disappearing pulpal radiolucency may give an indication that the canal bifurcates into two parts [29].Additionally, during treatment magnification (dental operatory microscope and ocular loops) and fibre optic illumination facilitate the observation of anatomical landmarks in the pulp chamber floor that may help to identify root canal aberrations[17].

Conclusion

CBCT imaging plays an integral role in clinical diagnostic imaging and delivers compendious information regarding the canal morphology of mandibular premolars. Mandibular first and second premolars in the Malaysian subpopulation have shown an overall prevalence of 26.5% of Vertucci Type V morphology. Therefore, an insight and comprehension of the prevalence of these variations in mandibular premolars during root canal treatment leads to a successful treatment, avoiding undesirable failures.

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Legend Figures

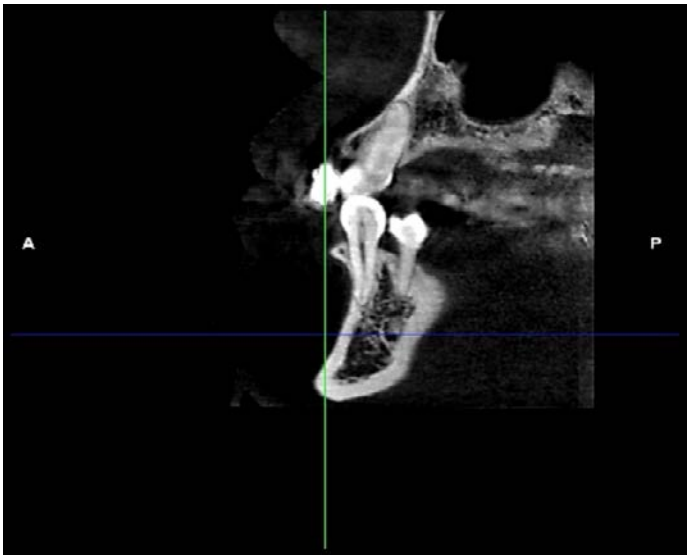

Figure 1:Vertucci Type V Root canal morphology in mandibular premolars-sagittal view

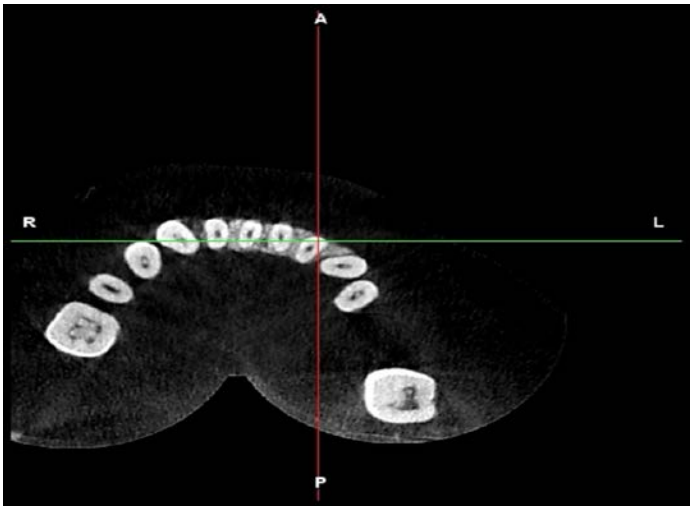

Figure 2: Vertucci Type V Root canal morphology in mandibular premolars-coronal view

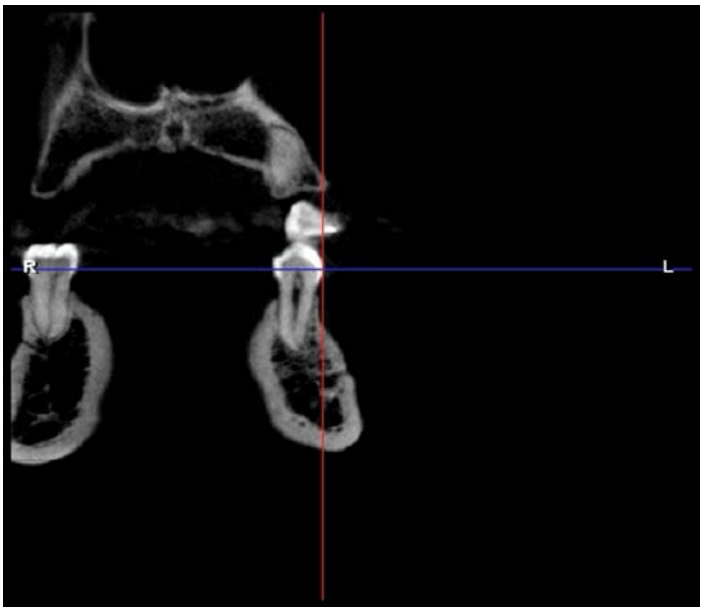

Figure 3: Vertucci Type V Root canal morphology in mandibular premolars-axial view