How to Cite:
Induja, M. P., & Chokkattu, J. J. (2022). Root canal morphology of mandibular premolars: CBCT analysis. *International Journal of Health Sciences*, *6*(S2), 11936–11943. https://doi.org/10.53730/ijhs.v6nS2.8222

Root canal morphology of mandibular premolars: CBCT analysis

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***Abstract*---**The root canal system is complex and the canal may branch, divide and rejoin taking various pathways to the apex.One of the predominant causes of the failure of root canal treatment in mandibular premolars is due to the variations in root canal anatomy. The aim of this study was to survey the root canal morphology of mandibular first and second premolar teeth in a South Indian population using CBCT analysis.The sample included 150 CBCT images comprising mandibular first premolars and second premolars were collected from Saveetha Dental College and Hospitals.The study showed that Type 1(1-1) vertucci classification is seen in most of the mandibular first and second premolars.Within the limits of this study, Type I [1-1] Vertucci's classification is seen in most of the first premolar and second premolars.It can be concluded from the results of this study that mandibular first and second premolar teeth present a wide variety of radicular features, with one root and one canal being found in majority of cases.

***Keywords*---**mandibular premolars, CBCT, vertucci classification, root canal morphology.

Introduction

A proper knowledge of root canal morphology is necessary for successful endodontic treatment(Alfawaz *et al.*, 2019).The root canal system is complex and the canal may branch, divide and rejoin taking various pathways to the apex.Vertucci's established a proper method for differentiating root canal variations into the eight types.The classification has been widely used in several studies(Vertucci, Seelig and Gillis, 1974). As a group, the mandibular premolars

are considered the most difficult teeth to treat endodontically and have high flare ups and high failure rates, as they have a high incidence of multiple roots or canals(Liu *et al.*, 2013).Mandibular premolars may have extra root, not obvious in preoperative radiograph, challenging for shaping, cleaning, and obturation.Furthermore, the incidence, location, and morphology of root canal systems may vary in different ethnic or regional populations(Barakat *et al.*, 2018; Alfawaz *et al.*, 2019).

CBCT is more accurate when compared to digital radiographs in establishing root canal systems, which can also be used in vivo studies for diagnosis and assessment.(Alrahabi and Zafar, 2015; Mathew *et al.*, 2018). There are various methods to recognize root canal morphology such as digital radiographic techniques,radiographic assessment enhanced with contrast media canal staining and tooth clearing, conventional radiograph, cone beam computed tomography (CBCT) techniques and modified canal staining and clearing.Several studies revealed that CBCT is verified as a reliable tool for studying internal anatomy of tooth(Neelakantan *et al.*, 2010).CBCT technique uses a specific beam to fabricate three dimensional images to reveal anatomic details clearly.The main advantages of using CBCT are that it is non-invasive and permits 3-D reconstruction of the root canals(LiyanaHannahBintiIzhamAkmal *et al.*, 2019).CBCT is considered as better than other techniques to understand the root and canal systems(Mathew *et al.*, 2018).Many studies regarding root canal morphology performed using CBCT revealed that the application of CBCT is favourable in recognizing variations in canal configuration. Therefore, the aim of this study is to assess the Root canal morphology of mandibular premolars using CBCT analysis.

Materials and Methods

The sample included 50 CBCT CDs of patients comprising mandibular first premolars and second premolars were collected from Saveetha Dental College and Hospitals.The Number of roots and canals, and canal configuration according to Vertucci's classification were recorded.CBCT Analysis was done using SIRONA, Analysis was done using software SIDEXES. Samples of fully erupted permanent mandibular first and second premolars were included.

Inclusion criteria

The study included only Qualifying mandibular premolars each demonstrated fully developed apices

Exclusion criteria

Root canal fillings, posts and crown restorations were not considered in the study.

