

Morphological Differences between the First and Second Permanent Upper Molars

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Abstract

The dental elements present similar and specific anatomical features, depending on the functions they have in the oral cavity. The permanent molars are the most complex structures, mainly the occlusal face, due to their function of food grinding. The aim of the present article is to present the upper first and second molars morphology, emphasizing the similarities and differences between them. Besides, the upper first and second molars of the collection of the Department of Morphology of Universidade Estadual de Paulista (UNESP), School of Dentistry, Araraquara, were evaluated regarding the presence of the oblique ridge, frequency and classification of the molar tubercle, and the crown morphology (upper second molars). In the 372 evaluated upper first molars, the molar tubercle was absent in most of the teeth. When present, the molar tubercle belonged to the mesiolingual cusp; 8.9% were classified as type I; 9.1% as type II; and 9.4% as type III. The oblique ridge was present in all upper first molars. The morphology of 401 upper second molars was also evaluated; 64.83% were tetracuspid; 35.16% tricuspid; and 17.02% presented compression morphology. In 100 tricuspid teeth, 50% presented oblique ridge, with it being prominent in 30%. No upper second molars presented molar tubercle. Although there are similarities between the upper first and second molars, we must always be aware of the features that differ between them, so their functionality can be restored.

Keywords

- anatomy and anthropology
- education in morphology
- macroscopic human anatomy

Introduction

The dental elements have similar and specific anatomical features depending on the functions they have in the oral cavity. Among the structures of the dental arch, the permanent molars are the most complex ones, mainly the occlusal face, due to their function of food grinding.¹

Among the upper molars, the upper first molar is the tooth with the least anatomic variations,² but when compared with the other teeth, its morphology is the most complex.³ Its crown may be like a rectangle, square, or rhomboid.^{4–7} Due to the large dental crown, it is supported by three dental roots.⁸ The upper first molar presents four cusps: the mesiolingual is

the largest one, followed by the mesiobuccal, the distobuccal, and the distolingual. The two lingual cusps are more prominent than the buccal ones. Therefore, they are the first to occlude with the antagonist tooth.^{1,9,10}

On the mesiolingual cusp, the Carabelli's tubercle may be observed;^{4,5,10–12} it is present in up to 80% of the cases¹³ and can be observed bilaterally.^{11,12} It can be referred to as Carabelli's cusp, fifth lobe, fifth cusp, supplemental cusp, accessory cusp, and mesiolingual prominence.^{12,14} In the current *Nomina Anatomica*, this structure is called molar tubercle, due to the substitution of the eponymous.¹⁵

The second permanent molar is the second tooth that is most affected by dental anomalies considering the upper

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molars. Álvares & Freitas² analyzed the frequency of dental fusion and found that the most affected teeth are deciduous incisors and cuspid, permanent incisors, permanent upper third and second molars.

Known as the six-years-old molar, the upper first permanent molar presents the greatest volume among the upper molars. It has four cusps and three roots, and one cusp is not supported by a root of its own.⁴ The upper second permanent molar is known as the "teenager tooth" due to the age of eruption, which occurs between the ages of 13 and 15. The upper second molar presents anatomic variations due to the number of cusps, and it may present variations in its measurements.^{4,5,9}

When compared with the upper first molar, a modification in the contour of the occlusal surface is observed because the distolingual cusp is much smaller in the second molar, and the lingual margin of this surface is smaller than the buccal margin.^{4,5,9} Due to the number of cusps, the morphology of the occlusal surface is variable, being tetracuspid, tricuspid, or presenting a compression morphology.^{1,4,5} And the presence of tubercles in the upper second and third molars is not so common.⁹

When searching in scientific bases, like SciELO, Scopus, Bireme, Google Scholar and PubMed, through the last 5 years, using the following keywords "*dental anatomy*," "*upper molar anatomy*," "*molar anatomy*," "*molars*," "*upper molars*," "*molar morphology*," we verified that thousands of papers were related to them. However, only six papers were related to the crown morphology of molars. Most of the papers were related to endodontics and internal anatomy of molars. Therefore, the number of studies related to the upper molars crown anatomy is rare. The available papers, the dental anatomy books and the analysis provide valuable information about the normal morphology and anatomic variations present in the upper molars.

