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SEX DETERMINATION BY ODONTOMETRIC METHODS – A REVIEW

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ABSTRACT:
Forensic Odontology is a specialty of forensic medicine that deals with dental evidence presented in the court of law in the interest of justice because no two people have identical teeth. Forensic odontology has widespread acceptability in the field of criminal justice. Research has indicated that odontometric tooth size criteria are region specific which can be used to identify gender and age. This review investigates odontometric methods for determining gender dimorphism.

KEYWORDS: Forensic odontology, odontometric methods, sexual dimorphism

INTRODUCTION:

Keiser–Neilsen in 1970, described forensic odontology as "the discipline of forensic medicine which, in the interest of justice, deals with the handling and inspection of dental information, as well as proper interpretation and analysis of the tooth findings" [1]. A correct gender assessment would instantly rule out nearly half of the population in search operations. Gender determination is an important stage in identifying the genetic evidence of unidentified skeletal bones [1, 2]. "Sexual Dimorphism" is the term used to describe the variations in height, stature, and appearance between men and women that can be used to identify teeth [1, 3]. Personal identification can be made based on certain features and descriptions, such as the physical features of an individual. Personal identification is a necessary component of forensic science. There are times when an individual must be recognized, such as following a genocide, a natural disaster, or when a missing person must be matched with the remains of an unknown victim discovered months or years later [4]. The accuracy rate of recognizing the proper gender utilizing morphological assessment of shape and size, as well as osteometric approaches, has reached as high as 100 percent using traditional gender indicators such as the

pelvis and skull [5]. The solid, mineral structures of teeth, unlike any other skeletal structure, are more resistant to post-mortem decomposition and purposeful, accidental, or natural change. Odontometrics has been studied as a method for gender evaluation in the forensics for the past twenty-five years [1, 6].
Teeth contain sexual dimorphism, according to Boaz et al., (2009). (SD). The tooth measurements comparison in males and females is used to determine sex using dental traits. According to Bosset, Marks, and Krogh, studying the canine teeth has several advantages. They are the teeth that are extracted the least and have the least periodontal disease[7]. The various methods and limitations of detecting gender using odontometrics are discussed in this article.

ODONTOMETRIC METHODS:
Odontometrics refers to tooth measurements. A metrical approach to estimating sex is more systematic, less subjective, and may be repeated to validate the results.[8]. The linear measurements of mesiodistal (MD) and buccolingual (BL) tooth diameters can be used to determine sex based on differences in size and proportion of the tooth[1,8]. In addition to direct measurement, lateral measurements are essential for monitoring tilted, overcrowded, and proximally fixed teeth. The tooth is measured MB-DL and DB-ML (corner to corner) [9].

TOOTH SIZE:
Most of the studies revealed that the mesiodistal and buccolingual dimension measurements of teeth have been found to be good markers of sex, making them the most simple and reliable means of determining sexual dimorphism[10, 11]. Buthz and Ehrhardt proved in 1938 that human dental variation may be computed using permanent crown measurements. Male teeth appear to be broader than female teeth in general. According to some experts, tooth size varies, but is unlikely to be sufficient to establish gender orientation. Females have more hypoplasia and agenesia of the third molar, but males have more hyperdontia of the second molar roots.[10].

MESIO DISTAL MEASUREMENT:
The maximum distance between the contact points on the proximal surfaces of the crown is known as the mesiodistal dimension. The greatest MD distance between crown approximation surfaces was measured using caliper beaks mounted occlusally along the long axis of the tooth. Measurement was taken between sites on the crown approximation surfaces where contact with adjacent teeth was predicted properly in the event of tooth movement or malposition[7, 10]. The fact that mesiodistal dimensions are prone to proximal wear and tear may reduce their dimension and make them unusable in forensic investigations, which is one of their main limitations.

BUCCOLINGUAL MEASUREMENT:
The largest gap between the labial or buccal surface and the lingual or palatal surface of the crown is known as the buccolingual dimension. Proximal wear does not change the buccolingual surfaces; instead, attrition and calculus deposits may have an impact.

DENTAL INDEX:
The linear measurements show different sexual dimorphism, but they are not accurate enough to be used as the sole sex indicator. In an attempt to improve this, dental characters were created, which used tooth proportions in addition to tooth size to distinguish between the sexes[1, 10]. Simple mathematical combinations of linear measurements are used to create the dental index. Among these are the Incisor index, Mandibular and maxillary canine index, Crown module, Crown area and Crown index.

