

Permanent human canines: their importance for dental anatomy teaching.

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Abstract

Objectives: Permanent canines have an important functional role during mastication due to their anatomy, besides its relevance in oral esthetics. However, dentistry undergraduates have great difficulty in differentiating them during dental anatomy classes. The objective of this work was to study the morphology of the extracted permanent maxillary canines (MC) and lower canine (LC) in order to describe the anatomical similarities and differences.

Methods: One hundred maxillary canines and 100 lower canines were evaluated. Measurements were performed using a digital caliper, and also visual analysis. The data obtained in each evaluation were submitted to descriptive statistical analysis, and the chi-square test and Fisher's exact test with a significance level of 5% were applied.

Results: It was observed that the MC root groove was present on the two proximal surfaces and the groove depth was greater on the mesial surface, as reported in the literature. The MC incisal ridge was normally worn, and imprecision in dental differentiation could occur during the anatomical study, while it is stated that the incisal ridge allows distinguishing this tooth by a simple visual examination. The marginal ridges of the MC had a moderate prominence, as observed in the literature. The MC cingulum often presented a moderate prominence, contradicting some studies which reported a large cingulum. The presence of the cervicoincisal ridge on the lingual surface was frequently observed with moderate, absent or little prominence, while some authors reported that this structure is quite evident. Furthermore, it is reported that MC usually presents a foramen cecum, which was not observed in our sample. LC often presented a worn incisal ridge. The cingulum, marginal ridges, lingual fossa and developmental grooves were less evident and, in some cases, the lingual surface presented a flat shape, which is not usually reported in the literature.

Conclusions: The morphological differences and similarities of MC and LC are important for a detailed anatomical study to help dentistry undergraduates identify them correctly. Furthermore, the anatomical study is important for the restorative area for an appropriate aesthetics and function rehabilitation.

Keywords: anatomy, canine tooth, morphology.

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Introduction

In the oral cavity, anterior teeth have a great functional and aesthetic importance,¹ especially the canines, as they are considered foundations due to their location in the curvature of the tooth arch. The name canine is of Greek origin,² and this tooth receives this name due to the similarity to the tusks of dogs.

Canines play an important role during chewing due to their anatomy that resembles a spear, with the function of piercing and tearing food.³ Besides, it acts protecting the other teeth, avoiding harmful excessive horizontal forces affecting the posterior teeth during some excursive movements of the mandible.²

MC are the longest teeth in the mouth, surpassing both the crown and the root, which is long and robust,²⁻⁴ allowing a secure anchor in the alveolar process.² In comparison, LC has a smaller dimension with similar anatomical features.²⁻⁴ The root is 1 or 2 mm shorter than the MC, with a biradicular prevalence around 5%,⁴ and the anatomical details on the lingual surface of the LC are less evident.⁵

However, there are some anatomical questions, according to Vieira.⁵ In LC, normally the apical third of the root is directed to mesial, while the superior third is often distally bent. However, Madeira & Rizzolo⁴ reported that this inclination usually occurs distally and, in MC, the apical third of the root rarely deviates sharply towards the distal surface.

Anatomical knowledge of these dental elements is crucial for several procedures and areas such as endodontics.^{1, 6-8} External treatments such as canine reanatomization in case of maxillary lateral incisor agenesis are frequent.⁹⁻¹¹ Aesthetic dentistry applies dental morphology in order to achieve proportions in the smile that harmonize with the face.^{9,10,12}

Thus, the importance of knowledge of the individual anatomy of teeth is noted. During the study of canine anatomy in Dental Anatomy classes, dentistry undergraduates often experience difficulties in differentiating between maxillary and lower canines, and between lower canines and maxillary lateral incisors (MLI). The MLI vary a lot in terms of shape, and may present a pointed shape of the crown, besides malformations,⁴ which may generate doubts during the individual study of teeth and students may confuse it with canine or vice versa.

Despite the numerous books on dental anatomy, there are rare scientific papers that cover a detailed study of the external anatomy of teeth, especially canines. Thus, it is mainly



relevant for the area of dental anatomy and for the clinical area focused on aesthetics, the development of studies focused on the dental anatomy of upper and lower canines, in order to clarify and obtain valuable new information on this topic.