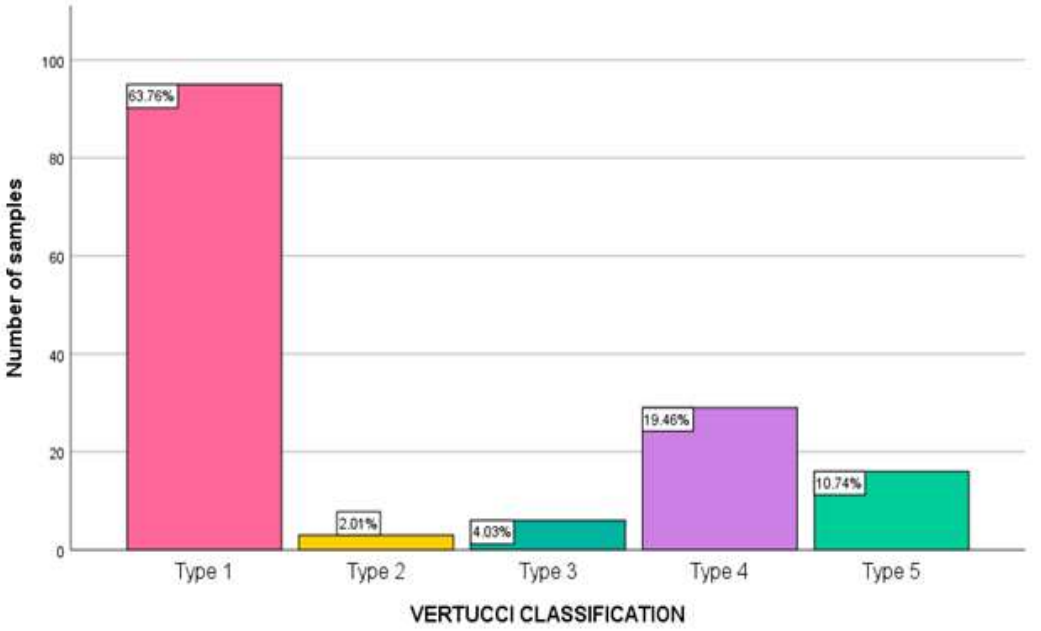
Statistical analysis

Data was recorded in Microsoft excel and later exported to IBM SPSS (version 20.0 Chicago USA) and subjected to Statistical analysis .Chi Square test was then employed with level of significance set at $P<0.05$.The statistical analysis between teeth number and vertucci classification was carried out in SPSS software.Chi

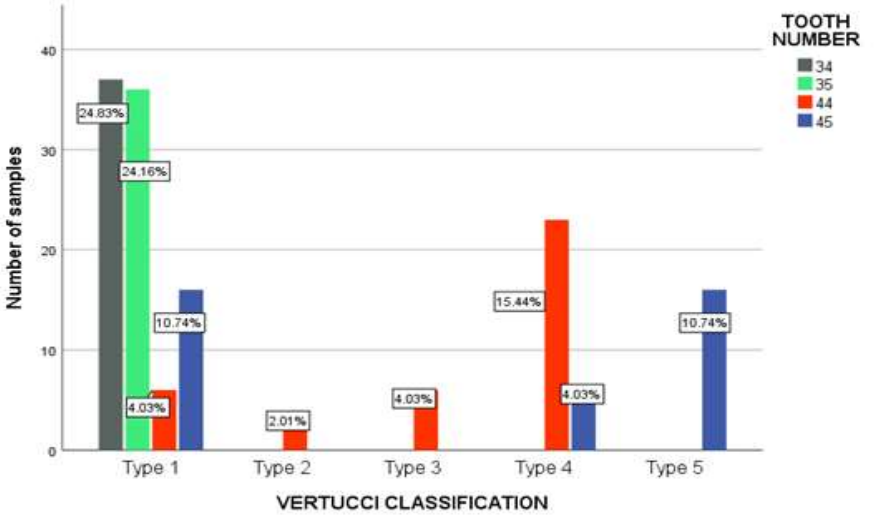
square test was done to compare the parameters. The outcome was represented in a form of tables and bar charts.

