A CBCT study of root canal morphology of bilateral maxillary premolars in South Indian population

Priyanka Sivasubramanian
Saveetha Dental College and Hospitals,
Saveetha Institute of Medical and Technical Science,
Saveetha University, Chennai.
Email Id: 152001002.sdc@saveetha.com
Dr. Kalaivani
Saveetha Dental College and Hospitals,
Saveetha Institute of Medical and Technical Science,
Saveetha University, Chennai.

ABSTRACT: -

Background: The objective of this study was to use CBCT to look into the root canal morphology of bilateral maxillary premolars in a South Indian population and associate the results to existing canal morphology classifications.

Materials and methods: The sample size for this analysis was 50 right and left untreated maxillary first and second premolars with fully formed roots from South Indian residents (25 male and 25 female). The following observations were made using CBCT on the teeth related: The number and morphology of roots and the canal morphology for each root according to Vertucci's classification. The frequency and similarities between the right and left sides, as well as between females and males, were studied. The Chi-square test was used to assess the results.

Results: In single-rooted maxillary first premolars, one canal was observed in 50.4% and two canals in 49.6% of cases. The most common canal configuration was Vertucci type II (25%), followed by type IV (22.7%), type III (21%), and type I (20.2%), with types V and VI occurring less frequently. In two-rooted premolars, Vertucci type I configuration was predominant in both buccal and palatal roots (97%). Bilateral symmetry in root number was observed in 82% of cases, and symmetry in canal configuration was observed in 78% of cases. No statistically significant differences were noted between genders ($P > 0.05$).

Conclusion: Maxillary premolars in the South Indian population exhibit considerable anatomical variation, with a high prevalence of bilateral symmetry. CBCT is a reliable and effective imaging modality for evaluating root canal morphology, facilitating accurate diagnosis and improved endodontic treatment outcomes.

Keywords: Cone beam computed tomography, Canal morphology, Maxillary premolars, South Indian population

INTRODUCTION: -

The science of root canal care is founded on the anatomy of the base tooth. Today, root apex is not the only field of endodontic research, but the concept of three-dimensional root canal filling implies that, while working length and maintaining it are more important, access to all canals within complications is also essential to facilitate root canal filling.(1)

Failure to consider differences in root and canal morphologies is the most common cause of failed root canal care. To avoid endodontic failure due to incomplete debridement and

obturation, a detailed knowledge of the anatomy of the teeth and an expectation of their possible deviations is essential.(2) Previous research has found that different populations have different patterns in the number and shape of roots and canals, which tend to be hereditarily determined and are significant for locating population ethnic backgrounds. As a result, it is critical to be aware of the differences in tooth morphology and distinguishing structures among different ethnic groups, as this information can help with canal position and negotiation, as well as their subsequent management.(2,3)

Current research has shown that the root canal system is not a single canal that runs uniformly from orifice to apex, but rather a complex system that splits and joins canals along the way to the apex.(2–4) A root canal begins with an orifice in the pulp chamber and ends with an apical foramen in the periodontium. Root canals offer a number of configurations from tooth to tooth in different as well as the same individual during their course.(2–5)

The maxillary premolars are considered among the most problematic teeth during endodontic treatment because of various root canal configurations. Furthermore, the root canal morphology of maxillary premolars has been found to be highly variable. Clinical treatment of maxillary premolars with unpredictably morphological roots and canals can be difficult. Among the difficulties are repeated endodontic treatment errors due to missing canals or the inability to radiographically image the apical limit of multi-rooted premolars.(6) As a result, detailed information of the anatomical features of the root canal system in the maxillary premolars is critical for improving root canal therapy and post core restoration success rates while also reducing complications.(6,7)

Root modelling, sectioning, tooth-clearing procedure, radiographic inspection, cone-beam computed tomography (CBCT), and micro-computed tomography (micro-CT) imaging are some of the methods used to assess the anatomy and morphology of root canals. Several researchers compared the effectiveness of four tomography methods with tooth-clearing technique and a digital radiography. They found that peripheral quantitative computed tomography and CBCT were as effective as tooth-clearing technique and canal staining in recognizing root canal systems.(8) While micro-CT has grown in popularity as a result of its precision, high resolution, and ability to perform comprehensive qualitative and quantitative measurements of root canal anatomy, it is not available in every country. In addition, the cost and radiation dose of micro-CT are important considerations.(8,9)

The objective of this research was to use CBCT to look into the root canal morphology of maxillary premolars in a Saudi Arabian subpopulation and associate the results to existing canal morphology classifications.(8–10)

MATERIALS AND METHODS:-

Fifty individuals (25 females and 25 males) were registered in this study, from those who attended the radiologic diagnostic centre for three-dimensional radiological scanning in the period between August 2022 and September 2022. Informed consent was waived by the ethics committee of Saveetha Dental College due to the retrospective nature of the study. The patients that underwent CBCT scanning for diagnostic purposes of maxillary premolars were collected. The records were reviewed retrospectively. All of the reports analysed belonged to patients who had been treated at Saveetha Dental College. Any photographs, radiographs, or test results collected during care can be used for academic and research purposes, but no personally identifiable details will be disclosed.

