

A Contribution to the Anatomical Study of the Mandibular Premolars

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Abstract

Introduction During the practical classes of Dental Anatomy, some students have difficulties in identifying the mandibular first premolars, especially in determining the proximal surfaces.

Objective The objective of this study was to evaluate the anatomical structures of those teeth, to determine the criteria for identifying the proximal surfaces in individual teeth.

Materials and Methods Two hundred mandibular first premolars belonging to 100 individuals, at the age of 18 to 25 years old and from both sexes were evaluated according to some features of the dental crown. The associations of interest were estimated using the chi-square test or Fisher's Exact Test and kappa statistic. The level of significance was 5%.

Results The distal occlusal fossa (DOF) was the widest fossa (94.5%), and the distal surface constituted the proximal surface with the largest dimension (94.5%). It was found that in 60% of the teeth, the DOF was located closer to the lingual surface. The grooves from the mesial and distal occlusal fossa, toward the lingual surface, were absent in most teeth (64.5% and 91.5%, respectively).

Conclusions The criteria for determining the proximal surfaces when evaluating individual first mandibular premolars should be: DOF will be the widest occlusal fossa; the proximal surface with the largest buccolingual dimension will be the distal surface. The occlusal fossa which is closer to the lingual surface may also be evaluated, being considered as the DOF. However, this should be considered the last of the three highlighted criteria, since it generates a greater margin of error in relation to the others.

Keywords

- anatomy
- premolar
- dental crown
- dental education

Introduction

Normal shapes of the teeth, suitable arrangement on dental arch and natural occlusion are closely related to a functional performance and a physiological action. The shape of the

tooth has an important role in masticating and protecting periodontal tissue.¹ Knowledge of tooth morphology and function is fundamental to all aspects of dental practice,² and it is essential to establish a correct diagnosis, to indicate the appropriate treatment and to avoid complications during

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certain procedures like dental extractions, endodontic treatments, and surgical procedures.³

The discipline of Dental Anatomy is a component of the Basic Sciences in the program of Dentistry Schools⁴ that comprises the study and organization of the tooth as an isolated entity and as an integrant of both dental and masticatory systems.⁵ The professional (dental surgeon) who is committed to the preservation of human teeth should have a clear understanding of the characteristics and fundamentals of dental morphology.⁵ The learning process is mainly based on the identification of natural teeth, the study of stone or resin macro models,^{4,5} the computer-assisted learning program⁶ or even internet resources.⁷

Most dental anatomy textbooks describe the human dentition appropriately, but sometimes they fail in providing details, such as the variation in external root anatomy and internal root canal systems, as in the case of the mandibular first and second premolars.⁸ According to Kraus and Furr (1953),⁹ the mandibular first premolar shows an extremely wide range of morphologic variability.⁹ From all the teeth of the human denture, the first mandibular premolar is the most interesting morphologically.¹⁰

The first mandibular premolar is usually described as uniradicular, with an oval cross-section.^{11,12} However, there may be variability in root morphology, such as the presence of three roots and variation in the number of canals.^{3,8,13}

As noticed relating to the roots of the mandibular first premolars, morphological variations in the dental crown of these teeth can also be observed. Kraus and Furr (1953)⁹ published a relevant study about the morphology of the first mandibular premolars, describing seventeen different structures of the dental crown and the variations related to some of them, such as the number of lingual cusps, the position of the enamel ridge, and the grooves on the lingual surface.⁹

Dental anomalies involving the mandibular first premolars are rare, but they may occur, as in the case report of a 33-year-old man who presented bilateral *Dens invaginatus* (*dens in dente*) that is a rare developmental anomaly resulting from invagination of a portion of the dental crown. It is an important dental anomaly, due to the possible pulpal involvement.¹⁴

There are few studies about premolar morphology,¹⁵ and the ones that exist do not study all the morphological characteristics, or use different methodologies.¹

During the practical classes of Dental Anatomy, we can see some students with difficulties in identifying the first premolars, especially in determining the proximal surfaces. We can see the literature describing some features that may facilitate the identification of proximal surfaces of those teeth, although there are few studies in which researchers performed standardized measures, and provided more detailed information. According to Madeira and Rizzolo (2016),¹² the distal occlusal fossa is the largest, and from both occlusal fossae (mesial and distal), the distal one is the closest to the lingual surface. These features may be facilitating the criteria for identifying the tooth's side.¹² However, these characteristics are not routinely described in dental anatomy textbooks or in research papers.

