ODONTOMETRIC STUDY OF PREMOLARS FOR SEX DETERMINATION

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Palavras-chave: Dentre Pré-molar. Odontometria. Caracteres Sexuais. Odontologia Legal. Antropologia Forense.

RESUMO

Objetivo: Este estudo cego e transversal objetivou verificar diferenças nas medidas odontométricas dos pré-molares de acordo com o sexo. **Métodos:** Os tamanhos dos dentes foram estabelecidos para os sexos masculino e feminino com base em uma amostra de 100 pares de modelos de gesso (50 de cada sexo) de estudantes de Odontologia da Universidade Federal da Paraíba. Os primeiro e segundo pré-molares, superiores e inferiores, esquerdo e direito, foram examinados em relação às suas medidas mésio-distal, vestíbulo-lingual e à distância entre os pré-molares homólogos em cada quadrante. Testes paramétricos foram utilizados com significância de 5%. O intervalo de confiança de 95% foi determinado para avaliar o poder de diferenciação de cada dente. **Resultados:** Houve diferenças estatisticamente significantes em todas as medidas entre os segundos pré-molares, com maiores valores nos homens ($p<0,05$). Entre os primeiros pré-molares, o dimorfismo sexual foi encontrado nos dentes 24 (comprimento mésio-distal) e 34 e 44 (comprimento vestíbulo-lingual). Quanto aos dentes homólogos, houve diferença significativa entre os pré-molares superiores e inferiores ($p<0,001$), sem distinção entre os lados direito e esquerdo. O intervalo de confiança 95% não mostrou valores de sobreposição, indicando dimorfismo sexual na medida mésio-distal do dente 15 e na medida vestíbulo-lingual dos dentes 15 e 34. **Conclusão:** Nós concluímos que o dente 15 tem o maior potencial de dimorfismo sexual, podendo ser utilizado para identificação humana na determinação do sexo com base nas medições mésio-distal (feminino: 6,40 a 6,63; masculino: 6,64-6,89) e vestíbulo-lingual (feminino: 9,28-9,54; masculino: 9,56-9,88).

Keywords: Bicuspid. Odontometry. Sex Characteristics. Forensic Dentistry. Forensic Anthropology.

ABSTRACT

Objective: This cross-sectional blind study aimed to verify differences in odontometric measurements of premolars according to sex. **Methods:** Teeth size values were established for males and females based on a sample of 100 pairs of plaster models (50 from each sex) from dental students. Upper and lower, left and right, first and second premolars were examined with regard to their mesiodistal and buccolingual measurements and the distance between homologous premolars in each quadrant. Parametric tests were used with a 5% significance. The 95% confidence interval was determined to assess the differentiation power of each tooth. **Results:** There were statistically significant differences in all measures among the second premolars, with higher values in men ($p<0.05$). Among the first premolars, sexual dimorphism was found in the teeth 24 (mesiodistal length) and 34 and 44 (buccolingual length). As for homologous teeth, there was a significant difference between upper and lower premolars ($p <0.001$), with no distinction between right and left sides. The 95% confidence interval showed no overlapping values, thus indicating sex dimorphism in the mesiodistal measure of tooth 15 and in the buccolingual measure of teeth 15 and 34. **Conclusion:** We conclude that the tooth 15 has the greatest potential for sex dimorphism, which could be utilized for human identification in sex determination based on mesiodistal (females: 6.40 to 6.63; males: 6.64 to 6.89) and buccolingual (females: 9.28 to 9.54; males: 9.56 to 9.88) measurements.

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INTRODUCTION

Forensic dentistry, combined with the knowledge from the fields of Dentistry and Law, may provide evidence to subsidize the Court of Justice's decisions. Forensic dentistry can be defined as a specialty that aims to identify psychic, physical, chemical and biological processes that can affect or have affected a human, either alive, dead or bones, and even fragments or traces, resulting in partial or total damage, reversible or irreversible.[1]

Among several areas of expertise, specialists in forensic dentistry have an important role in human identification, which aims to determine the identity of someone or something, i.e., a set of physical, functional and/or psychological features that make one person different from the other and only identical to themselves. With this purpose, a set of procedures is performed by comparing pre and post-fact evidence so that to match possible concordance and discrepancy of present and remote data. The access of the experts to relevant records and their scientific knowledge are critical during the identification process.[1-3]

Body recognition of a deceased individual is a common procedure carried out by relatives or friends who claim to have known or lived with the individual. It is worth noting that such technique is limited as it is usually performed by lay people and may involve emotional conditions of the missing person's relatives. In addition, in most cases only the individual's bones are found, rendering the recognition approach impossible to be accomplished. Therefore, it becomes crucial to investigate the pieces of evidence with a focus on the features that link the body to the missing subject.[1,4-7]

