Odontometric Analysis of Canines to Establish Sexual Dimorphism in an Urban Population

Abstract

Background: Teeth are the most durable part of the skeleton. Under most of the adverse conditions occurring in nature like putrefaction, mutilation, fire and prolonged immersion in water, teeth are the most indestructible part of the body and may survive all these challenges. Due to this, the use of dental morphology to determine sexual dimorphism is a procedure established in anthropological and biological studies. Among all teeth, canines are found to exhibit greatest sexual dimorphism. Aims and Objectives: This study aimed to determine the gender of an individual based on the buccal-lingual dimensions of the canines and the inter-canine arch width and analyse if any sexual variation existed in them. Setting and Design: It was a cross-sectional study. Materials and Methods: In the present study, 50 male and 50 female volunteers residing in Navi Mumbai, in the age group of 18-60 years were selected to observe the sexual dimorphism in the buccal-lingual crown dimensions of the canine and difference in inter-canine width. The buccal-lingual dimensions were measured on the study casts as the greatest distance between the buccal and the lingual surfaces of the canine crown with a digital Vernier calliper. The inter-canine width was measured between the tips of the canines with the calliper beaks placed along the long axis of the teeth. Statistical Analysis used: Unpaired ‘t’ test and ROC curve using SPSS 21.0 statistical programme for Windows. Results: It was found that the buccal-lingual dimension was significantly larger in males as compared to females and the difference was statistically significant. The difference in mandibular inter-canine arch width was statistically significant. Conclusion: The study defines that the buccal-lingual dimensions are more reliable criteria for sexual dimorphism in Navi Mumbai population than the inter-canine arch width. Thus, it is indicated that the dimorphism in canines can be of immense medicolegal use in identification and gender determination.

Keywords: Canines, odontometric analysis, sexual dimorphism

Introduction

Human identification being the mainstay of civilization, the identification of unknown individuals has been of immense importance to society. Identification of an individual, living or dead, is based on the theory that all individuals are unique. When an unidentified body is found, it is assumed that it could be of anybody. By dividing the individual into characteristic groups (sex, age, height, race) the probabilities are reduced.[1] Establishing the gender of a dead person is a vital procedure in forensic medicine, more so in mass disasters. Teeth are the hardest mineralized tissue in the human body, which makes them resistant to chemical, mechanical and thermal effects. Compared to other parts of the human body, teeth are resistant to post mortem destruction. This renders them useful in identifying the sex of victims in mass disasters. Correct sex identification limits the pool of missing persons to just one half of the population.[2] The concept of sexual dimorphism refers to differences in size, appearance, shape, etc., between males and females that can be applied to dental identification because no two people are identical.[1]

Considering that there are differences in odontometric features in specific populations, it is necessary to determine specific population values in order to make identification possible on the basis of dental measurements.[2] Since there are no odontometric standards for determining sex in the Navi Mumbai population, the present study was conducted to observe for the presence of sexual dimorphism in the buccolingual dimensions of the maxillary
and mandibular permanent canines and also study the difference in maxillary and mandibular inter-canine arch width in a sample of Navi Mumbai population.

Materials and Methods
A blinded, prospective and cross-sectional study was conducted in the population of Navi Mumbai, Maharashtra, India after obtaining permission from the Institutional ethical committee (No. DYPUSOD/SS-BDS/123/of 2016. The study group consisted of 50 males and 50 females between the age group of 19-30 years, consisting of caries-free teeth without attrition, spacing or crowding, having healthy periodontal status, with class I molar relationship, normal overjet and overbite (2-3 mm) and absence of congenital anomalies [Figures 1-3].

Impressions of maxillary and mandibular dentition were made with irreversible hydrocolloid material after obtaining the written consent and casts poured using dental stone. Inter-canine width (ICW) and bucco-lingual dimension of canines were determined in male and female casts separately. The inter-canine arch width was measured between the tips of both maxillary and mandibular canines with calliper beaks placed along the long axis of the teeth. The bucco-lingual dimension of the canines was measured as the greatest distance between the buccal and lingual surfaces of the maxillary and mandibular canines. Measurements were taken using a digital Vernier calliper. Each reading was taken three times and the mean was considered.

Statistical analysis
Unpaired ‘t’ test and ROC curve using SPSS 21.0 (IBM corporation, Armonk, NY, USA) was used. Unpaired ‘t’ test was used to find the significance of study parameters on continuous scale between two groups.

Calculation of sexual dimorphism
Sexual dimorphism was calculated by the following formula (Garn 1967):[3]

\[
\text{Sexual dimorphism} = \frac{\text{X}_m - 1}{\text{X}_f} \times 100
\]

\[
\text{X}_m = \text{mean of diameter of males}
\]

\[
\text{X}_f = \text{mean of diameter of females}
\]

Results
The mean inter-canine arch width of both arches was more in males than in females. The difference was statistically significant for mandibular inter-canine arch width but not in maxillary inter-canine arch width [Graph 1]. The mean of bucco-lingual diameters exceeded in males with existence of statistically significant sexual dimorphism in maxillary and mandibular canines [Tables 1-3].