A database of 100 CBCT scans was analysed, and 50 of them met the study's inclusion criteria: non-distorted CBCT scans of maxillary premolars with completely developed roots in patients aged 18 to 60 years. Images of teeth treated endodontically or with postcoronal restorations, metallic restorations, full-coverage restorations, or those causing scan artefacts were removed. Teeth with root resorption or calcification of teeth associated with periapical lesions and low-quality CBCT images were also excluded. Anatomical symmetry was determined by comparing scans that involved teeth on both sides. The final sample size in this study was 50 CBCT images after examination of the 100 images according to the inclusion/exclusion criteria.

The CBCT machine used for the scans was the Carestream CS 8100 3D. X-ray generator specified with 60–90 kV, 2–15 mA and 140 kHz. Analysing the images was performed using the CS 3D Imaging Software.

Axial, sagittal, and coronal two-dimensional sections of each scan were displayed and data were recorded. Image contrast and brightness were changed as needed using the image processing function in the utilised program to achieve best display and visualisation.

The following observations were made using CBCT on the teeth related:

- The number and morphology of roots
- The canal morphology for each root according to Vertucci's classification.

The inter-examiner reliability and intra-examiner reliability were analysed. The statistical analysis was performed using SPSS Software to examine the results. The total number of roots, root canal configuration, and unilateral and bilateral occurrences were all investigated. The frequency and similarities between the right and left sides, as well as between females and males, were studied. The Chi-square test was used to assess the statistical significance of the result and it was identified at the level of $P < 0.05$.

RESULT:-

Maxillary first premolar

Root canal morphology :-

In the single-rooted Maxillary first premolar, the prevalence of a single canal was 50.4% and the prevalence of two canals was 49.6%. The most common root canal configuration in the single-rooted Maxillary first premolar is type II (25%), followed by type IV (22.7%), type III (21%), and type I (20.2%). Other classifications such as type V, VI, (7.6%, 1.6% respectively) were also observed in single-rooted Maxillary first premolar in lesser quantities.

In two-rooted Maxillary first premolar, root canal configuration was found to be mainly type I in both buccal and palatal roots (BI, PI) in 97% of the sample. The other variations found include Buccal type III Vertucci classification combined with palatal type I Vertucci classification (BIII, PI) in 1%, (BV, PI) in 0.3%, (BVII, PI) in 0.3%, and (B1, PV) in 0.3%.

Bilateral symmetry:-

Symmetry in root number between right and left maxillary first premolars was observed in 41 out of 50 patients (82%). Among these:

- 77.3% had two roots bilaterally
- 19.7% had a single root bilaterally
- 2.9% exhibited three roots bilaterally

Symmetry in the number of canals per root was observed in 81.7% of cases. Among these:

- 79.1% showed one canal in each root (B1, P1)
- 9.7% had a single canal in a single root (C1/R1)
- 8.2% had two canals in a single root (C2/R1)
- 2.9% had three roots with one canal each (MB1, DB1, P1)

Overall, canal configuration symmetry was observed in 78% of cases, with the majority showing Vertucci type I configuration in both roots.

Gender comparison:-

No statistically significant differences were observed between males and females in terms of root number, canal number, or canal configuration ($P > 0.05$).

DISCUSSION:-

A comprehensive understanding of root canal morphology is essential for successful endodontic therapy, particularly in teeth such as maxillary premolars that exhibit high anatomical variability. The present CBCT-based study evaluated the root canal morphology of bilateral maxillary premolars in a South Indian population and assessed symmetry patterns.(11) The findings of this study demonstrated that single-rooted maxillary first premolars exhibited nearly equal prevalence of one and two canals, highlighting the complexity of these teeth. Vertucci type lI configuration was the most common in single-rooted premolars, which is consistent with several previous studies conducted in different populations.(11) However, variations in prevalence rates may be attributed to ethnic and genetic differences.

Two-rooted premolars predominantly exhibited Vertucci type I configuration in both buccal and palatal roots, indicating a relatively simpler morphology in such cases. Nevertheless, the presence of less common configurations emphasizes the need for careful radiographic and clinical evaluation to avoid missed canals.(11,12)

A significant finding of this study was the high degree of bilateral symmetry in both root number (82%) and canal configuration (78%). This suggests that the contralateral tooth can serve as a useful reference during diagnosis and treatment planning. Similar findings have been reported in other CBCT-based studies, reinforcing the clinical relevance of symmetry in endodontics.(13)

No significant gender differences were observed, indicating that canal morphology is not influenced by sex in this population. This is in agreement with several previous studies.(14) CBCT proved to be a highly effective diagnostic tool in this study, allowing three-dimensional evaluation of root canal systems without superimposition, which is a limitation of conventional radiography. Its ability to detect complex canal configurations enhances treatment accuracy and reduces the risk of endodontic failure.(14,15)

LIMITATIONS:-

This study has certain limitations. The sample size was relatively small, and only one population group was studied. Additionally, the retrospective design may introduce selection bias. Further studies with larger and more diverse populations are recommended.

CONCLUSION:-

Within the limitations of this study, maxillary premolars in the South Indian population exhibit considerable variability in root and canal morphology. Single-rooted premolars demonstrated diverse canal configurations, with Vertucci type Il being the most prevalent, while two-rooted premolars predominantly showed type I configuration in both roots. A high degree of bilateral symmetry was observed, suggesting that the contralateral tooth may serve as a useful guide during endodontic procedures. CBCT is a reliable and valuable imaging modality for the assessment of root canal anatomy, contributing to improved diagnosis, treatment planning, and clinical outcomes.

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