The aim of this study was to evaluate the morphology of mandibular first premolars in young individuals, in which anatomical criteria were determined to identify the proximal surfaces, improving the anatomical study when those teeth were analyzed individually analyzed.

Therefore, it is expected that this study upgrades the published data about the mandibular first premolars, improving the identification of the hemi-arch of the individual mandibular first premolar, during morphological study in Dental Anatomy Classes.

Materials and Methods

This project was approved by the Ethics Committee of São Paulo State University (UNESP), School of Dentistry, Araraquara (CAAE 17513313.6.0000.5416).

A clinical evaluation was performed and it was based on 200 mandibular first premolars belonging to 100 students of São Paulo State University (UNESP), School of Dentistry, Araraquara, at the age of 18 to 25 years old, from both sexes.

As an inclusion criterion, individuals with healthy mandibular first premolars were evaluated. The analyses of individuals with those teeth with caries lesions, fractured and/or restored teeth, or with the mandibular first premolars absent were not included.

The following structures were evaluated: size of mesial occlusal fossa (MOF) and distal occlusal fossa (DOF) (1 = discreet; 2 = small; 3 = medium; 4 = large), occlusal fossa located closer to the lingual surface, presence/absence of grooves in the lingual surface that emerged from MOF and DOF, and from which proximal surface showed larger buccolingual dimension.

It was used a visual criteria for the classification of the occlusal fossae. Photographs of occlusal surface of mandibular premolars were made, and discreet, small, medium and large fossae were exemplified, in order that the examiner could follow those patterns during the analysis.

The buccolingual dimension of the proximal surfaces was also evaluated by visual criteria, without any metric instrument. The apexes of the buccal and lingual cusps were taken as reference points, and the distance from the apex of the buccal cusp to the apex of the lingual cusp was analyzed in the mesial and distal surfaces.

The analyses were made by a qualified examiner. For calibration of the examiner, the teeth were analyzed in duplicate, with an interval of at least 7 days between the analyses. From the 100 students who constituted the sample, 15 (30 teeth) were randomly selected. The minimum sample size was estimated considering a minimum agreement of 0.50, power of 80% and $\alpha = 5\%$. The reproducibility was estimated using Kappa (k) Statistics when the data were dichotomous and Kappa statistic with linear weighting (kp) when the data were ordinal. It should be clarified that this step was necessary to ensure that evaluations were performed with an adequate accuracy.

To get the reproducibility of the two analyzes (initial and after interval), the measurements obtained from the initial evaluation were considered to compose the data of the study,

since the other 85 students, who constituted the sample, were evaluated only once.

The associations of interest were estimated using Chi-square test or Fisher's exact test. The agreement between the categories of the anatomical structures of the teeth (44×34) was assessed using kappa statistic. The significance level was 5%. To determine the number of teeth the rule of thumb was used, which recommends from 5 to 10 sample units per category of row and column variables. Therefore, considering that the test of association used in this study with the highest number of categories was $4 \times 4 (= 16)$, the minimum sample size should comprise from 80 to 160 teeth.

The criteria for identifying proximal surfaces of the mandibular first premolars were determined after the statistical analysis.

Results

From the 100 students, 80 were female. The intra-examiner reproducibility was performed in two different moments. Seven parameters were evaluated; four of them presented "Optimal" intra-examiner agreement (widest occlusal fossa, occlusal fossa closer to the lingual surface, proximal surface with the largest buccolingual dimension and groove from MOF; $\kappa = 1.0$), and three presented "good" agreement (MOF, DOF, groove from DOF, ranging from 0.609 to 0.762) (Kappa- κ).

The frequencies of the features observed in teeth 34 and 44 are presented in ►Table 1. It can be observed that the size of most MOF for both teeth was "discreet" and "small," with no statistically significant difference between the teeth ($p = 0.244$). However, for DOF, the most frequent sizes were "small" and "medium," and there were no significant differences between the teeth ($p = 0.966$). The widest occlusal fossa for both teeth was the distal one (►Table 1; ►Fig. 1).

For most of the evaluated teeth, the proximal surface with the largest buccolingual dimension was the distal surface, with no difference between the teeth ($p = 1.0$) (►Table 1). We could observe that the distal surface presented a rounded configuration, whereas the mesial surface had a pointed contour, as if it presented two segments (►Fig. 1).

The occlusal fossa located closest to the lingual surface was also the distal fossa, however a high frequency of symmetrical occlusal fossae (44% and 29% for 44 and 34, respectively) was observed, with no difference between the teeth ($p = 0.77$) (►Table 1; ►Fig. 2).