The main objective of the present study is to present a review of the literature on the morphology of the dental crown of the first and second permanent maxillary molars, and to perform an evaluation of upper first molars (regarding the presence of the oblique ridge, frequency and classification of the molar tubercle) and of upper second molars (regarding the dental crown morphology).

Material and Methods

For the current study, a literature review was conducted after searching papers in scientific bases like SciELO, Scopus, Bireme, Google Scholar, PubMed, and dental anatomy books.

Evaluations were made by direct observation, without any instrument, in 372 permanent upper first molars and 401 permanent upper second molars, belonging to the didactic collection of the Discipline of Anatomy of the Department of Morphology of the School of Dentistry at Universidade Estadual Paulista (UNESP), Araraquara, SP, Brazil.

The frequency and classification of the upper molars were made according to Sousa et al.⁷

In the permanent upper first molar, the presence of the oblique ridge, frequency and classification of the molar tubercle were evaluated. In the permanent upper second molar, the

crown morphology (tetracuspid, tricuspid or compressed) and the molar tubercle frequency were evaluated.

Results and Discussion

The calcification of the permanent first upper molar begins at birth and its eruption occurs around the age of 6. The end of calcification occurs between the ages of 9 and 10.¹ The dimensions are larger than those of the upper second molar and may range according to gender.¹

The permanent upper molars have a larger buccolingual dimension compared with the mesiodistal one.^{1,5,16} According to Della Serra & Ferreira,⁸ the buccolingual dimension of the upper first molar is ~ 12 mm, and the mesiodistal dimension is ~ 10 mm.

According to Della Serra,⁴ the total length of the permanent upper first molar can range from 20.80 mm to 25.00 mm. According to Picosse,¹ the total length mean of those teeth in women was 21.41 mm, and in male it was 20.99 mm. Regarding the crown length of the upper first molar, Picosse¹ reported a dimension of 8.44 mm in men and 7.29 mm in women; a buccolingual dimension of 11.83 mm in men and 11.70 in women; and a mesiodistal dimension of 11.30 mm in men and 10.80 in women. Similar values were described by Della Serra,⁴ who reported a crown length of 8.44 mm; a buccolingual dimension ranging from 11.0 to 12.0 mm; and a mesiodistal dimension ranging from 10.0 to 11.0 mm.

The upper first molars always present a structure connecting the mesiolingual and distobuccal cusps, and it is called oblique ridge or enamel bridge, on the occlusal surface. According to Della Serra,⁴ the oblique ridge is always found in the occlusal surface of the upper first molars, and it may be continuous or interrupted by a supplemental groove (20.4%). We disagree with Della Serra⁴ regarding the type of groove that interrupts the oblique ridge. We consider it to be a development groove. Madeira & Rizzolo⁵ reported that the oblique ridge is always present in the permanent upper first molar, and the groove only deepens the central part without interrupting it, and they cited that, in fact, it is the oblique ridge that interrupts the groove. All the 372 permanent upper first molars evaluated in the present study presented the oblique ridge on the occlusal surface, connecting the mesiolingual and distobuccal cusps.

The developmental grooves have an H-shaped arrangement, which separates the four cusps¹ (►Fig. 1). In the direction of the mesial occlusal pit to the central occlusal pit, there is a groove separating the mesial cusps. The buccal cusps are separated by a groove that connects the buccal surface to the central occlusal pit. The lingual cusps are separated by a curved groove that connects the lingual surface to the distal occlusal pit.^{1,5,9}

These three grooves may be connected to each other by the presence of an inconstant groove that, starting from the central pit, will find the distolingual groove near the distal pit. This groove, when present, creates with the other grooves a shape that resembles an inclined "H."¹

The permanent upper first molar presents an exception compared with the other teeth. The buccal surface is smaller than the lingual one.^{4,5,9,10} This feature makes the proximal



Fig. 1 Permanent upper first molars. (A) Absence of molar tubercle. (B) Type I molar tubercle (depression). (C) Type II molar tubercle (small prominence). (D) Type III molar tubercle (big prominence).

surfaces slightly converge to the buccal surface, and not to the lingual one, as occurs with the other teeth.⁵ According to Della Serra,⁴ the lingual surface shows evident convexity and presents a dimension of ~ 10.2 mm.