The present study proposed to evaluate the morphology of the extracted maxillary and lower canines, verifying the anatomical similarities and differences between them.

Material and methods

This project was approved by the Ethics Committee of School of Dentistry, Araraquara, (CAAE: 18128719.8.0000.5416). One hundred MC and 100 CI belonging to the teaching collection of the Department of Morphology of Universidade Estadual de Paulista (UNESP), School of Dentistry, Araraquara, were evaluated.

Healthy maxillary and lower canines were evaluated, excluding teeth with caries lesions, fractures that hinder the assessment and execution of the measurements. Measurements were performed with a digital caliper (Absolute AOS Digimatic - Mitutoyo® Sul Americana Ltda), and also visual assessments were made

Statistical analysis

The data obtained in each evaluation were subjected to descriptive statistical analysis and the chi-square and Fisher's exact statistical tests with a significance level of 5% were applied.

Results

The metric evaluations with the minimum, maximum, mean values in millimeters and standard deviation (SD) of the maxillary canines (MC) and lower canines (LC) are shown in Table 1. It can be observed that all measurements performed were higher in the MC.



Table 1. Measures of the evaluated structures of the maxillary canines (MC) and lower canines (LC). Minimum, maximum value, mean in millimeters and standard deviation (SD).

Structure	MC				LC			
	Minimum	Maximum	Mean	SD	Minimum	Maximum	Mean	SD
Buccal surface of the crown								
Cervicoincisal distance	8.4	14.2	10.6	1.2	7.3	13.3	10.3	1.1
Mesiodistal distance	6.9	9.9	7.8	0.5	5.8	7.9	6.7	0.4
Lingual surface of the crown								
Cervicoincisal distance	5.5	13.7	10.6	1.3	7.1	11.6	9.4	0.9
Mesiodistal distance	5.3	9.0	7.7	0.5	5.5	8.5	6.7	0.5
Mesial surface of the crown								
Cervicoincisal distance	4.0	11.6	7.3	1.3	4.9	9.2	6.4	0.8
Buccolingual distance	3.8	8.4	5.4	0.7	3.2	7.7	4.7	0.7
Distal surface of the crown								
Cervicoincisal distance	5.1	10.9	7.8	1.3	4.5	9.1	6.4	0.8
Buccolingual distance	3.5	7.7	5.1	0.7	2.9	8.0	4.4	0.7
Buccal surface of the root								
Cervicoapical distance	11.9	21.6	16.9	1.9	12.4	19.5	14.9	1.5
Mesiodistal distance	4.1	6.7	5.5	0.5	3.9	6.6	5.0	0.4
Lingual surface of the root								
Cervicoapical distance	13.4	22.6	17.5	2.0	5.2	22.2	15.4	2.1
Mesiodistal distance	4.0	6.8	4.9	0.5	3.4	9.7	4.8	1.0
Mesial surface of the root								
Cervicoapical distance	14.9	24.5	19.1	2.1	13.4	21.9	17.0	1.7
Buccolingual distance	5.3	9.9	7.7	0.9	3.3	9.5	7.3	0.8
Distal surface of the root								
Cervicoapical distance	13.9	24.1	18.2	2.0	13.0	20.7	16.1	1.7
Buccolingual distance	4.4	10.5	7.5	0.9	5.9	9.5	7.3	0.6
Incisal ridge								
Mesial slope measurement	2.3	6.3	4.0	0.7	2.1	5.4	3.2	0.6
Distal slope measurement	1.7	6.9	4.4	1.0	1.4	6.6	4.3	0.7
Overall length	22.4	34.2	27.1	2.3	20.8	30.5	24.4	1.9

Visual assessments of MC and LC are shown in Table 2.

Table 2. Distribution of features observed in the maxillary (MC) and lower (LC) canines.