Grooves from MOF and DOF were not present in most individuals for 34 and 44 (►Table 1). ►Table 2 presents the coincidences of each anatomical structure evaluated in 34 and 44, in the same individual.

According to Kappa statistics, the agreement between 34 and 44 ranged from "weak" to "regular," except for the distal occlusal fossa that presented the "greatest" coincidence. Therefore, teeth 34 and 44 are not symmetrical, i.e., the size and morphology of the anatomical features assessed in the dental crown are not coincident on the right and left sides of the first mandibular premolars, in the same individual (►Table 2).

The frequencies of the anatomical features observed in 44 and 34, according to sex, are presented in ►Table 3. It can be

Table 1 Frequency of the anatomical features observed in teeth 44 and 34

| Anatomical Features | n | | p |
|---|----|----|-------|
| | 44 | 34 | |
| MFO | | | |
| Discreet | 42 | 45 | 0.244 |
| Small | 54 | 45 | |
| Medium | 4 | 9 | |
| Large | — | 1 | |
| DOF | | | |
| Discreet | — | — | 0.966 |
| Small | 37 | 38 | |
| Medium | 43 | 41 | |
| Large | 20 | 21 | |
| Widest Occlusal Fossa | | | |
| Distal | 94 | 95 | 0.118 |
| Mesial | — | 3 | |
| Symmetrical | 6 | 2 | |
| Occlusal fossa closer to the lingual surface | | | |
| Distal | 53 | 67 | 0.077 |
| Mesial | 3 | 4 | |
| Symmetrical | 44 | 29 | |
| Proximal surface with the largest buccolingual dimension | | | |
| Distal | 95 | 94 | 1.000 |
| Mesial | 3 | 4 | |
| Symmetrical | 2 | 2 | |
| Groove from MOF | | | |
| Absent | 68 | 61 | 0.301 |
| Present | 32 | 39 | |
| Groove from DOF | | | |
| Absent | 91 | 92 | 0.800 |
| Present | 9 | 8 | |

observed that there was no statistically significant association between the observed features and sex in 44 and 34 ($p > 0.05$).

From the 200 analyzed teeth, most presented DOF as the widest fossa, (94.5%), as well as the distal surface constituted the proximal surface with the largest buccolingual dimension (94.5%) (►Fig. 1).

When the occlusal fossa located closest to the lingual surface was evaluated, it was observed that in 60% of the examined teeth, the DOF occupied this position (►Fig. 1). In 36.5%, MOF and DOF occupied a symmetrical position, and in 3.5% MOF was closer to the lingual surface.

Regarding the grooves from the occlusal fossae, the groove from MOF (MOF groove) was more frequent (35.5%) compared with the groove from DOF (DOF groove) (8.5%), with no

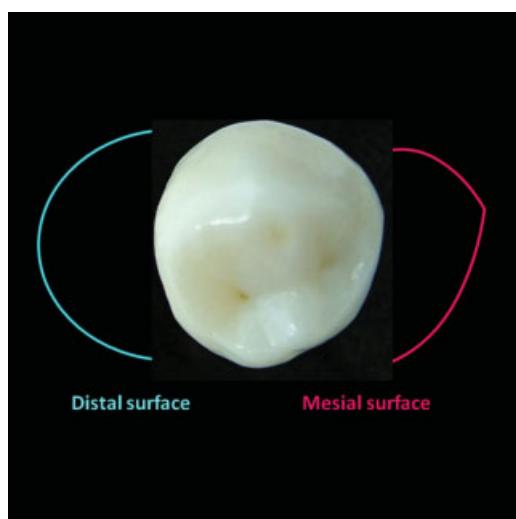


Fig. 1 Occlusal surface of a mandibular first premolar. MOF and DOF with different sizes. DOF is the widest one. Distal surface presenting the largest buccolingual dimension and a rounded configuration.

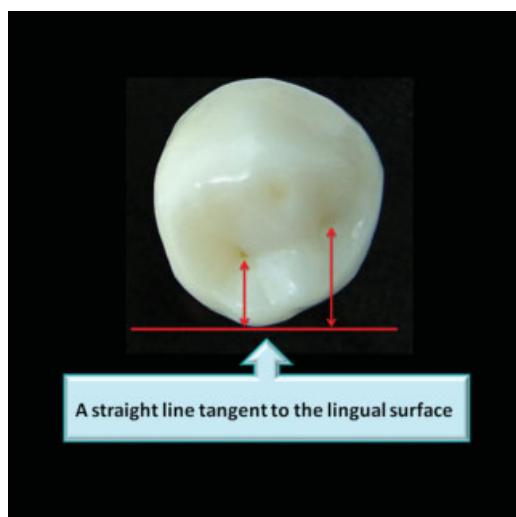


Fig. 2 Occlusal surface of a mandibular first premolar. DOF located closer to the line tangent to the lingual surface.

statistically significant difference between them ($p = 1.0$), and in most of the teeth, the grooves were absent.