The buccal surface presents a trapezium shape, convex in all directions.⁴ It is bordered by a cervical ridge, formed by two curved segments with concavity facing the root. The proximal ridges converge to the cervical area.^{1,4,10,13} The buccal surface presents the buccal groove, which is the continuity to the buccal-occlusal groove. The buccal groove begins in the occlusal surface, and it ends in the middle third of the buccal surface, just on the buccal pit, a very discrete triangle-shaped depression.^{1,4}

As on any other tooth, the mesial surface is larger and flatter than the distal one. The width of the mesial surface of the first upper molar on the dental cervix is about 10 mm, and on the occlusal third it is about 11.7 mm. The height of the mesial surface is about 7.5 mm.⁴ There is a convergence of the buccal and lingual ridges to the occlusal ridge; the lingual ridge is convex from the dental cervix to the occlusal surface, and the buccal ridge is convex on the cervical area and it remains

straight to the occlusal area.^{1,10} The distal surface has the same shape; however, with smaller dimensions and more convex shape if compared with the mesial one.^{1,5,10}

A frequency of 61.1% of the molar tubercle with variations in size and shape was reported,⁴ and, according to the author, it may be considered a fifth cusp. This tubercle may also be present in other molars, such as in the upper second molars. Della Serra & Ferreira⁸ observed a frequency of 1.7% in the second and third upper molars. However, according to Della Serra,⁴ it is present in the second molar if it also appears in the first molar, being morphologically similar. Thus, this structure alone cannot be distinctive between the upper molars.^{4,14}

The molar tubercle can be classified according to its anatomical shape: like a cuspid (5.3%), like a tubercle (2.1%), like a groove (30.1%), and like a pit (23.6%).⁴ Another classification was reported by Sousa et al.⁷ It may be a depression (Type I), a small prominence (Type II), or a big prominence (Type III).⁷ According to Woelfel & Scheid,⁹ when analyzing 1,558 first molars, they found a large Carabelli cusp in 19%, a small Carabelli cusp in 27.5%, a slight depression in 24%, and absence in 29.5%. The authors concluded that 70.5% of the teeth had a

Table 1 Frequency and classification (according to Sousa et al⁷) of the molar tubercle of permanent upper first molars in the didactic collection of the discipline of anatomy of the department of morphology of the School of Dentistry of Universidade Estadual Paulista (UNESP), Araraquara, São Paulo, Brazil

Classification	Frequency (%)
Absent	270 (72.6)
Type I	33 (8.9)
Type II	34 (9.1)
Type III	35 (9.4)
Total	372 (100.0)

molar tubercle. We found a different frequency when the 372 upper first molars were analyzed (**Table 1**; **Fig. 1**). We observed the absence of the molar tubercle in 270 teeth (72.6%) (**Fig. 1**). However, its presence was found in 102 teeth (27.4%), and it was always present in the mesiolingual cusp, as demonstrated by the study of Meredith & Hixon.¹¹ Ferreira et al¹⁵ evaluated 192 permanent upper first molars in 126 Brazilian individuals, and observed the absence of the molar tubercle in 92 teeth (47.91%).

In the present study, the expression of the molar tubercle in the permanent first molars was similar for types I, II, and III (**Fig. 1**). However, for Ferreira et al,¹⁵ the expression of the most common molar tubercle was type I, present in 30.12%, followed by small prominence (type II), with the big prominence being the least observed.

Ferreira et al¹⁵ evaluated 402 teeth, with 210 being deciduous and 192 permanent teeth. The authors reported that the most frequent molar tubercle morphology was depression in primary teeth (57.14%) and in permanent teeth (30.12%), followed by small prominence. The prominent morphology was the least observed, and the absence of molar tubercle was observed in 30.48% of primary teeth and in 47.91% of permanent teeth. The authors¹⁵ also observed a significant association between the presence of the molar tubercle and the dentition, with the primary dentition being the most affected. The molar tubercle was observed in 69.52% of the evaluated primary second molars and 52.09% of the permanent first molars. Sexual dimorphism related to the presence or absence of the molar tubercle was also observed, with a higher prevalence in men.