Structure	MC	LC	p
Root apex			
Rectilinear	36	60	<0.0001
Distal curve	46	19	
Mesial curve	16	15	
Buccal curve	2	6	
Lingual curve	0	0	



Root grooves			
Present on the distal surface	6	4	
Present on the mesial surface	4	14	
Present on both sides	74	80	
Absent	16	2	<0.0001
Deeper root groove			
Mesial	66	38	
Distal	20	60	
Absent	14	2	<0.0001
Cervical line with greater curvature			
Mesial	91	95	
Distal	9	5	0.407
Cusp morphology			
Pointed	34	10	
Pointless	11	24	
With wear	55	63	
Straight (no wear)	0	3	<0.0001
Cusp position			
Centralized	50	33	
Mesial	31	55	
Distal	19	12	0.003
Inclination of the buccal surface from mesial to distal			
Evident	66	89	
Not evident	34	11	<0.0001
Size of marginal ridges			
Very prominent	17	0	
Moderate prominence	51	12	
Little prominence	32	63	
No prominence	0	25	<0.0001
Cingulum size			
Very prominent	24	1	
Moderate prominence	48	16	
Little prominent	26	58	
Flat	2	25	<0.0001
Presence of the cervicoincisal crest on the lingual surface			
Very prominent	7	0	
Moderate prominence	35	1	
Small prominence	26	39	
Absent	32	60	0.020
Lingual fossa depth			
Very deep	9	0	
Moderate depth	42	15	
Shallow	41	60	
Same level of marginal ridges	8	25	<0.0001

It can be seen that the position of the rectilinear and distally curved root apex occurred more frequently in the MC, while in the LC the straight root apex was more frequent, with a statistically significant difference between the teeth ($p < 0.0001$). The root groove was present on the two proximal surfaces of both teeth, but in different ways, with a statistically significant difference between them ($p < 0.0001$). The groove depth was



greater on the mesial surface of the MC, and on the LC, the groove with greater depth was on the distal surface, with a statistically significant difference between the teeth ($p < 0.0001$).

The cervical line with the most closed curvature for both teeth was the mesial one, with no statistically significant difference between the teeth ($p = 0.407$). The cusp morphology in the MC and LC frequently presented with wear ($p < 0.0001$).

Most of MC presented centralized cusp position, and in the LC, its position was mesial, with a statistically significant difference between the teeth ($p = 0.003$).

The inclination of the buccal surface from mesial to distal was evident in both teeth, but there was a statistically significant difference between the them ($p < 0.0001$), being more evident on LC.

The cingulum on the CS frequently showed a moderate prominence, as well as the size of the marginal ridges, while the cingulum and marginal ridges on the LC were not very prominent ($p < 0.0001$).

The presence of the cervicoincisal crest on the lingual surface of the MC was frequently observed with moderate, absent or slightly prominent prominence, and on LC, it was absent (60%), followed by small prominence (29%) ($p = 0.020$).

The lingual fossa on the MC presented a moderate and shallow depth, whereas the highest frequency on the LC was shallow ($p < 0.0001$).

Discussion

With the functionalities of chewing, protection of other teeth and aesthetics that permanent canines present in the oral cavity^{2,3,5} it is of great importance performing anatomical studies to facilitate understanding and learning of dentistry undergraduates regarding the difference and similarity of MC and LC, since there are few studies in the literature related to the external morphology of teeth. Furthermore, the anatomical study is important for the restorative area for an appropriate aesthetics and function rehabilitation.

Canines are the longest human teeth,^{2,13} with an aspect of strength and robustness;⁴ its cups tips exceed the occlusal plane of the other teeth. In the present study, the mean total length of the MC was 27.1 mm compared to 24.4 mm for the LC.



MC is the first tooth that is implanted in the maxillary bone itself,^{3,13} since the maxillary incisors are implanted in the incisor bone. Its crown has vertical and transverse dimensions with similar values. Its calcification begins around 5 to 6 months; its eruption occurs around 11 to 12 years, and its calcification ends around 10 to 13 years. LC presents calcification at 4 to 7 months; its eruption occurs around 9 to 10 years, and calcification ends at 10 to 13 years.¹³

According to Della Serra & Ferreira,³ the total length of the MC varies from 26.8 mm to 32.0 mm; root length ranges from 16.0 mm to 20.0 mm; crown length ranges from 9.39 mm to 12.0 mm; the mesiodistal distance varies from 7.6 mm to 9.0 mm and the buccolingual distance from the crown varies from 8 mm to 9.0 mm. These data is similar to our results, with some variations, mainly related to the measurements of the buccolingual distance. In our study, we observed a variation in the measure of the buccolingual distance of the crown from 3.8 mm to 8.4 mm, with a mean value of 5.4 mm, which is smaller than those above mentioned. This variation may be related to the measurement instruments and also to the areas of performed measurements, which were not mentioned by the authors.