Results & Discussion

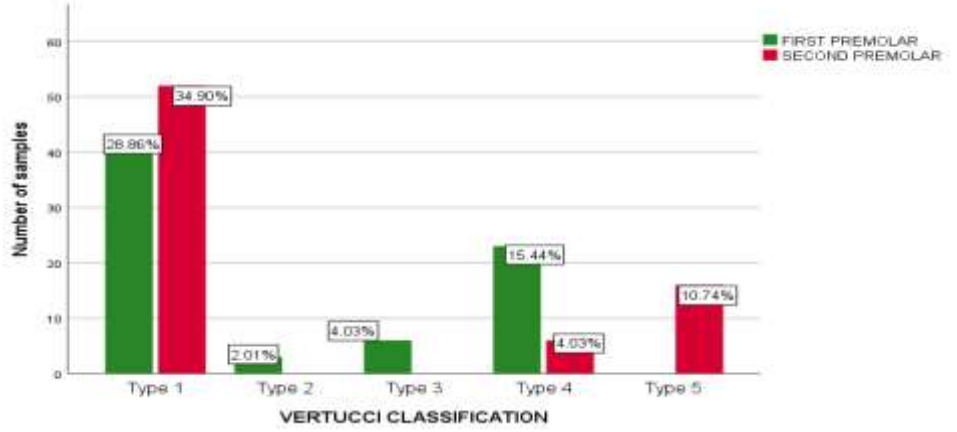
Out of 150 teeth, 63.76%(n=95) of the teeth showed Type 1 vertucci classification, 2.01%(n=3) of the teeth had Type 2 Vertucci's classification,4.03%(n=6) of the teeth had type 3 vertucci classification, 19.46%(n=29) of the teeth had Type 4 Vertucci's classification and 10.74%(n=16) of the teeth had Type 5 vertucci classification as shown in (Graph 1). Association between tooth number and vertucci classification showed that Type I vertucci classification was the most common type in which tooth number 34 was 24.83%, 35 was 24.16% , 44 was 4.03% and 45 was 10.74% as shown in (Graph 2).Pearson Chi square value:151.966,DF:12,p value:0.000(<0.05 which is statistically significant) as shown in (Table 1).



Graph 1 : Bar graph represents the types of Vertucci's classification, where pink , yellow, blue, violet and green colours denote the Type 1,2,3,4 & 5 respectively. X axis represents the types of vertucci classification and Y axis represents the number of samples present.



Graph 2: Bar graph represents the association between the tooth number and vertucci classification,where grey, green, orange and blue colour denotes the tooth number 34,35,44 and 45 respectively. X axis represents the Vertucci's classification and Y axis represents the number of samples of the CBCT images.All types of vertucci classification from type 1 to type 5 were present in mandibular premolars and type I(1-1) was the most common followed by type 4 and type 5.Chi square test (Table 1)was done and association was found to be statistically significant, P value:0.01 (<0.05) hence statistically significant.



Graph 3: Bar graph represents association between mandibular first and second premolars and vertucci classification. X-axis represents Vertucci's classification and Y-axis represents the number of samples. From the results of this graph it is evident that mandibular first premolar (green) had type 1, type 2 , type 3 and type 4 vertucci's root canal configurations whereas mandibular second premolars mostly presented with Vertucci's type 1, type 4 and type 5. The mandibular first premolar (green) mostly had Vertucci's Type 1 (28.86%) configuration followed by Type 4 (15.44%), Type 3 (4.03%) and Type 2 (2.01%). Similarly, Mandibular second premolar(red) had Vertucci's Type 1(34.90%) followed by Type 5 (10.74%)

and Type 4(4.03%). Chi square test (Table 1)was done and association was found to be statistically significant, P value:0.01 (<0.05) hence statistically significant.