The upper first molar presents three roots. Among them, two are buccal roots (mesiobuccal and distobuccal) and one is a lingual root (the largest, longest, most conical and most regular).^{5,9,13} Fusion of dental roots is not frequent, and, when it appears, it is usually between the buccal roots, and/or between the distobuccal and lingual roots.^{1,4}

The upper second molar is present distally to the permanent upper first molar. Its calcification begins around the ages of 2.5 and 3; its eruption occurs around the ages of 13 and 15, and the end of calcification around the ages of 14 and 16.¹ Comparing it to the upper first molar, its dimensions are smaller.

The total length of the upper second molars range from 20.0 to 24.0 mm, the crown height ranges from 7.11 to 8.00



Fig. 2 Permanent upper second molar. Tetracuspid morphology.

mm, the mesiodistal crown dimension ranges from 9.2 to 10.5 mm, the mesiodistal crown dimension in cervical cervix area ranges from 6.7 to 9.0 mm, the maximum buccolingual dimension of the crown ranges from 11.0 to 12.0 mm, and the length of the roots ranges from 12.95 to 16.0 mm.⁴

It is verified from the buccal surface view, that the distobuccal cusp is smaller than the mesiobuccal one. This difference leads a cervical inclination of the occlusal ridge from mesial to distal direction. The developmental grooves (which separates the cusps) are smaller and uncommonly end in a pit.⁵

The mesial surface is almost flat, and the distal surface presents a slight convexity.^{3,17}

The rhomboid morphology, which is tetracuspid, resembles the shape of the upper first molar, although the fourth cusp is decreased (**Fig. 2**). All cusps and marginal ridges are perfectly differentiated. These cusps have different sizes, with the mesiolingual cusp being the largest one. Following the mesiolingual cusp, in decreasing order, is the mesiobuccal, the distobuccal and the distolingual cusps.¹ The oblique ridge is less frequent and when it appears it is not very high.^{1,5} The grooves are basically those described in the upper first molar, with the difference that the groove that connects the central pit to the distal pit, crossing the oblique ridge, is much deeper, actually dividing it, and creating an H-shape effectively.⁵

In the evaluation of the 401 upper second molars of Brazilian individuals, we observed that 197 (64.83%) presented the tetracuspid morphology. In those teeth, the presence of oblique ridge was observed in 153 (77.66%) teeth. Of these, the presence of oblique ridge was observed in 153 teeth (77.66%). Picosse¹ reported a frequency of 30 to 40% of the tetracuspid morphology. Della Serra⁴ reports different frequencies of tetracuspid morphology of upper second molars, ranging from

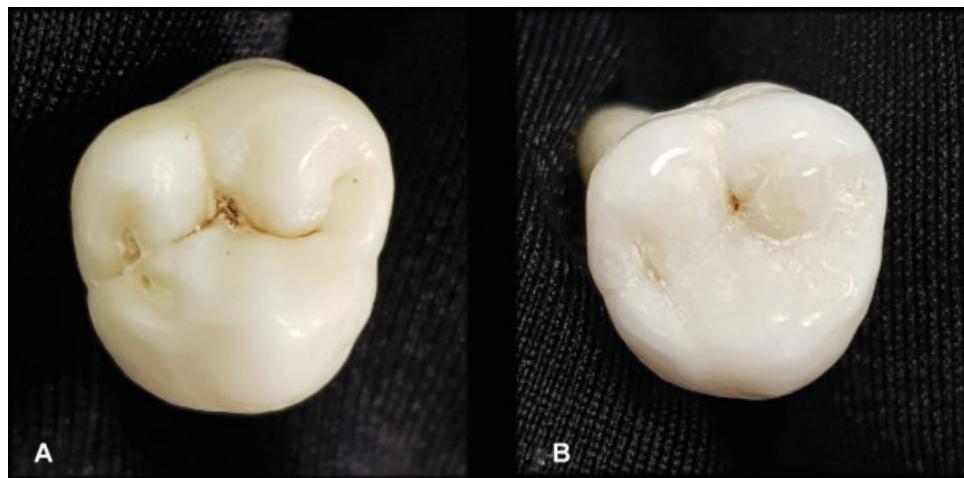


Fig. 3 Permanent upper second molars. (A) Tricuspid with very prominent oblique ridge. (B) Tricuspid with small prominent oblique ridge.

