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Applicability of "Dimodent" Sex Predictive Equation Assessed in an Senegalese Population

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Abstract

Aims : The determination of sex is one of the most important and crucial steps in identification. Sexual dimorphism using odontometric data showed a great diversity depending on the study population, which therefore requires data specific to each population. The purpose of this study is to establish the degree of dental dimorphism within the population. A sample of Senegalese subjects using the Dimodent method described by Fronty et al 1998

Materials and Methods: A total of 104 subjects (52 males and 52 females) aged 20 to 60 years were included in this study. Mesio-distal and vestibulo diameters - linguale of the lateral incisor and the mandibular canine were measured with a digital caliper on plaster models. The measurements obtained were integrated into the sexual prediction equation

$$P = 1 / (1 + ey)$$

Y is evaluated based on measurements of mesiodistal and buccolingual diameters

The collected data were analyzed using Microsoft Excel version 2013.software.

The Comparison of the data was made with the Chi-square Xtests2 and Pearson and a significance level $p \leq 0.05$ was retained.

Results: In this study, the overall positive prediction rate is 86.53%. The success rate was higher for men (90.38%) than for women (82.69%).

Conclusion: The method used in this study is simple and inexpensive to conduct and therefore can be applied in forensic odontology to establish an individual's sexual identity.

Keywords : Sex Assessment; Dimodent Equation; Mandibular Canines; Mandibular Lateral Incisors; Forensic Odontology

Introduction

In human identification the major problem faced by investigators and forensic scientists is the determination of age, sex, stature, ethnicity. Indeed in life all humans have a unique identity, even if the identical twins can present the same DNA profile preventing certain judicial investigations to succeed, but other elements like the teeth can differentiate them. The identification of living or dead people by teeth and jaws plays an important role in the forensic sciences [1]. Thus in front of human remains or bodies in a state of advanced degradation linked to the phenomena of saponification, putrefaction or charred bodies, the determination of age and sex poses certain difficulties and is based mainly on the study of skeletal structures (oxal bone, crane sacrum) and teeth, because these structures survive for a long time after the death of an individual [1,2,3]. The determination of sex using dental characteristics is based primarily on the comparison of dental dimensions. This is based on the fact that, although the morphology of the tooth structure is similar in men and women, the size of the tooth does not necessarily remain the same. «Sexual dimorphism» refers to differences in size, and of appearance between men and women who can be applied in dental identification.

Several studies have been conducted using canine for sex determination [4,5]. The Anderson et Thompson study [6] of 171 American subjects, including 83 men and 88 women aged 14 to 17 years, shows that the mesio-distal width of the mandibular canines, lateral incisors and the width of the canine bow (inter-canine distance) was greater in men than in women and allowed a correct classification of sex at 74.3%. However, after going through various databases, no study has been conducted in Senegal so far for sex determination from teeth using the mandibular canine. Given this situation, it was necessary to design the present study to determine sex using the method of Dimodent [7]. The aim of this work was to test the applicability of the Dimodent method developed by Fronty et al on a sample of Senegalese melanoderm subjects.

Material and Method

This study was conducted among 104 Senegalese subjects including (52 men and 52 women) coming to consult in the department of odontology of the Faculty of Medicine, Pharmacy and Odontology of the University Cheikh Anta Diop of Dakar and in a private dental office taken at random. The institutional authorization of the ethics committee was obtained for the conduct of the study. Subjects were randomly selected from those who met the following inclusion criteria.

Criteria for Inclusion

a) Senegalese subject of Senegalese parents and grandparents;

b) Age between 20 and 60 years;

c) Presence of a canine and a lower lateral incisor preferably of the same dial free from carious or non-carious lesions, malformation, restorative treatment and in a good position on the arch;

d) Periodontal in front of his teeth, healthy;

e) Patients who have not undergone sexual transformation surgeries.

Data Collection

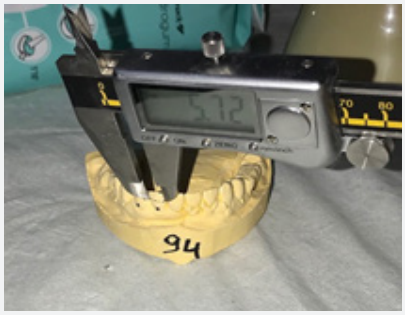

Figure 1: Measurement on plaster.

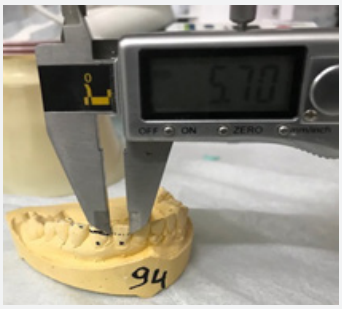

Figure 2: Measurement on plaster

After casting alginate (irreversible hydro-colloid) impressions with hard plaster, the measurements were taken along the long axis of each tooth, with a digital caliper with digital display (Digimatic caliper, Mitutoyo, UK) of precision 0.01mm according to the method described by Dimodent. A second measurement was performed on 1/3 of the sample (30 models) taken at random to evaluate intra and inter-examiner variability with another operator to test interobserver variability. The buccolingual (VL) and mesiodistal (MD) diameters of the canine and lower lateral incisor were measured (Figures 1 & 2).