	Value	df	Asymptotic Significance (2-sided)
Pearson-ChiSquare	151.966	12	.000
Likelihood ratio	153.681	12	.000
Linear by Linear Association	57.936	1	.000
N valid cases	150		

Table 1: Shows the Chi Square Test for the association between Tooth number and Vertucci's classification. From this table it is evident that Type 1 is seen mostly in 34 and 35, Type 4 is seen mostly in 44 and Type 5 is mostly seen in 45.

This study aiming at finding out the root canal morphology of mandibular premolars using CBCT images.Successful endodontic therapy needs significant knowledge of the anatomic features of the root and root canal system.The CBCT images of the mandibular premolars have been represented in(fig 1,2,3,4).

Figure 1: Type 1(1-1)

Figure 2: Type 2(2-1)

Figure 3: Type 3(2-1-2)

Figure 4:Type 4(2-2)

Figure 5:Type 5(1-2)

Many studies denoted an increased level of endodontic failures due to complexity and diversity of root canal configurations in mandibular premolars.(England, Hartwell and Lance, 1991).The lack of knowledge and missing a root canal are the most common reasons for failure in endodontic treatment.A study conducted by Sepanta Hosseinpour et al, showed that 70.9% were Vertucci's type I, followed by 10.4% type III, 7.18% type IV, 5.23% type II and 5.16% type V in mandibular first premolar and among mandibular second premolars, 82.86% were type I, 6.25 type III, 5.32% type II, 4.27% type IV, and 0.69% type V which was similar to our study.(Hosseinpour *et al.*, 2016).

According to Velmurugan et al, reported that 97.10% of the mandibular first premolar teeth were found to have one root (134 teeth) whereas 2.89% teeth were found to have two roots (4 teeth) (Velmurugan and Sandhya, 2009). In 2007, Rahimi *et al*, in a study on Tabriz population demonstrated the highest prevalence of *type V* (16.9%) between reviewed studies. (Rahimi *et al.*, 2007). Bolhari *et al.* noted that 91.24% of root canals classified as type I in mandibular premolar and the 8.86% were going to other types in Tehran population(Bolhari, Assadian and Fattah, 2013).

A study conducted by Vega-Lizama et al, reported that the most variations in the first mandibular premolar in this Maya population had a C-shaped configuration, had more than one root canal, and were located from the middle to the apical portion of the root.It showed that 54 teeth with one canal were Vertucci´s Type I (Vertucci). Of the 35 cases with two canals, 13 (37.1 %) corresponded to Type III, 19 (54.3 %) to Type V, two cases were Type VII (5.7 %) and one had a 12121 (2.9 %) pattern(Vega-Lizama *et al.*, 2018). The most commonly observed root morphology was the single rooted mandibular first premolars (80%), followed by 2 (18%), and 3 rooted (2%). It is interesting to note the higher prevalence of two rooted mandibular first premolars in Saudi population compared to Egypt (3.2%), Indian (6%) populations(Alhadainy, 2013),(Singh and Pawar, 2014).The study from the Kuwait population reported a high incidence of two rooted teeth (15%), but it assessed only twenty mandibular first premolars(Zaatar *et al.*, 1997).

A study conducted by Maghfuri et al, reported that the majority of the study samples had a single root and one root canal, two roots were found in 18% and two canals in 26%. Such morphological variations should be taken into consideration to ensure successful root canal treatment of these teeth(Maghfuri *et al.*, 2019). Thus, this study helps in knowing the importance of locating all the canals and its configuration for a successful root canal therapy and also the importance of CBCT.

Conclusion

From this study, it can be concluded that Type I [1-1] and Type 4 Vertucci's classification was mostly seen in mandibular first premolars. Type 1 and Type 5 were mostly seen in mandibular second premolars.Missing a root canal are the most common reasons for failure in endodontic treatment. Clinicians should be aware of the canals and its configurations because its morphology varies largely in different individuals.Thus, CBCT is the gold standard diagnostic method in recognizing canal configurations.

Acknowledgement

I sincerely thank Saveetha Dental College for the access provided for the CBCT CDs which was very informative.

Conflict of Interest

The authors would like to declare that there is no conflict of interests.

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