93.7 to 1.3%, with 93.7% being observed in Melanesians; 69.4% in Semites, Berbers and Egyptians; 46% found in Portuguese; 45.6% in Europeans and 1.3% in Swiss. Analyzing 97 Brazilian teeth, Della Serra⁴ observed that 56.7% of the teeth were tetracuspid.

The second classification of the upper second molars is the triangle morphology. Those teeth present the absence of the distolingual cusp. The lingual dimension decreases the occlusal surface and shows only three cusps. The grooves resemble a "T," whose distal segment is directed toward the lingual surface.^{1,16}

From the 401 upper second molars, we observed that 141 teeth (35.16%) were tricuspid. From the same sample, the presence of oblique ridge was evaluated. From the 100 tricuspid upper second molars, 50 teeth (50%) presented oblique ridge, and in 15 (30%) the oblique ridge was very prominent, and 50% slightly prominent (**►Fig. 3**). According to Picosse,¹ the tricuspid morphology is the most common, present in ~ 50% of the cases. Della Serra⁷ reports different frequencies of tricuspid morphology of upper second molars: 54.4% in Europeans; 46% in Portuguese; 31.6% in

Semites, Berbers and, and 7.3% in Melanesians. In Brazilians, Della Serra⁴ mentioned a frequency of 43.2%.

The third form of classification of the upper second molars is the compression morphology.^{1,4,5,11,16} This morphology is characterized by a tetracuspid tooth that seems to have suffered a compression in the distobuccal and mesiolingual ridges, joining the mesiolingual and distobuccal angles.¹⁶ From the occlusal view, the crown presents an ellipsoid morphology.¹ The mesiobuccal and distolingual cusps can be connected by an oblique ridge. In teeth in which those cusps are very close, they may be fused, creating a tricuspid tooth, by the loss of the fourth cusp.⁴ According to Sicher,¹² in the original morphology of the tricuspid upper second molar, the cusps are arranged in a straight line. The mesiobuccal cusp is located alongside a cusp, which is derived from the merging of the distobuccal cusp with the mesiolingual one.¹²

From the 401 evaluated upper second molars, 69 (17.02%) presented a compression morphology (**►Fig. 4**). According to the literature, this classification is present in 5 to 10% of the cases.^{5,18} According to Picosse,¹ this morphology can be present in 10% of the cases, much more than in the upper



Fig. 4 Permanent upper second molars. (A) Compression morphology with a deep groove crossing the oblique ridge. (B) Compression morphology with a prominent oblique ridge.

first molar, in which the frequency is rarer. Della Serra⁴ reports that this morphology is present in 5% of cases. In Portuguese people, the frequency is 18.7%.⁴ Della Serra⁴ observed a frequency of 4.3% of a small compression in upper first molars; the upper second molars presented a much higher frequency, 36% presented mild compression, and 7.2% presented high compression, while the third molars presented 16% of small compression, and 7.1% presented high compression.

None of the 401 upper second molars presented molar tubercle. According to Sicher,¹² the presence of molar tubercle in the upper second molar can occur, but it is rare. Woelfel & Scheid⁹ reported that the presence of tubercles in the upper second and third molars is not so common. Madeira⁵ stated that there is no molar tubercle in the upper second molar, similarly to our results.

The upper second molar presents three roots: the lingual root, which is the highest one, and the mesiobuccal and distobuccal roots.^{1,5} Compared with the upper first molar, the roots divergence is lower^{1,2} and presents a higher fusion frequency, mainly between the mesiobuccal and the lingual root.^{1,2,5,8,12,19}

Conclusion

Regarding the permanent upper first molars, they were all tetracuspid and presented the oblique ridge connecting the mesiolingual and the distobuccal cusps. The molar tubercle was absent in most of the evaluated teeth, and, when present, it was located in the mesiolingual cusp.

Most of the evaluated permanent upper second molars were tetracuspid, followed by tricuspid and compression morphology. The oblique ridge was present in most of the tetracuspid teeth and only in a few tricuspid teeth. The compression morphology was the least frequent. None of the evaluated upper second molars showed molar tubercle.

Although there are similarities between the upper first and second molars, we must always be aware of the features that differentiate them, so their functionality can be restored.

Conflicts of Interest

The authors have no conflicts of interest to declare.

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