There was no significant association between the groove from MOF and the size of MOF ($p = 0.323$), and no association between the presence and absence of the groove from DOF, and the occlusal fossa located closest to the lingual surface ($p = 0.840$).

When the occlusal fossa located closest to the lingual surface was the DOF, the groove from MOF was generally absent ($p = 0.004$). However, there was no significant association between the presence and absence of the groove from DOF, and the occlusal fossa located closest to the lingual surface ($p = 0.504$).

There was a statistical significant association between the sizes of the mesial and distal occlusal fossae ($p < 0.001$). The distal occlusal fossae were generally larger than the mesial fossae.

Table 2 Frequencies of evaluated anatomical features according to the tooth (44 × 34) showing the coincidences in the same individual

| Anatomical Features (44) | 34 | | | | k* |
|--|----------|---------|-------------|-------|--------|
| MOF | Discreet | Small | Medium | Large | |
| Discreet | 32 | 9 | — | 1 | 0.4953 |
| Small | 13 | 35 | 6 | — | |
| Medium | — | 1 | 3 | — | |
| Large | — | — | — | — | |
| DOF | Discreet | Small | Medium | | |
| Discreet | — | — | — | — | 0.6225 |
| Small | — | 27 | 10 | — | |
| Medium | — | 11 | 27 | 5 | |
| Large | — | — | 4 | 16 | |
| Widest Occlusal Fossa | Distal | Mesial | Symmetrical | | |
| Distal | 90 | 2 | 2 | — | 0.0639 |
| Mesial | — | — | — | — | |
| Symmetrical | 5 | 1 | — | — | |
| Occlusal fossa closer to the lingual surface | Distal | Mesial | Symmetrical | | |
| Distal | 48 | 1 | 4 | — | 0.4920 |
| Mesial | — | 2 | 1 | — | |
| Symmetrical | 19 | 1 | 24 | — | |
| Proximal surface with the largest dimension | Distal | Mesial | Symmetrical | | |
| Distal | 91 | 3 | 1 | — | 0.3715 |
| Mesial | 2 | 1 | — | — | |
| Symmetrical | 1 | — | 1 | — | |
| Groove from MOF | Absent | Present | | | |
| Absent | 54 | 14 | — | — | 0.5439 |
| Present | 7 | 25 | — | — | |
| Groove from DOF | Absent | Present | | | |
| Absent | 86 | 5 | — | — | 0.2931 |
| Present | 6 | 3 | — | — | |

Discussion

In the discipline of Anatomy at São Paulo State University (UNESP), School of Dentistry, Araraquara, the methodology used to teach Dental Anatomy is based on direct observation of natural teeth, visualizing the general and specific features of each tooth. Other complementary methodologies such as macro models, dental sculpture and computer-assisted learning programs can be used. However, all these methodologies require knowledge of the specific anatomical features of each tooth. The purpose is that the student understands that knowing these features is important to

Table 3 Frequency of anatomical features observed in 44 and 34 according to sex

| | 44 | | | 34 | | |
|---|--------|------|-------|--------|------|-------|
| | Sex | | | Sex | | |
| Anatomical Features | Female | Male | p | Female | Male | p |
| MOF | | | | | | |
| Discreet | 34 | 8 | 1.000 | 37 | 8 | 0.852 |
| Small | 43 | 11 | | 35 | 10 | |
| Medium | 3 | 1 | | 7 | 2 | |
| Large | — | — | | 1 | — | |
| DOF | | | | | | |
| Discreet | — | — | 0.196 | — | — | 0.394 |
| Small | 31 | 6 | | 29 | 9 | |
| Medium | 31 | 12 | | 32 | 9 | |
| Large | 18 | 2 | | 19 | 2 | |
| Widest Occlusal Fossa | | | | | | |
| Distal | 74 | 20 | 0.597 | 75 | 20 | 1.000 |
| Mesial | — | — | | 3 | — | |
| Symmetrical | 6 | — | | 2 | — | |
| Occlusal fossa closer to the lingual surface | | | | | | |
| Distal | 42 | 11 | 0.132 | 52 | 15 | 0.516 |
| Mesial | 1 | 2 | | 3 | 1 | |
| Symmetrical | 37 | 7 | | 25 | 4 | |
| Proximal surface with the largest buccolingual dimension | | | | | | |
| Distal | 76 | 19 | 0.681 | 75 | 19 | 1.000 |
| Mesial | 2 | 1 | | 3 | 1 | |
| Symmetrical | 2 | — | | 2 | — | |
| Groove from MOF | | | | | | |
| Absent | 55 | 13 | 0.957 | 48 | 13 | 0.682 |
| Present | 25 | 7 | | 32 | 7 | |
| Groove from DOF | | | | | | |
| Absent | 72 | 19 | 0.793 | 72 | 20 | 0.352 |
| Present | 8 | 1 | | 8 | — | |