LC has an average overall length ranging from 24.0 mm to 32.0 mm; root length ranges from 14.0 mm to 20.0 mm; crown length ranges from 9.0 mm to 12.0 mm; the mesiodistal distance ranges from 6.7 mm to 8.0 mm and the buccolingual distance from the crown ranges from 7.5 mm to 9.0 mm. These data are also similar to our results, with some variations, being the most striking difference related to the the buccolingual distance of the crown. The average of this distance in our study was 4.7 mm, ranging from 3.3 mm to 7.7 mm.

The buccal surface of the MC is lance-shaped and can be described as a pentagon with rounded edges and angles, with a lot of convexity in all directions (Figure 1). MC presents a greater mesiodistal distance compared to the LC, more accentuated developmental grooves that separate three lobes of unequal size. The middle lobe is the largest one, corresponding to the position of the cusp tip; distal and mesial lobes are smaller and end at cusp ridges.^{2,3,4,13}

On MC, the mesial slope of the cusp is shorter than the distal one, with an average length of 4.04 mm (Table 1), which makes possible to differentiate the proximal surfaces, but after tooth wear there may be an inversion of disposition.^{3,13}

The buccal surface of the LC is similar to the MC, but LC has a more elongated aspect with a larger cervicoincisal dimension, and a smaller mesiodistal distance.^{2,5,13} Although the

cervicoincisal and mesiodistal distances were both greater in the CS, we calculated the proportion of these distances using the measurements made on the buccal surface. The proportion was 1.53 on LC, and on MC, it was 1.35, demonstrating that the LC has a tendency to present a narrow in the mesiodistal direction.

Due to the greater narrowing of the LC than MC, the buccal surface of LC is more convex, but the cervicoincisal crest is not so marked, and its developmental grooves are also less evident. When dividing the buccal surface in half, the distal half is wider and extends distally, and the mesial half is more robust and projects buccally, as observed on MC.⁴ (Figure 1).



Figure 1. A) Buccal surface of the MC. B) Buccal surface of the LC.

On both canines, the lingual surface presents a cingulum, marginal ridges, lingual fossa and developmental grooves, but these characteristics are less evident on the LC.^{3,4,13} These features were also observed in our study, with LC presenting less prominent cingulum, marginal ridges and lingual fossa.

MC has a pentagonal and very convex shape in the cervical third,¹³ a large cingulum that is centralized,² which can form a true cusp due to its large size. Most of the canines of our study presented moderate prominence cingulum, and we noticed that it was rare to find LC with a very prominent cingulum (1%), and 25% presented a flat shape, with no prominence.

Frequently, MC presents marginal ridges with moderate prominence,² such as noted in our study. MC with marginal ridges without prominence were not observed, as well as no marginal ridges with great prominence were found on the LC. According to Picosse,¹³ MC usually presents a foramen cecum, which was not observed in our sample.



Figure 2. A) Proximal view: Cingulum on the MC. B) Proximal view: Cingulum on the LC. C) Lingual surface of the MC. D) Lingual surface of the LC.

The contact surfaces of MC are triangular, convex in the buccolingual direction, being more accentuated in the incisal third. However, near the cervical region, the contact surfaces become slightly depressed or flat. The mesial surface is flatter, less excavated in the cervical third and present a more discrete modeling than the distal surface, which is smaller and more convex.^{4,13}

The LC contact surfaces are also triangular and slightly convex in the incisal third. The cervical line is lower on the lingual surface compared to the buccal side.¹³ The contact surfaces are narrower and more elongated compared to MC.¹³

With a lance or perforating shape, the incisal ridge of the MC allows this tooth to be distinguished by a simple visual examination. It has a pentagon shape or a letter V with open and unequal slopes, with the distal ridge larger and more inclined than the mesial slope.^{2-4,13} In our study, the MC incisal ridge was normally worn (55%), and a pointed cusp morphology was also observed with some frequency (34%). LC incisal ridge also presented a V appearance, however, wear distinguishes it from MC,¹³ and changes the position of the cusp to the mesial, as demonstrated in our study. Most of the LC incisal ridges were worn (63%), or and with a pointless cusp morphology (24%).

