

# ROOT CANAL MORPHOLOGY AND ITS RELATIONSHIP TO ENDODONTIC PROCEDURES

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## ABSTRACT

**Background:** Root canal morphology varies between the types of the teeth; maxillary teeth are different in their general morphology and termed accordingly as incisors, canine, premolar, and molar. This variation is further subject to classification systems of their root canals.

**Methodology:** We searched Pubmed for ((root canal) (AND (morphology) OR (anatomy)) OR maxillary tooth))).

**Review:** Type I of the Vertucci classification is prevalent across all maxillary teeth. This finding is true in populations regardless of geographic location. With the advent of modern imaging modalities such as the cone-beam computerized tomographic scan, the detection of rare morphologies is readily accessible. Hence, the dentist can act accordingly and provide better informed care.

**Conclusion:** Clinical importance of understanding the potential rare root canal morphologies is mainly to prevent technical errors. When available, the dentist should perform appropriate pre-procedural imaging of the affected tooth.

**Key words:** Endodontics, Root canal, Maxillary, Molar, Premolar, Incisors.

## Introduction

The anatomical dimensions of the tooth is central to dental practice, as many procedures extend to the root canal. The root is particularly complicated with variable anatomy, similar to the complexity seen in other areas of the body such as the Calot's triangle. In dental procedures, a main objective is successful root canal treatment. This depends on factors such as detecting any anatomical variation in canals, unexpected curvatures, or accessory canals. The aforementioned factors are important in surgical interventions, as there is an associated increase in technical errors. These errors include, but not limited to, non-filled and underfilled root canals.<sup>1</sup> The detection of these morphological changes between otherwise similar teeth is largely dependent on the usage of novel imaging such as cone-beam computerized tomographic scans.<sup>2</sup>

## Methodology

We searched Pubmed for ((root canal) (AND (morphology) OR (anatomy)) OR maxillary tooth))). In regard to the inclusion criteria, the articles were selected based on

inclusion of one of the following topics; dental anatomy, endodontics, root canal morphology, maxillary teeth (incisors, canines, premolars, and molars). Exclusion criteria were all other articles which did not have one of these topics as their primary endpoint.

## Review

It is clinically important that the dentist is able to accurately evaluate root canal variations and thereafter offer endodontic treatment that is relatively low on operator and technical errors. Variation exists even between the opposing teeth in the same person. The work done by Vertucci has had an impact on how dental procedures are conducted in relation to root canal morphology.<sup>3</sup> The Vertucci classification is used in categorizing root canal morphology into eight distinct types (Table 1).

	Description
Type I	One canal extending to the apex
Type II	One canal starting at the pulp chamber and diverging into two at the first third of the root and merging again into one canal

Type III	One canal leaving pulp chamber diverging into two and then merging again into one canal
Type IV	Two canals leaving the pulp chamber without combining with one another
Type V	One canal leaving the pulp chamber and diverging into two distinct canals with separate apical foramina
Type VI	Two separate canals leaving the pulp chamber and merging at the third of the root canal and then separating again into two distinct canals
Type VII	One canal leaving the pulp chamber and merging at the third of the canal separating as two distinct canals
Type VIII	Three separate canals extending from the pulp chamber to the apex

Table 1: Vertucci Classification of Root Canal Morphology

**Maxillary Incisor Teeth**

The incisor teeth are expected to follow the common one root and one canal variation. While incisors follow the Vertucci’s classification, recent reports of newer root canal types that are unclassified were found.<sup>4</sup> In the population, mandibular incisors will most commonly follow the type I morphology of Vertucci’s classification. Rare anatomical variations may occur and are usually either type II or III.<sup>5</sup> In patients with rare types of maxillary incisors, the dentist should be diligent in locating and cleaning additional root canal systems. Failure to do so would inevitably result in post-procedural disease.<sup>6</sup>

**Maxillary Canine Teeth**

The maxillary canine teeth, similar to adjacent teeth, are commonly of type I variety.<sup>3</sup> There is a considerable prevalence of accessory canals in maxillary canine teeth. This apical accessory canals reach 3 mm in length, distributed at 46% in central incisors. Additionally, accessory canals are also found in lateral incisors and canines at 29% and 38%, respectively.<sup>7</sup>

**Maxillary Premolar Teeth**

The most common variants are of type I, II and IV of Vertucci classification in maxillary premolar teeth.<sup>1</sup> This is not always the case, as in Myanmar population, it is type I and III that are the most prevalent. Maxillary premolars have two roots and, accordingly two root canals, with an important furcation groove that is important to outline in endodontic and prosthodontic procedures.<sup>8</sup> By comparison, there is a notable prevalence of multiple root canals in mandibular premolars.<sup>9</sup>

The Vertucci’s classification divides the premolar root canals into eight types. Prevalence of different types has type

I as the most common, followed by type IV and type II.<sup>1</sup> The other types are uncommonly seen in practice but are worth knowing for the avid dentist. In the most common type, type I, it is the underfilling error that is most prevalent.<sup>10</sup> In type II and type VIII, the error more commonly manifests as underfilling and non-filling of root canals.<sup>10</sup>

**Maxillary Molar Teeth**

The variation in maxillary molar teeth is interesting as three roots was the most common finding in the first two maxillary molars.<sup>11</sup> This shows that the prevalence of secondary mesiobuccal canals is highly prevalent within the first two maxillary molars.<sup>12</sup> This is, however, more common in first molar teeth than second molars.<sup>11</sup> Additionally, this latter finding is commonly bilateral, and is more gender-specific to males.<sup>12</sup> According to the Vertucci’s classification, the most common root canal morphology is similar in both first and second maxillary molar teeth. The most common anatomical variation in either tooth was type I, followed by type II and type IV.<sup>12</sup> This is similar to the Vertucci distribution of maxillary premolar teeth.<sup>1</sup> The distribution of maxillary root canal morphology is tilted towards type I, but rare types may be found incidentally (Table 2).

Teeth	Most Common Vertucci Types
Maxillary Incisor	Type I
Maxillary Canine	Type I
Maxillary Premolar	Type I, II and IV
Maxillary Molar	Type I, II and IV

Table 2: Maxillary Root Canal Morphology by Prevalence

Molars are anatomically different from each other and with other teeth, especially when it comes to the number of roots and canals.<sup>13</sup> Interestingly, studies have shown high prevalence of apical radiolucency, this is suspected to be due to poor coronal restoration and endodontic technical errors.<sup>14</sup> Of all teeth types, it was the maxillary molars and the anterior teeth that showed predilection towards periapical lesions.<sup>14</sup> Furthermore, the use of advanced imaging techniques, in particular cone-beam computerized tomography, would prove useful in the pre-procedural evaluation and subsequent treatment of lesions affecting these teeth.<sup>12</sup>

**Conclusion**

Becoming aware of the detailed variation of root canals is important, as the dental practitioner would be knowledgeable about the potential errors that could occur, and how to avoid them with diligent pre-procedural planning. It is, therefore, important to evaluate root canal systems and presence of confluent apices, estimate

distance towards root end, and check for symmetry between bilateral teeth.

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