establish the function, and they must be accurately reproduced in the patient.

Therefore, a poor contour, the absence of a groove, and a ridge out of position would compromise the function.¹²

In this study, we evaluated the occlusal features of the first mandibular premolar, because it is considered to be one of the most complex teeth, and students present difficulties in identifying it, particularly in relation to the determination of the hemi-arch.

It was verified that teeth 34 and 44 were not symmetrical in the same individual. Morphodifferentiation of teeth is clearly under genetic control, but the extent to which environmental factors can influence the process is unknown. Different teeth have characteristic occlusal topographies, and the variance in these topographies can be measured and used to determine the relative similarity between individuals. Heredity estimations revealed that genetic factors

strongly influence occlusal morphology of mandibular primary first molars.¹⁶ According to Consolaro, epigenetics may explain why teeth of the same patient are not exactly the same on both sides. The genetic information that DNA carries is to develop teeth bilaterally equal. However, it does not happen due to the action of environmental features.¹⁷

The occlusal surface of the first mandibular premolar presents an ovoid form,^{11,12,18} frequently with the presence of two cusps, buccal and lingual, which are almost always united by an enamel ridge, which limits a fossa on each side (mesial and distal occlusal fossae).^{12,19,20}

Our results showed that the widest occlusal fossa was the distal. According to Figún and Garino, even though the occlusal fossae are irregularly arranged, the distal fossa is the widest one.¹¹ Some other authors reported that the DOF is the widest one.^{12,18} Other authors^{10,19,20} did not mention whether there were differences between the occlusal fossae.

According to our results, the distal surface presented the largest buccolingual dimension, and it presented a rounded configuration, whereas the mesial surface had a pointed contour. Figún and Garino (2003) also verified that the distal segment is the largest portion of the occlusal surface, and the mesial segment presents a large slope and a small dimension.¹¹ Pagano et al. (1965)¹⁸ reported that the occlusal surface presents a large/moderate reduction of the mesiolingual segment; the convex lingual surface is continuous with the contact surface and a large buccolingual dimension of the distal surface.¹⁸

The mesial surface presenting the largest size compared with the distal surface is considered to be one of the anatomical features, which is common to all teeth. Therefore, it was verified that the first mandibular premolar presents an exception to this rule, i.e., it presents the distal surface larger than the mesial one. The anatomy professor should point out this issue during the Dental Anatomy classes to improve the identification of the hemi-arch, and also the reconstruction of this tooth during oral rehabilitation procedures.

Besides the DOF being the widest, we also verified that it is the one which is located closest to the lingual surface. We observed only two authors who reported that the distal fossa is located closer to the lingual surface.^{11,12}

The groove from MOF frequently continues to the lingual surface of the tooth.^{12,20} In our study, the groove from MOF was also the most frequent compared with the groove from DOF, though with no statistically significant difference between them. According to Pagano et al.,¹⁸ there are some different situations related to the occlusal grooves: grooves from DOF, short grooves from MOF and DOF, or mesiolingual groove crossing the mesial marginal ridge.¹⁸

We observed that the grooves toward the lingual surface from MOF and DOF were not present in most individuals. Nevertheless, Madeira and Rizzolo reported that it is rarely absent.¹²

Considering the results confirmed by statistical tests, we determined the most reliable criteria for the identification of the proximal surfaces of the first mandibular premolars, which will probably improve the individual study of these teeth during Dental Anatomy classes.

Conclusion

According to the results, the following criteria were determined to identify the proximal surfaces of the mandibular first premolar:

- The distal occlusal fossa will be considered the largest occlusal fossa;
- The distal surface will be considered the proximal surface presenting larger buccolingual dimension and a rounded shape.

The occlusal fossa located closer to the lingual surface can also be evaluated, being considered the distal fossa. However, this feature should be considered the last of the three indicated criteria, because it generates a greater degree of error regarding the others.

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