

Root morphology of the maxillary first premolar in Singaporeans

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Abstract

Extracted teeth were collected from clinical procedures performed in the Faculty of Dentistry, National University of Singapore. A selected sample of 957 maxillary first premolars were subjected to visual examination and digital radiography. There was a higher incidence of two-root form (50.6 per cent) than previously reported for the Singaporean dentition. In the two-root category, 307 teeth exhibited the fused-root form (two fused roots with two root canals) and 177 were distinctively of the two-root form (two separate roots with two root canals and two foramina). The fused-root form was emphasized as an entity in this study. The one-root form accounted for 49.4 per cent. No three-root form was detected.

Key words: Maxillary first premolar, root, morphology.

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Introduction

The maxillary first premolar¹ has two cusps, with the buccal cusp prominently larger than the palatal. The mesiodistal (central) developmental groove is clearly visible on the occlusal surface. There is a distinctive marginal groove which often cuts across the mesial ridge. The outstanding feature of identification of this tooth is the marked concavity (canine fossa) that is situated from the cervical two-thirds of the crown and extends across the cervical line towards the root(s) as a shallow groove.

Although there is a fairly consistent coronal description in most textbooks, the root morphology including its canal anatomy can vary significantly in different individuals and populations. Pedersen² mentioned that there was an astonishingly high incidence of one-root maxillary first premolars in the East Greenland Eskimo dentition. Another early pioneer (Tratman)³ stated that the two-root form was distinctly uncommon in the Mongoloid stock.

In a recent textbook of endodontics,⁴ the one-root form was given as the lowest (ten per cent) of its various configurations. Three-root forms had also been reported, with a study⁵ quoting the highest incidence at six per cent.

In view of its varying root form and its canal configuration, the maxillary first premolar can pose some clinical problems. An extraction tends to be more difficult when the tooth is of the two-root form. Endodontic therapy will not be successful if the palatal root is missed out. Orthodontic movement may be more difficult to achieve. Pre-operative radiographic technique may need to be adjusted to demonstrate the seemingly frequent occurrence of the two-root form as evidenced in this study.

The aim of this study is to determine the external root morphology of the maxillary first premolar in the Singaporean dentition and to compare the findings with published reports of different races.

Materials and methods

Extracted teeth from clinical procedures performed in the Faculty of Dentistry were collected and preserved in the usual manner. Preservation of the teeth was made by soaking them in a ten per cent formalin solution. After washing, they were boiled in water containing sodium hydroxide for 15 minutes. The teeth were allowed to dry after cleaning.

The maxillary first premolar was identified by the coronal morphological features described earlier. Care was exercised to distinguish it from the second premolar, which does not possess the features of identification so demonstrated by the first premolar. Cases which were ambiguous were not included in this study. Also, data were excluded when the collected teeth were restored occlusally or were heavily broken down, especially in the root regions. In the sample, orthodontic extractions provided many excellent specimens. It was not possible to record personal data like age, sex and race in this retrospective collection.

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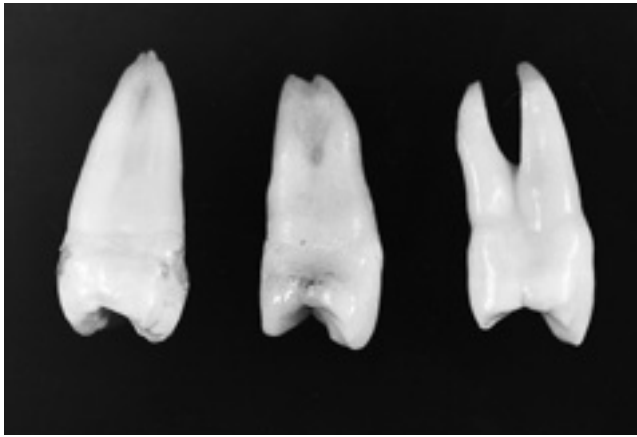


Fig. 1. – External root morphology of the maxillary first premolar: one-root (left), fused-root (centre) and two-root (right).

A final sample of 957 teeth was selected and studied. Visual determination of the external root morphology was made and the findings were recorded. The teeth were separated into groups according to their external root forms (Fig. 1). Subsequently, all the specimens were subjected to digital radiography to illustrate the internal canal anatomy and configurations. The teeth were radiographed in three groups on large films, according to their external root morphology.