MC has the largest tooth root; it is largest on the buccal surface than on the lingual side,^{2,13} which forms prominence on the buccal surface of the alveolar process, named canine eminence, sometimes perforating the thin layer of cortical bone.¹³ It is conical, It has a conicity with a degree of mesiodistal narrowing.¹³ In some cases the root can reach twice the length of the crown.⁴ We observed an average length of the MS root mesial surface of 19.1 mm the average length of the crown was 7.3 mm, the root may be more than twice as long as the crown.

The root of the LC is shorter compared to the MS, less wide and narrower in the mesiodistal direction,^{2,4,13} which in many cases can configure two roots in this tooth,^{2,13} with a frequency of 5% cases of biradicular LC. Biradicular teeth were not observed in our sample. The deepest cervicoapical root groove is located on the distal surface,^{2,4} (Table 2, Figure 3).

MC root presents mesial and distal grooves, distal deviation due to its long length,^{5,13} and the angle formed between the root and the distal surface of the crown is accentuated, allowing us to know which side the tooth belongs to.¹³ According to Woelfel & Scheid,² the deepest cervicoapical groove of MC is located on the mesial surface. The same feature was observed in our study. Furthermore, we verified that the cervical line with the greatest curvature for both teeth was on the mesial surface, with no statistically significant difference between MC and LC.

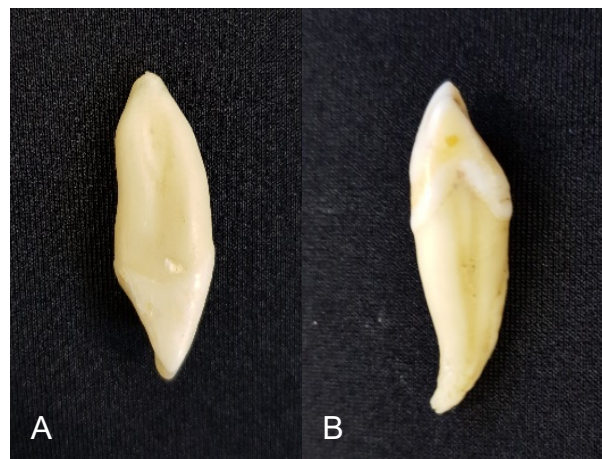


Figure 3. A) Root groove on the MC. B) Root groove on the LC.

According to Madeira & Rizzolo,⁴ the root of the LC often bends distally, or at least its apical third, however, Vieira (2018) stated that the apical third of the root is frequently bent



to mesial. In our study, 60% of the LC presented a rectilinear root apex, contradicting both authors.

The anatomical features of the canines are extremely important for the study of dental anatomy.

It was verified that the MC crown is greater in the mesiodistal distance and smaller in the cervicoincisal distance, presenting a difference between length and width; the cusp tip usually presents with wear. Normally, marginal ridges with moderate prominence were observed; the cingulum, marginal ridges, lingual fossa and developmental grooves were more evident compared to LC. The deepest cervicoapical root groove was located on the mesial surface; the cervical line with greater curvature was present on the mesial surface. The root apex were distally bent. Our results corroborate with the literature.^{3,4,13} However, Picosse¹³ reported that MC usually presents a foramen cecum, which was not observed in our sample.

LC often presented a worn incisal ridge. The cingulum, marginal ridges, lingual fossa and developmental grooves were less evident and, in some cases, the lingual surface presented a flat shape, which is not usually reported in the literature. The mesial surface also presented the cervical line with greater curvature. In the literature, it is reported that the LC root often bends distally,⁴ or mesially.⁵ However, in our study, most of LC presented a rectilinear root apex.

Conclusion

The morphological differences and similarities of MC and LC are important for a detailed anatomical study to help dentistry undergraduates identify them correctly. Furthermore, the anatomical study is important for the restorative area for an appropriate aesthetics and function rehabilitation.

Conflicts of Interest

The authors have no conflicts of interest to declare.



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