A Study of Root Canal Morphology of Human Deciduous Maxillary Molars using Cone Beam Computed Tomography (CBCT): An in Vivo Study

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Abstract

**Aim:** The purpose of this study was to investigate the root canal morphology of the primary maxillary right first and second molars using CBCT according to Vertucci & New root canal classification system given by Ahmed HMA et al., Method: 60 Patients aged 3-9 years were taken in the study. The CBCT of maxillary right quadrants of study subjects were taken at imaging centre and evaluated on CBCT scans according to Vertucci & Ahmed HMA et al.,’s classification both. **Result:** The most common canal configuration for right primary maxillary 1st and 2nd molar was Vertucci Type I except mesio-buccal canal in right maxillary second molar was Vertucci Type IV. **Conclusion:** As deciduous molar teeth exhibit thin tortuous canals and ribbon like roots a thorough knowledge of the root canals can improve the outcome of pulp treatment in pediatric patients.

**Keywords:** root canal morphology, primary maxillary, CBCT scans, teeth exhibit.

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INTRODUCTION

In childhood, primary teeth have crucial roles such as chewing, speaking, and maintaining spaces for permanent teeth. Therefore, maintaining primary teeth in the dental arch is the first aim of a pediatric dentist. To improve the success of endodontics in primary molars, more detailed knowledge of root canal number and morphology is needed [1].

The external and internal morphology of primary teeth are different in many aspects from permanent successors. In primary molars, the complexity of this system may increase over time due to the formation of secondary dentine and narrowing of the canal system and eventually the resorption process [2]. The primary maxillary first and second molars are difficult to be treated endodontically due to the variation in a number of roots, canal configuration, direction and longitudinal depressions of the roots, and pulp cavity configurations.

Many techniques can be used to research root canal morphology of teeth, such as computerized tomography, clearing technique, radiographs, operating microscope and high-resolution X-ray micro-computed tomography (micro-CT) [3]. Recently, cone-beam computed tomography (CBCT) images have been found to be useful and accurate in evaluating root and canal morphology in permanent mandibular and maxillary molars [3]. As an emerging technology in endodontics, CBCT has a lower radiation dose and a higher resolution than traditional computed tomography scans. It has proved useful in detecting periapical lesions and root canal morphology in the maxillary region [3].

The Vertucci classification system is the most widely established and used classification system and categorises the root canal configurations into eight types, increasing in complexity, from Type I to Type VIII. While this is used primarily for classification of permanent teeth, the nomenclature has been adapted for use in primary dentition root canal morphology studies. Another classification which was given by Ahmed et al.,
that also has been adopted for use in primary dentition root canal configuration studies [4].

So, the aim of this study is to investigate the root canal morphology of the primary maxillary right first and second molars according to both Vertucci & Ahmed et al’s new root canal classification system using CBCT.

MATERIALS & METHODOLOGY

60 Patients aged 3-9 years attending the OPD in the Department of Pediatric and Preventive Dentistry of K.D. Dental College and hospital, Mathura will be required in the study. After Ethical clearance taken from the Ethical Committee of K.D. Dental College, Mathura, the written consent will be obtained from all the subjects. Study subjects will comprise of patients having valid diagnostic reasons or treatment in anterior region of primary maxillary right quadrant. Intraoral periapical X-rays of maxillary right deciduous molars were taken to examine the pathogenesis and carious lesion. The CBCT of maxillary right quadrants of study subjects will be taken at CBCT imaging centre. Then the primary maxillary first molars (n=60) and second molars (n=60) of patients will be evaluated on CBCT scans.

Patients who have signed the consent form, patient with complete root completion, high quality CBCT image were included in this study. Primary tooth with incomplete root completion, tooth associated with pathologies, root with open apices, immature apex, resorption or any calcification, medically compromised patient, Poor quality of CBCT image were excluded from this study. The data was calculated, organized, tabulated in Microsoft excel, and statistically analysed with SPSS V.24 software. The variables are presented with frequency and percentage. Z test is used for the comparisons. The P value ≤ 0.05 is considered as statistically significant.