The author adopted the following method and criteria to provide a classification to reconcile the external root morphology with the internal canal anatomy. A root was considered to be of the one-root form when the tooth showed one root and one canal at its origin from the pulp chamber which terminated in one foramen. The fused-root form was recorded when externally two roots were joined almost to the root apices, evidently by calcification, and internally there were two root canals at origin. The same identification was made for those cases which originally, by visual examination, looked like a one-root form but on radiographic examination revealed two distinct root canals at origin. In some cases, the two root canals joined and terminated in one foramen and in others ended separately in two foramina. Finally, the two-root form was determined when the roots were clearly demarcated immediately from the bifurcation and internally there were two root canals at origin, terminating in two foramina or more (Fig. 2). The three-root form would be one in which there were three external roots, each with its own canal and foramen.

Results

From the sample, 177 teeth (18.5 per cent) were identified as two-rooted, one placed buccally and the other palatally, corresponding to the two cusps. The roots were clearly separated and their apices were further apart than those classified in the fused-root

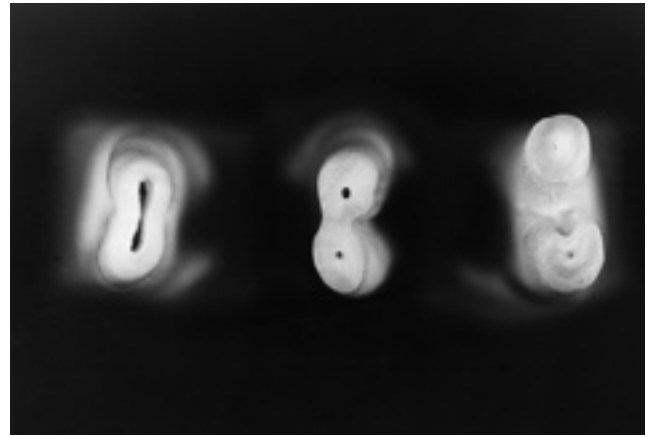


Fig. 2. – Transverse section of the different root forms: one-root (left), fused-root (centre) and two-root (right).

form. The furcation of the roots was clearly defined and consistently started at a level about half of the lengths of the two roots. This feature gave rise to a prominent trunk structure. The divergence of the roots was variable, with a tendency to come closer at the apical ends. Generally, there was little curvature along each length of the two roots, except the palatal tended to curve inwards at its end. The buccal root appeared to be larger and slightly longer in most cases. There was no difficulty in the visual assessment of this root morphology and the radiographic examination of this sample group confirmed the accuracy in all of the teeth so determined visually.

A total of 307 teeth (32.1 per cent) were grouped into the fused-root form. Externally, the vast majority in this category had obvious calcified lamination along the two roots, which were also placed in the buccal and palatal positions. The roots were fused almost to the ends and this feature was more evident from the mesial aspect. The apices were positioned very close together. Externally, some appeared like the one-root form when viewed distally, but internally, as shown by radiography, there were two distinct root canals at origin of the pulp chamber. The majority of the canal configurations (226 cases) in this group ended up in two separate apical foramina and others (81 cases) joined together just prior to the apex to exit from one foramen.

On visual assessment, 473 teeth (49.4 per cent) had a single root. The root was often straight along its entire length. It was compressed mesiodistally. Its apical third could be deviated to the distal. On the mesial surface was the continuation of the canine fossa, which now exhibited itself as a shallow groove, fading towards the apex.

Discussion

The materials and methods used by other investigators did vary and, in some cases, the details were not available to establish definitive trends and

Table 1. Number of roots in the maxillary first premolar

Author	Year of report	Number of teeth studied	One-root (%)	Two-root total (%)	Two-root fused (%)	Two-root distinct (%)	Three-root (%)
Loh	1996	957	49.4	50.6	32.1	18.5	0.0
Walton and Torabinejad ⁴	1996	Not available	10.0	85.0	28.0	57.0	5.0
Vertucci and Gegauff ¹¹	1979	400	26.0	70.0	13.5	56.5	4.0
Carns and Skidmore ⁵	1973	100	22.0	72.0	15.0	57.0	6.0
Ingle ¹²	1965	Not available	43.0	55.0	33.0	22.0	2.0

racial affinities of the root morphology of the second premolar. Examinations involving sockets in skulls, casts of teeth and root canals, and direct visual assessment were utilized. The sample size in this study (957 teeth) was the largest in the various reports cited in this paper. Both visual and radiographic determinations were employed to accurately classify the root morphology. By placing each tooth flat on the proximal side against the X-ray film, this investigation provided a life-size image, good definition and contrast. Determination of the internal canal configuration together with the external root morphology was not always undertaken in previous studies and therefore differences in classification can occur. Other workers utilized sections of teeth, casts of teeth and their canals.