As for human bones, the skull corresponds to one of the body parts providing the most relevant information. It is possible that all bones belonging to a subject are not found in the archaeological and forensic excavation scenes. In these cases, the skull and teeth remain the major resource for human identification.[8]

A very important step in the identification process refers to sex determination. This information alone reduces by half the likelihood of a given hypothesis. A number of quantitative and qualitative features related to sex dimorphism can be found in the skull, which are broadly reported in the literature.[1,5,7]

The increased incidence of mass disasters has highlighted the importance of Forensic Dentistry, given that bodies are frequently found in decomposed, carbonized or fragmented conditions. For instance, in cases of fires or plane crashes it is common to find dental arches as the only preserved structures, thereby making it possible to identify the corpses.[2] This is possible because teeth are the most resistant, hard and stable structures of the human body and also because individuals do not have identical dental features.[9]

Although smaller in size, premolars are posterior teeth presenting functions similar to those of molars. These teeth have a favorable position which usually prevents their displacement in case of trauma. As sex determination is a critical step in human identification and teeth are considered relevant resources,[6,10-13] this study aimed to assess the degree of sex dimorphism in the upper and lower, left and right premolars by odontometric analysis, as well as to establish the size range of premolars in men and women.

MATERIALS AND METHODS

This was an observational, cross-sectional, blind study. An intensive direct observation procedure was performed using maxillary and mandibular plaster casts. This study received prior approval by the Research Ethics Committee of the Center for Health Sciences at Federal University of Paraíba (CAAE: 17488213.3.0000.5188).

Figure 1*: Mesiodistal distance in a second upper premolar. Source: current research.*

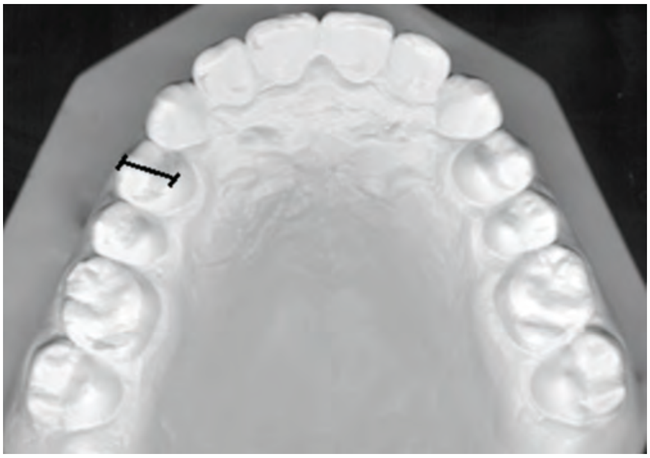

Figure 2*: Buccolingual ou BuccoPalatal distance in first lower premolar. Source: current research.*

The study universe was composed of upper and lower plaster casts from undergraduate dental students of Federal University of Paraíba, João Pessoa, PB, Brazil. The casts were guarded by the Occlusion discipline for research purposes. The sample consisted of 100 pairs of plaster casts (50 from males and 50 from females) of individuals aged 20 to 31 years.

First, the plaster casts were catalogued and all information concerning the respective individuals was tabulated into a worksheet. In order to perform a blind analysis, we used a coding system so that the examiner did not have access to the students' names. With the aid of a digital caliper (Stainless® - 150mm/6, Mainland, China) the examiner measured the mesiodistal (MD) (Figure 1) and buccolingual (BL) (Figure 2) length of the crowns of the upper and lower, first and second premolars. In addition, the distance between the lingual cusps of corresponding (homologous) premolars in each quadrant (Figure 3) was measured using a string and a millimeter ruler.

The MD measure corresponds to the maximum distance between the proximal surfaces of premolars. It is measured with a caliper in a way so to follow the inclination of the triturating slopes of the buccal cusp. The BL measure is the distance between the extreme points of the buccal and lingual surfaces of the premolar crowns. The lingual-lingual distance between the lingual cusps of the premolars was measured using a string, which was transferred to a millimeter ruler in order to obtain a numerical value. In our study, the distances were measured considering the homologous teeth in each side (quadrant) of the same arch.

A pilot study was previously performed to train the examiner. Sixteen plaster casts were selected and examined using a digital caliper. All measurements were registered into a worksheet. After eight days, the casts were re-evaluated under the same conditions, in order to compare the results and check for intra-examiner agreement. The data were analyzed by intraclass correlation coefficient. Overall, good reproducibility rates were found for the MD (0.717 to 0.962), BL (0.732 to 0.920) and lingual-lingual (0.927, 0.906 and 0.900) measurements. The distance between the teeth 34 and 44 showed an agreement value of 0.624, which is still considered acceptable. Given that no changes and/or adjustments in the pilot study were necessary, all 16 pairs of plaster casts were also included in the final sample.