The Mesiodistal Dimension (MD) was defined as the largest distance between the contact points on the proximal surfaces of the dental crown.

The Buccolingual Dimension (VL): was defined as the greatest distance between the buccal and lingual surfaces of the crown perpendicular to the mesiodistal diameter of the crown of the tooth.

Sexual Prediction Equation

After measurements of the mesio-distal and vestibulo-lingual diameters of the mandibular incisors and canines, the data were reported to the sexual prediction equation P described by Dimodent

$$P = 1/(1+ey)$$

Y is evaluated according to measurements of mesiodistal and vestibulo-lingual diameters

$$Y = 24.2+(1.54*I\ MD)+(1.92*I\ VL)-(2.84*\ C\ MD)-(3,38*C\ VL)$$

MD = Mesio-distal I = Incisor

VL = Vestibulo-lingual, C = Canine

The equations and P and Y were created on Excel thanks to the writing of the functions.

$$P = 1/(1+ey)$$

where P expresses the probability of being in the presence of a feminine or masculine dentition. According to Dimodent:

If P is between 50% and 100%, the teeth are probably female.

If P is between 0% and 49%, the teeth are likely to be males.

Depending on the value of P found, the samples were ranked according to the patterns found or probability of female or male dentition.

Statistical Analysis

The data collected were analyzed with the Microsoft Excel 2013 software. The quantitative variables are expressed in mean and standard deviation and the qualitative variables in percentage and number. The comparison of the data was made using the Student's test and a significance level $p \leq 0.05$ was retained.

Inter and intraobserver variabilities were evaluated with the Kappa Cohen test.

Results

This study included 104 Senegalese melanoderm subjects, including 52 women and 52 men randomly selected; with an average age of 41.22 years ± 12.58. The study of inter and intra-

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examiner variability yielded a satisfactory kappa of 0.70. Tables 1 & 2 describe mean and standard deviations of sex-related measurements. A statistically significant difference was found in the median-distal p <0.0001 and vestibul-lingual P <0.0001 diameter of the canine. The measurements obtained on the lateral incisor mesiodistal diameter are not discriminate

Table 1: Mesio-distal and vestibulo-lingual diameter of the mandibular canines.

Canine	Sexe	Means	SD	Maximum	Minimum	P-value
bucco-lingual	Males	7,827	0,540	8,940	6,55	<0,0001
	Females	7,073	0,603	8,21	5,60	
Mésio-distal	Males	7,060	0,405	7,900	6,190	P<0,0001
	Females	6,630	0,427	7,650	5,800	

Table 2: Mesio-distal and vestibul-lingual diameter of the mandibular lateral incisor.

Lateral incisor	Sex	Means	SD	Maximum	Minimum	P-value
bucco-lingual	Males	6,145	0,467	7,290	5,250	0,061
	Females	5,938	0,637	6,990	4,150	
Mésio-distal	Males	5,728	0,487	6,860	4,670	0,071
	Females	5,552	0,492	6,840	4,360	

Sexual Prediction The overall results of this study show a positive sexual prediction rate of 86.53% and a negative prediction rate of 13.47%. For men, the positive prediction rate was 90.38%, compared with 9.62% negative prediction rate. For women, the positive prediction rate was 82.69% compared to the 17.31% negative prediction rate. The rate of sexual prediction was higher for men (90.38%) than for women (82.69%) (Table 3). The difference found was statistically significant $p \leq 0.05$. In this study, the Dimodent method was applicable in 86.53% of cases. Sexual prediction was positive in 90 out of 104 people studied. This prediction was higher for men with 90.38% (9 out of 10 men) than for women with 82.69% (8 women out of 10).

Table 3: Results of the study.

Sex	Effectif (n)	Success	failure	Rate (%) of prédiction	Rate (%) failure
Males	52	47	5	90,38	9,62
Females	52	43	9	82,69	17,31
Global Results	104	90	14	86,53	13,47

Discussion

Sex determination is one of the first steps in estimating identification. In general, sexual identification is done using anatomical and / or genetic parameters [8]. However, in certain circumstances, only bones and teeth may be the only possible remains to provide sexual identification. Teeth have always interested anthropologists, forensic experts, biologists because they are the most resistant anatomical structures and still persist where all other previous structures have disappeared. Sexual determination by dental measurements has been the subject of several studies [9,10,11]. The latter focused more on the mesio-distal and vestibul-lingual diameters of certain teeth such as the canine and incisors but especially the mandibular incisors. In this present study, the method described by Dimodent was used. This one focuses on the canine and the mandibular lateral incisor. This study was conducted among 104 Senegalese subjects, Senegalese parents and grandparents. The size of the sample (104 subjects) is in the average found in the literature. In Lebanon, a much smaller sample was used (60 subjects) and in India, Barthi et al worked on a sample of 200 people including 100 men and 100 women [12,13]. The measurements of buccolingual and mesio-distal diameter of the canine found in men were statistically higher than in women. For the lateral incisor, the vestibulo-lingual and mesio-distal diameters found in men were also higher than in women, but the difference was not statistically significant.