Fig 1: CBCT images viewed by CS-3D imaging software viewer
Fig 2: Axial, Sagittal and Coronal View of Palatal root of Maxillary Primary 2nd molar in right quadrant

Fig 3: View of Root Canal Morphology according to classification by sectional view of Maxillary primary 2nd molar in right quadrant
Fig 4: Vertucci Type 2 Root Canal Morphology in both Mesio-buccal & Disto-buccal root of of Primary maxillary first molar in right quadrant

Fig 5: 1 Mesio-buccal canals, 1 Disto-buccal canal & 1 Palatal canal of Primary maxillary first molar in right quadrant

Fig 6: 1 Mesio-buccal canals, 1 Disto-buccal canal & 1 Palatal canal of Primary maxillary second molar in right quadrant
RESULT

In present study, 60 primary right maxillary 1st molars (tooth no. 54) and 60 primary right maxillary 2nd molars (tooth no. 55) & their number of canals in the mesio-buccal, disto-buccal & palatal canal were evaluated by using CBCT. Among 60 Right Maxillary 1st primary molars evaluated, mesio buccal root had one canal in 80% cases and 2 canals in 20% cases. In disto-buccal roots, 86.66% had single canal and 13.33% had 2 canals. In Palatal root, 100% had single canal. In maxillary right primary second molar, Meso-buccal root has high frequency of two distinct canals and Disto-buccal root & Palatal root has high frequency of single canal.

So maximum roots in right primary maxillary molars, tend to have 1 canal except mesiobuccal root of maxillary primary 2nd molar. Vertucci type I canal configuration are most commonly found in mesiobuccal, distobuccal and palatal root of maxillary 1st and 2nd molars, except mesiobuccal root of maxillary primary 2nd molar where Vertucci Type I and Type IV both are most common.

| Table 1: Incidence of different types in Mesio buccal root of primary maxillary 1st molar |
|-----------------------------------------------|----------------|----------------|
| TYPE (Vertucci / New System Classification)  | NUMBER OF TEETH | PERCENTAGE     |
| TYPE I / 54 MB^1                             | 35             | 58.33%         |
| TYPE II / 54 MB^1-1                          | 3              | 5%             |
| TYPE III / 54 MB^1-2-1                       | 3              | 5%             |
| TYPE IV / 54 MB^2                            | 9              | 15%            |
| TYPE V / 54 MB^1-2                           | 10             | 16.66%         |

| Table 2: Incidence of different types in Disto buccal root of primary maxillary 1st molar |
|-----------------------------------------------|----------------|----------------|
| TYPE (Vertucci / New System Classification)  | NUMBER OF TEETH | PERCENTAGE     |
| TYPE I / 54 DB^1                             | 47             | 78.33%         |
| TYPE IV / 54 DB^2                            | 8              | 13.33%         |
| TYPE V / 54 DB^1-2                           | 5              | 8.33%          |

| Table 3: Incidence of different types in Palatal root of primary maxillary 1st molar |
|-----------------------------------------------|----------------|----------------|
| TYPE (Vertucci / New System Classification)  | NUMBER OF TEETH | PERCENTAGE     |
| TYPE I / 54 P^1                              | 60             | 100%           |

| Table 4: Incidence of different types in Mesio buccal root of primary maxillary 2nd molar |
|-----------------------------------------------|----------------|----------------|
| TYPE (Vertucci / New System Classification)  | NUMBER OF TEETH | PERCENTAGE     |
| Type I / 55 MB^1                             | 18             | 30%            |
| Type II / 55 MB^1-1                          | 14             | 23.33%         |
| Type III / 55 MB^1-2-1                       | 1              | 1.66%          |
| Type IV / 55 MB^2                            | 22             | 36.66%         |
| Type V / 55 MB^1-2                           | 5              | 8.33%          |

| Table 5: Incidence of different types in Disto buccal root of primary maxillary 2nd Molar |
|-----------------------------------------------|----------------|----------------|
| TYPE (Vertucci / New System Classification)  | NUMBER OF TEETH | PERCENTAGE     |
| Type I / 55 DB^1                             | 54             | 90%            |
| Type II / 55 DB^1-1                          | 1              | 1.66%          |
| Type IV / 55 DB^2                            | 5              | 8.33%          |

| Table 6: Incidence of different types in Palatal root of Primary maxillary 2nd molar |
|-----------------------------------------------|----------------|----------------|
| TYPE (Vertucci / New System Classification)  | NUMBER OF TEETH | PERCENTAGE     |
| Type I / 55 P^1                              | 60             | 100%           |