Discussion
Teeth are the most indestructible part of the body. Among all natural structures, they demonstrate the least turnover, are easily accessible for examination and do not require special dissection. Hence, teeth provide excellent material in living and non-living populations for genetic, anthropological, odontological and forensic investigations. Among teeth, canines differ from other teeth with respect to function and show the greatest sex differences.[4] Periodontal involvement of canines is less common and also they are the last teeth to be extracted with respect to age.[1] Hashim and Murshid (1993) conducted study on Saudi males and females in the age group of 13-20 years and found that only the canines in both jaws exhibited a significant sexual difference.[5] Gender determination is one of the important
Although DNA analysis is the most accurate method to estimate sex using solely the dentition. Approximately 90% of the genetic coding for amelogenin (the organic component which constitutes 90% of enamel) is located on the X chromosome with the remaining 10% on the Y chromosome. This provides the basis for odontometric sexual dimorphism and so the means and standard deviations are statistically significant.

In the present study the mean of bucco-lingual diameters exceeded in males with existence of statistically significant sexual dimorphism in maxillary and mandibular canines. The results were in confirmation with the findings obtained by Aggarwal and Gorea [4] in their study on buccolingual diameter of canines in North Indian population. The reasons for the high level of dimorphic differences between male and female canines are uncertain, and consequently, it has been postulated that, in the evolution of primates, the canines are functionally not masticatory but are related to threat of aggression and actual aggression. A transfer of the aggressive function occurred from the teeth to fingers in man and until this transfer was complete, survival was dependent on canines, especially in males. The notable difference between canine in determining the sex was noted to be due to the influence of Y chromosome, which was not uniform in all teeth. The X-linked genetic influence on tooth was rather uniform for all the teeth [1].

Amelogenesis is a sex-linked process and provides the basis for odontometric sexual dimorphism and so the means to estimate sex using solely the dentition. Approximately 90% of the genetic coding for amelogenin (the organic component which constitutes 90% of enamel) is located on the X chromosome with the remaining 10% on the Y chromosome. The physiological manifestation of this coding is that males undergo a lengthier period of enamel formation than females, approximately 80 days or 0.56 mm diametrically in permanent canines according to some sources. Others assert that male canines are some 3-9% larger than females, and so metric sexual dimorphism in canines should be apparent within two standard deviations of variation (where P < 0.05) and so statistically identifiable [3].
It was proposed by Moss and Salentijn that a longer period of amelogenesis in the males probably contributes to the larger size of teeth.\textsuperscript{[11]} Moss and Salentijn, explained that the tooth crowns being larger in males may be because of the greater thickness of enamel due to the longer period of amelogenesis for both the primary and secondary dentitions in males,\textsuperscript{[10]} and according to Acharya \textit{et al.}, it is because of Y chromosome producing slower male maturation.\textsuperscript{[12]}

In the present study, the mean inter-canine arch width of both arches was more in males than in females. The difference was statistically significant for mandibular inter-canine arch width but not for maxillary inter-canine arch width. Sreedhar \textit{et al.} in their study on a population in Moradabad observed significant difference in the inter-canine distance between males and females with mean inter-canine distance in males being greater as compared to females.\textsuperscript{[1]} This could be due to the fact that the larger jaw dimensions and a greater predilection for bi-lobate and square-shaped chin in males in contrast to pointed one in females. The inter-canine width which is related to the mandibular arch dimension may, therefore, be expected to show recognizable sexual dimorphism.\textsuperscript{[1]} Grewal \textit{et al.}, in their study found statistically significant difference in maxillary inter-canine width.\textsuperscript{[13]}

Variations in the intensity of sexual dimorphism in different studies and different populations, may be explained by genetics, the influence of environmental factors, different eating habits and the complex coordinated action of environmental factors and biological influences.\textsuperscript{[2]} It must be however noted that the method of sex determination by measurement of canine dimensions and inter-canine width has its limitations. The sex of the subject to whom the fragment of the mandible belongs can be determined satisfactorily only when the fragment is found in the geographically area where the subject was born.\textsuperscript{[14]}

**Conclusion**

Teeth may be used for sex determination with the aid of odontometric analysis. Sex determination in tooth size is found to vary in different populations and there is a need for specific population data. Our study established the existence of sexual dimorphism between the permanent canines of males and females in the Navi Mumbai population, which might be useful in gender identification in forensic practice.

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**Conflicts of interest**

There are no conflicts of interest.

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