The collected data were entered into a database created in the Statistical Package for Social Sciences (SPSS) program, version 20.0. The data were analyzed descriptively and by statistical tests, with a 5% significance level. The hypothesis that quantitative variables obtained by odontometric measurement had a normal distribution was confirmed by the Kolmogorov-Smirnov test. The Levene's F test was used to check the data for equal variances. The other comparative analyses were carried out using the Student's t test and repeated-measures analysis of variance (ANOVA) with Bonferroni post-hoc test. The 95% confidence interval (95% CI) was calculated to identify the teeth showing the most significant sex dimorphism. In addition, we also check whether there was an overlap between the values in males and females. In cases where no overlap was detected, the 95% CI was used as a range to characterize such measures in men and women.

RESULTS

As shown in Table 1, as regards the mesiodistal length only the tooth 24 showed difference between sexes ($p=0.029$), with higher values found in males (7.06±0.46) than in females (6.86±0.40). As to the BL length, the teeth 34 and 44 showed difference between sexes ($p=0.001$ and $p=0.037$, respectively), with higher values in males. Upper teeth, in general, were found to show significant sex-related difference in relation to lower teeth ($p<0.001$).

All measurements of second premolars showed statistically significant differences between sexes, with higher values found in males. When comparing upper and lower teeth, no difference was observed in the MD length. The highest BL length values were found in the teeth 14 and 24, while the highest MD length values were observed in lower teeth, 35 and 45. There was no difference between sexes concerning the distance between the premolar cusps ($p>0.005$). However, significant differences were observed when the measurements of upper and lower teeth were compared.

As seen in Table 2, the tooth 15 may be used to discriminate between sexes as the 95% CI range did not overlap when comparing males and females. The teeth 24, 25, 35 and 45 also showed differences between sexes, with lower degree of discrimination though, as some CI values were found to overlap. These findings suggest that it is possible to determine the subject's sex based on the tooth 15, with some degree of uncertainty. The other tooth, however, did not show satisfactory degree of discrimination.

Table 3 shows that the teeth 15 and 34 discriminated between sexes, as the 95% CI values did not overlap. The other teeth (25, 35, and 45) also differed between sexes, although with a lower degree as some values overlapped. The data shown in Table 4 indicate that none of the distances between homologous premolars differed between sexes, as all 95% CI values overlapped.

***Table 1**: Means and standard-deviations of the mesiodistal, buccolingual and lingual-lingual distances in premolars (14, 24, 34, 44, 15, 25, 35 and 45) according to sex. João Pessoa, PB, Brazil, 2017.*

Measure	Sex					
		Female		Male		
	Tooth	Mean	Standard-deviation	Mean	Standard-deviation	p-value[1]
Mesiodistal (MD)	14	6.94[a]	0.43	7.06[a]	0.41	0.179
	24	6.86[a]	0.40	7.06[a]	0.46	0.029*
	34	6.88[a]	0.41	7.04[a]	0.45	0.072
	44	6.82[a]	0.42	6.87[a]	0.44	0.609
p-value[2]		0.591		0.075		
Buccolingual (BL)	14	9.40[a]	0.42	9.58[a]	0.55	0.070
	24	9.32[a]	0.43	9.48[a]	0.58	0.114
	34	7.71[b]	0.52	8.08[b]	0.53	0.001*
	44	7.73[b]	0.52	7.95[b]	0.50	0.037*
p-value[2]		<0.001*		<0.001*		
Mesiodistal (MD)	15	6.52[a]	0.41	6.77[a]	0.44	0.004*
	25	6.54[a]	0.52	6.79[a]	0.44	0.009*
	35	6.94[b]	0.45	7.18[b]	0.50	0.013*
	45	6.95[b]	0.39	7.16[b]	0.49	0.021*
p-valor[2]		<0.001*		<0.001*		
Buccolingual (BL)	15	9.42[a]	0.46	9.73[a]	0.57	0.004*
	25	9.42[a]	0.49	9.71[a]	0.56	0.007*
	35	8.41[b]	0.48	8.67[b]	0.53	0.012*
	45	8.45[b]	0.49	8.70[b]	0.45	0.011*
p-value[2]		<0.001*		<0.001*		
Distance	14 to 24	31.18	3.58	31.42	2.94	0.715
	34 to 44	36.08	3.09	36.16	3.68	0.907
p-value[2]		<0.001*		<0.001*		
Distance	15 to 25	27.44	2.29	27.52	2.29	0.862
	35 to 45	31.26	2.48	31.90	2.18	0.174
p-value[2]		<0.001*		<0.001*		