DISCUSSION

A thorough knowledge of anatomy of the tooth is essential before beginning the endodontic treatment. It is generally accepted that the major cause of failure of root canal treatment is an inability to recognize the number of canal and therefore treatment of all the canals of the root canal system is important (Gaurav V 2021) [5]. The purpose of this study was to investigate the root canal morphology of maxillary primary first and second molars in pediatric patients through CBCT scan. Bagherian A et al., 2010 [6] conducted a study on root canal morphology of human deciduous molars in an Iranian population and Katge F et al., ’s 2018 [7] study...
was on root canal morphology of primary molars by clearing technique, an in vitro study. Ariffin S et al., 2020 [8] conducted a study on root canal morphology of primary maxillary second molars using a micro-computed tomography analysis. No study was done on specific right side primary 1\textsuperscript{st} and 2\textsuperscript{nd} maxillary molar with a significant sample size. Most of these studies seem to lack in defining morphologic variations in a systematic classification in which only the prevalence of one or two root canals were reported and connecting branches, lateral fibrils were evaluated separately and above all these studies had taken very less sample size, that’s why no single study reported statistically significant result. Also major studies done on root canal morphology of primary mandibular molars than primary maxillary molars. So, the present study has aimed to analyze the detailed images of the root canal morphology and determine the frequency of complex morphologies of primary maxillary right first and second molars an in vivo study.

In present study, for primary maxillary 1\textsuperscript{st} molar 58.3% of mesiobuccal canal had Vertucci Type I, 15% was Vertucci Type IV, 16.66% was Vertucci Type V and Type III & II root canal configurations was 5% each. Bagherian et al., [6] found that, in mesial buccal root maxillary root canal morphology first molar, 92.6% of the samples had Vertucci's Type I root canal configuration and rest 7.4% of the samples were vertucci Type IV. Katge et al., [7] found that 91.10% of the samples had Vertucci Type I, 6.9% had Vertucci Type II and 6.9% had Type IV. In the distobuccal root, Type I was found in 78.33% of the samples and 13.33% of the specimens had Type IV and 8.3% had type V root canal configuration. According to the study conducted by Bagherian et al., [6] disto buccal root had Type I root canal configuration in 96.3% and Type IV root canal configuration in 3.7% of sample specimens. According to the study conducted by Katge et al., [7] 2016, disto buccal root of maxillary 2\textsuperscript{nd} molar also had Type I root canal configuration in 100% of sample specimens. Ariffin S et al., [4] found that 77.3% of the samples had Vertucci Type I, followed by 11.3% had Vertucci Type V, 6.8% had Vertucci Type III, 2.3% had Vertucci Type II & 2.3% had Vertucci Type VII. 100% Palatal root of maxillary primary 2\textsuperscript{nd} molar had Vertucci Type I canal configuration which was similar with previous study done by Bagherian et al., [6] and Ariffin et al., [4] But Katge et al., [7] found 96.3% Vertucci Type I and 3.7% Vertucci Type III root canal configuration in palatal root of maxillary 2\textsuperscript{nd} primary molar.

Thus in our study, the root canal configuration of primary maxillary 1\textsuperscript{st} and 2\textsuperscript{nd} molar showed almost similar to previous study result except mesio-buccal canal of primary maxillary second molar having Vertucci Type IV configuration majorly whereas, maximum number of Vertucci Type I found in the previous literature. Also in present study, Mesiobuccal root canal configuration of primary maxillary 2\textsuperscript{nd} molars had given statistically non-significant result where other roots of primary maxillary 1\textsuperscript{st} and 2\textsuperscript{nd} molars had given statistically significant result.

This variation in result compare to previously mentioned studies, may be due to variation in different technique, different method, in-vivo & in-vitro study on different population, also because of one or both quadrant of maxillary arch involvement.

Future Recommendation
1. Large sample size.
2. Different ethnicity and different population should be included.
3. Different geographic area should be included.
4. Most advanced technology should be used.

CONCLUSION
From the results of the present study, regarding the morphology of first and second maxillary primary molars, the following conclusions can be withdrawn:
1) There is a wide range of anatomical variations of the shape and number of all the root canals.
2) All the roots present complexity and variability of the canal system with additional interconnecting isthmuses.

3) The above findings may contribute to favourable clinical outcomes after endodontic treatment.

Why this study is important in pediatric dentistry?
1) Importance of knowledge about root canal morphology in pediatric dentistry to perform successful endodontic treatment.

2) This study prove that there are various types of root canal variations in primary maxillary 1st and 2nd molar.

REFERENCES