INCISOR INDEX:
Aitchison (1964) put forth the “incisor index” (Ii), calculated by the Formula

$$Ii = [MDI2 (/MDI1] \times 100,$$

MD I2 - The maxillary lateral incisor's maximal mesiodistal diameter
MD I1 – The maxillary central incisor's maximal mesiodistal diameter.
Aitchison discovered that this score is greater in males, indicating that the lateral incisor is much smaller in females than the central incisor.[3, 11.]

MANDIBULAR CANINE INDEX:
The ratio of the canine mesiodistal (MD) diameter to the inter-canine arch width is known as the Mandibular Canine Index (MCI), and it was created by Rao et al[1, 12].

Standard Mandibular canine index (MCIs) = [(Mean male MCI - SD)
+
(Mean female MCI + SD)] /2 MCIs

With an accuracy of 89%, the "mandibular canine index," which was introduced by Rao et al. (1989), offers a precise indicator of sex in the Indian population[11]. The formula yielded a result of 7.1, signifying that the maximum permissible mesiodistal dimension for female mandibular canines is 7.1 mm[1].

MAXILARY CANINE INDEX (MCI)

Maxillary Canine Index can also be used to determine the gender.

$$\text{Maxillary Canine Index} = \frac{\text{Mesiodistal crown width of upper canine}}{\text{Upper inter-canine width.}}$$

INTERCANINE WIDTH:

The other measurement was the straight-line distance between the tips of the two upper canines. To determine the distance each caliper beak was positioned above the center of the tip of right and left canine teeth.[7].

INTER PREMOLAR WIDTH:

Inter premolar width was measured from the distal pit of one maxillary first premolar to distal pit of opposite first premolar area[3].

$$\text{Premolar index:} \quad \frac{\text{Sum of the incisal widths}}{\text{Inter premolar width}} \times 100$$

INTERMOLAR WIDTH:

The inter molar width was measured from one upper first molar mesial pit to opposite first molar mesial pit[3].

$$\text{Molar index} = \frac{\text{Sum of the incisal width}}{\text{Inter molar width}} \times 100$$

ARCH LENGTH:

The arch length measurement was done using a Vernier caliper by measuring distances from one end to the other end of bite mark patterns of the maxillary or mandibular arch. (The entire arch was taken into account[13]).

PONT'S INDEX:

Pont's index was created in 1909 to forecast the maxillary dental arch width (inter-molar and inter-premolar) based on the total mesio distal (MD) diameter of the four maxillary incisors[14, 15]. (Figure 1)

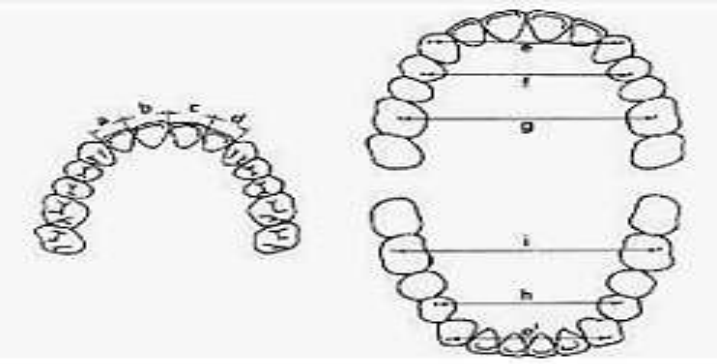

Figure 1: Figure showing Pont's Index.

A,b,c,d - Inter incisal distance
e -Inter canine distance
f - Inter premolar distance
g - Inter molar distance

$$\text{Inter-premolar arch width (IPW)} = \frac{\text{Sum of the incisal widths (SIW)}}{0.80}$$

$$\text{Inter-molar arch width (IMW)} = \frac{\text{Sum of the incisal widths (SIW)}}{0.64}$$

OTHER INDICES:

Crown area for each tooth is calculated by multiplying the Mesiodistal and Buccolingual dimensions. The average of the BL and MD dimensions for each tooth is calculated as (Bucco lingual + Mesiondistal)/2. On the other hand, the crown index is the percentage ratio of two linear measures (BL/MD) x100. According to the findings, linear measurements provide better sex discrimination hence these three dental characteristics are of little added value in forensic sex evaluation[14].

SEXUAL DIMORPHISM:

Garn and Lewis introduced a formula to calculate sexual dimorphism[7].

$$[Xm / Xf] - 1 \times 100$$

Xm = mean value of measurement for males.
Xf = mean value of measurement for females.