*Note: *Statistically significant difference (p-value<0.05). [1]Student's t test for equal variances. [2]Repeated-measures ANOVA. Different superscript letters indicate statistically significant difference between homologous teeth according to Bonferroni's multiple (pairwise) comparison test.*

Table 2: *Confidence intervals (CI) (95%) of the mesiodistal measurements of premolars according to sex in undergraduate dental students. João Pessoa, PB, Brazil, 2017.*

Tooth	Sex	
	Female	Male
14	6.82 – 7.06	6.93 – 7.17
15	6.40 – 6.63	6.64 – 6.89
24	6.75 – 6.98	6.92 – 7.18
25	6.38 – 6.68	6.66 – 6.91
34	6.76 – 7.00	6.91 – 7.16
35	6.81 – 7.06	7.03 – 7.32
44	6.70 – 6.94	6.74 – 6.99
45	6.84 – 7.06	7.02 – 7.30

Table 3: *Confidence intervals (CI) (95%) of the buccolingual measurements of premolars according to sex in undergraduate dental students. João Pessoa, PB, Brazil, 2017.*

Tooth	Sex	
	Female	Male
14	9.27 – 9.51	9.42 – 9.73
15	9.28 – 9.54	9.56 – 9.88
24	9.19 – 9.44	9.32 – 9.64
25	9.28 – 9.55	9.55 – 9.87
34	7.56 – 7.85	7.92 – 8.23
35	8.27 – 8.54	8.51 – 8.81
44	7.57 – 7.87	7.80 – 8.08
45	8.31 – 8.59	8.56 – 8.82

DISCUSSION

With regards to the relationship between tooth and sex, our findings showed that in all measurements premolars in men are bigger than in women. This is in agreement with studies conducted with other populations.[11,13-16] Nevertheless, Acharya and Mainali[17] found the MD length of lower second premolars to be higher in women than in men. The authors called this phenomenon reverse dimorphism, which could be explained by the diversity among populations.

As for the MD length, our study showed that only the upper left first premolar presented sex dimorphism, whereas for the BL length both lower first premolars showed differences between sexes. These findings are in disagreement with the reports by Zorba, Moraitis and Manolis,[13] in which higher levels of sex dimorphism were found in the upper and lower first premolars, followed by canines. A total of four measures were examined, which were found to be statistically different between sexes.

Overall, significant differences were found in the MD and BL measurements of second premolars, which suggests a potential use of this tooth for sex determination. In line with that, the study by Khan[16] reported that second premolars were the teeth presenting most dimorphic features.

The findings presented herein corroborate those reported by Costa, Lima and Rabello,[10] who carried out an analysis of canines in undergraduate dental students. The authors observed statistically significant sex dimorphism of the MD and BL dimensions in the canines, while in our study we observed sex dimorphism in the second premolars.

The lingual-lingual distance, which refers to the distance between the lingual cusps of homologous premolars in different quadrants, did not differ between sexes. Performing a similar odontometric calculation, Rastogi et al[19] measured the distance between the lower premolars by drawing a straight line between the occlusal grooves of the teeth. Their results revealed a sex-related difference, which is in disagreement with the data observed herein.

We used repeated-measures analysis of variance (ANOVA) with Bonferroni test to perform a comparative analysis of the left and right teeth. No difference was found between them, which suggests that there is no difference in the dimensions of the crowns of homologous teeth, as confirmed by other reports in the literature.[11,18] Nevertheless, we found significant differences when comparing the upper and lower teeth with regard to the study variables.

Given the presence of sex dimorphism in the examined teeth, our findings suggest that second premolars may be applied as a resource to estimate sex, particularly the tooth 15. The 95% CI values did not overlap in the MD and BL measurements, which may be useful in sex determination. The CI values in the tooth 34 did not overlap concerning the BL length but did for the MD length. Hence, the tooth 34 was not found to be as much dimorphic as the tooth 15.

Due to the positioning of premolars in the dental arch, we found some difficulty in positioning the digital caliper for measurement. However, the findings of this study can be considered significant and satisfactory as the more instruments are available the more reliable and accurate human identification becomes. Accordingly, these tools may speed up the investigational process while providing more efficient responses to support the Court of Justice. Further studies are needed to ensure the validity of these measures for sex differentiation.

It may be concluded that male premolars presented bigger dimensions than female ones. Upper and lower second premolars were found to have significant sex dimorphism when compared to first premolars. The tooth 15 has the greatest potential for sex dimorphism, which could be utilized for human identification in sex determination based on MD (females: 6.40 to 6.63; males: 6.64 to 6.89) and BL (females: 9.28 to 9.54; males: 9.56 to 9.88) measurement.

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