The same trends were found in India by Barthi et al, except that a statistically significant difference was found between men and women for lateral incisors. In Lebanon, too, all measurements at the lateral incisor and at the canine level gave higher averages for men than for women [13]. In most studies, the measurements of the male canine are larger than those of women. This trend has been confirmed in this study. In comparative anatomy, canines have always distinguished themselves from other teeth with respect to sexual onset and dichotomy. These differences are probably related to their function that differentiates them from other teeth for the survival of the lineage. In carnivores and most primates, the main function of the canines is not chewing, but is primarily related to the threat of aggression. Thus the survival of the species depends on the functional activity of the canines [1]. The results of this study corroborate evidence from other populations that canines showed greater sexual dimorphism than other teeth. These differences between men and women could be related to genetic factors. It is known that the Y chromosome is responsible for tooth size by controlling the thickness of the dentin while the X chromosome seems to be responsible for the modulation in enamel thickness [14,15]. Sexual differentiation

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may be due to more dentin in the crown of teeth in men. In this study, the overall success rate for sexual prediction is 86.53%. The percentage of success was higher for men (90.38%) than for women (82.69%).

Table 4: Comparisons with results obtained in France, India and Lebanon.

Country	percentage of sexual prediction					
	Males		Females		Total	
	Positive	Négative	Positive	Négative	Positive	Négative
Senegal n = 104	90,38 %	9,62 %	82,69 %	17,31 %	86,53 %	13.47 %
Lebanon n = 60	63,3 %	36,7 %	90 %	10 %	76.66 %	23.34 %
France n = 350	84 %	16 %	84 ,57%	15,43 %	90.6 %	9.4 %
India n = 200	75 %	25 %	69 %	31 %	72%	28 %

Similar earlier studies in other populations have shown different rates. In France, the prediction rate with the same method was 90.6%, which is almost similar to the rate found in Senegal. In Lebanon, the predictability rate found with Dimodent was 76.66%. In India, the predictability rate obtained was very low; about 34% (Table 4). In this study, the predictability rate was higher for men than for women. This same trend was found in India, unlike in Lebanon, where the percentage was much higher among women than among men. However, in France, according to Fronty, out of 120 subjects the prediction rate was almost equal; 84% for men and 84.57% for women. In India, the low rate among women (3%) compared to men (66%) led the authors to readjust Dimodent's formula by doing a logistic regression analysis on the measures obtained, allowing a another formula of Y different from that of Dimodent.

$$Y = -19.112 + (0.069 * LI - MD) - (0.382 * LI - BL) + (2.188 * C - MD) + (1.030 * C - BL)(B).$$

Equation P which follows.

$$P = 1/(1 + ey)$$

This allowed them to improve the percentage of prediction. Thus, the overall percentage in India increased from 34.5% to 72%. In this study, the predictability rate was higher for men than for women. This same trend was found in India, unlike in Lebanon, where the percentage was much higher among women than among men. However, in France, according to Fronty, out of 120 subjects the prediction rate was almost equal; 84% for men and 84.57% for women [8]. In India, the low rate among women (3%) compared to men (66%) led the authors to readjust Dimodent's formula by doing a logistic regression analysis on the measures obtained, allowing a another formula of Y different from that of Dimodent.

$$Y = -19.112 + (0.069 * LI - MD) - (0.382 * LI - BL) + (2.188 * C - MD) + (1.030 * C - BL)(B).$$

Equation P which follows.

$$P = 1/(1 + ey)$$

This allowed them to improve the percentage of prediction. So the overall percentage in India went from 34.5% to 72%, the method used in this study has the advantage of being easy to use because it involves only two teeth: the canine and mandibular lateral incisor. The prediction success rate exceeds 90% in some populations, such as Senegal, which confirms the effectiveness of this method as a sexual determination technique. This rate could be improved if all teeth were used, as suggested by the method of Acharya et al which, considering all the teeth, arrived at an overall prediction rate of almost 100% [1]. In the rest of this work, further studies using other complementary odontological characteristics could improve the percentage of prediction.

Conlusion

The determination of sex is one of the first parameters considered in human identification. The accuracy of sexual diagnoses using various body parameters such as genetics, cranio-facial morphology and pubic measurements varies from 96% to 100%. In this study, the application of the odontometric method of Dimodent produced a rather high rate of sexual prediction, suggesting its application in sex determination.

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