There were several teeth in which axial radiopaque masses were found in the pulpal tissues, although externally they had a clear single root. These masses could be due to secondary dentine deposits and this phenomenon is associated with age changes. It had been noted in the literature that this could lead to the appearance of two developing canals. However, this radiographic appearance was clearly dissimilar to that created by two separate canals at origin from the pulp chamber. There could be variation in interpretation in other reports and perhaps even error in a proper classification between a one-root form and the fused-root form. In this presentation, the detailed description of the canal anatomy and its varied configurations were not dealt with. Instead, they will be presented in another paper with an emphasis on their importance in endodontic practice. This paper aims to provide the incidence of occurrence of the three types of external root morphology in the Singaporean dentition.

In Singapore, the population is primarily made up of Chinese (about 76 per cent) with other racial groups being of Indian, Malay and Sri Lankan origins. Though multiracial, the subgroups remain largely homogenous due to a low incidence of inter-racial marriages. As such, like their forefathers from mainland China, Singaporeans can be considered primarily as a Mongoloid stock. Morphological characteristics in the local population have been documented by the author (three-rooted first mandibular molar,⁶ five-cusped second mandibular molar,⁷ coronal morphology of the mandibular premolar⁸ and dens evaginatus⁹). This additional

information of yet another aspect of the Singaporean dentition will help to formulate its distinctive racial morphology. It is appreciated that the sample in this study was not homogeneously Chinese. There were no previous publications on the other individual racial groups of the Singapore population.

Prior to the author's work, two notable contributions from Singapore were made on the subject. Tratman³ alluded to an uncommon incidence (without actual figures) for the two-root form, although he acknowledged the presence of the fused-root form. A study by Goh,¹⁰ eventually compiled into a local teaching manual, had not suggested a high incidence of the two-root first premolar. This present study corrected that fact. The fused-root type is actually a two-root variation as the tooth originally developed with two roots. It is recognized that there is an overlap in features between this form and the distinct two-root form. For all intents and purposes, they are actually two rooted. Taking the two-root and fused-root forms together, the prevalence (50.6 per cent) was very significantly higher than previously thought. One common finding did emerge in the research of this subject by the local authors. The three-root form was indeed rare. None was detected in this study, although from personal communications with local endodontic colleagues, three-rooted therapy had been performed in some cases.

A review was made of two other studies involving non-Chinese populations.^{11,12} There were some interesting findings. The incidence of two-root forms (distinct and fused types) was higher in other populations. The one-root form was not common, varying from 10 per cent⁴ to the 49.4 per cent of this present study, which happened to be the highest (Table 1). All other reports recorded a small number of teeth with three-rooted morphology (2 to 6 per cent). Perhaps the incidence is more evident in Caucasian populations.

The fused-root form was not clearly described, recognized and classified in many of the previous studies. Without noting its internal canal morphology, this form was often regarded as one-root, which in fact, it was not. Confusion could be generated when a report presented data on external root numbers which do not correspond with the incidence and arrangement of internal canal morphology.

To determine the number of external roots, the author adopted the principle of ascribing one root canal to a single root, two canals at origin to two-root or fused-root forms and three canals at origin to the three-root form. The terminations of these root canals could vary in the number of foramina that they end up with and therefore were not used to determine the external root number. The studies reviewed were interpreted along this principle for a comparable evaluation with the present study. It was also observed that the internal canal morphology can vary a great deal in the two-root and fused-root forms. This, together with the way they terminate in their foramina, is of clinical importance in endodontic practice.

It is natural to assume ethnology influences dental morphology, as it does for other features. It has been observed that different populations show distinctive variations of tooth morphology. It appears that the incidence of two-root and fused-root forms is higher in the western countries. A European study quoted by Pedersen² showed a 66.6 per cent incidence. Two American figures¹¹ were higher at 85 and 70 per cent respectively. Morphological differences in different populations, such as the root morphology of the maxillary first premolar, can help to distinguish between different populations. Dental traits used as identification tools are well documented,¹³ especially when dental structures are the most durable biological structures which are well preserved for observation and study.

Conclusion

The root morphology of the maxillary first premolar in Singaporeans shows a higher incidence of two-root forms (50.6 per cent) than previously reported. However, the figure is still lower than those for western countries. Two-root forms can occur with distinct roots or fused, but the latter is

more common in this category and is emphasized as a definitive entity. The three-root form is very rare. This study adds to the existing knowledge of morphological characteristics that were published on Singaporean dentitions.

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