CANINE DIMORPHISM:

Numerous methods like Fourier analysis (Minzuno, 1990) and Moiretopography (Suzuki et al., 1984) have been used to study canine teeth computation (buccolingual & mesiodistal width and inciso-cervical height). Mandibular canines are recognized for exhibiting the greatest sexual dimorphism and are commonly considered the "essential tool" for personal identification[16]. Anderson and Thompson (1973) reported that males have a higher mandibular canine width and inter-canine distance measurement than females. These measures allowed for 74% reliable gender distinction[13]. Upon assessing the mesiodistal width of canine teeth across multiple ethnic groups, Garn et al. (1988) found that mandibular canines exhibited greater sexual dimorphism than maxillary canines[11]. Rao et al (1989) also reported that the mesiodistal width of mandibular canine was substantially higher in Indian boys than girls[12].

With only 37.5% of all tooth variables statistically greater in Indian males, odontometric sex evaluation shows that the degree of sexual dimorphism in Indians is lower than in other populations, but comparable to South Asian tribes[1]. While canines typically showed the greatest sexual dimorphism across groups in other populations, the mandibular first molar was found to be most dimorphic in Indians, followed by canine and the buccolingual diameter of the upper first and second molars. When certain dental characteristics have a larger mean size in females this is referred to as reverse dimorphism[1, 11]. These studies illustrate differences in odontometric measurements in different populations. The current odontometric sex evaluation accuracy rate is 72 percent. Several other countries have similar rates of correct sex prediction accuracy.

CONCLUSION:

In India, forensic dentistry is a recent concept that relies mainly on low-cost, easy methods of identifying people from broken jaws and teeth fragments. Based on odontometric studies, tooth size standards are population-specific, with varying degrees of sexual dimorphism. It is not, however, uniform in all people, and sexual variation in tooth size is a continuum rather than a discrete characteristic. As a result, odontometrics is viewed as a useful adjunct to sex determination rather than the primary indicator of sex. Due to bone deterioration and fragmentation, teeth may be one of the few physiologic markers which are easily accessible for sex determination.

REFERENCE:

1.Joseph P Anna, RK Harish, Mohammed Rajeesh PK, RB Kumar Vinod. How reliable is sex differentiation from teeth measurements. Oral Max Path J. Jan-Jun 2013: 4(1), 289-292.
2. Pretty and Sweet. A look at forensic dentistry —Part 1-The role of teeth in the determination of human identity. British Dental Journal 2001; 190(7):359-66.
3. Rani ST. Applicability of odontometric dimensions and indices in sexual dimorphism among Nalgonda population. J Forensic Dent Sci. 2017 Sep-Dec;9(3):175. doi: 10.4103/jfo.jfds_42_16. PMID: 29657496; PMCID: PMC5887642.
4. Rao K1et al .Odontometric parameters as a forensic tool for stature estimation among three Asian ethnicities. Egyptian Journal of Forensic Sciences (2019) 9:60 Page 2 of 5
5. Kanchan R. Patil, Rajendra N. Mody. Determination of sex by discriminant function analysis and stature by regression analysis: a lateral cephalometric study. Forensic Science International. 2005; 147: 175–180.
6. I˙scan, Kedici. Sexual variation in bucco-lingual dimensions in Turkish dentition. Forensic Science International. 2003; 137:160–164.
7. Gupta, *et al.*: Establishment of sexual dimorphism by odontometric study of permanent maxillary canine teeth. Journal of the international clinical dental research organization. July –december 2014 volume 6 issue
8. Bidmos MA, Gibbon VE, Štrkalj G. Recent advances in sex identification of human skeletal remains in South Africa. S. Afr. j. sci. [Internet]. 2010 Dec [cited 2022 June 30] ; 106 (11-12): 1-6.
9. Karaman, Feryal. Use of diagonal Teeth Measurements in Predicting Gender in a Turkish Population. Journal of forensic sciences. 2006; 51(3): 630-635.
10. R Rajendran, B Sivapathasundharam. Forensic odontology. Shafer's textbook of Oral Pathology. 6th edition 2009; Elsevier :880 – 882
11. Siritta Ndapandula Kalistuet al, Gender Determination by Forensic Odontologist: A Review of various methods. IOSR Journal of Dental and Medical Sciences. e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 15, Issue 11 Ver. I (November. 2016), PP 78-85
12. Rao GN, Rao NN, Pai ML, Kotian MS. Mandibular canine index – a clue for establishing sex identity. Forensic Science International. 1989; 42: 249 – 54.
13. Pagare N, Chourasiya S and Dedhia H. Study of Odontometric Parameters in Gender Identification. Austin J Forensic Sci Criminol. 2017; 4(2): 1060.
14. Acharya, Mainali. Are dental indexes useful in sex assessment? J Forensic Odontostomatol. 2008; 27(2):53-59.
15. Ahmet Arif Celebi et al, Determination and Application of Pont's Index in Turkish Population. The Scientific World Journal. Volume 2012, Article ID 494623, 5 pages doi:10.1100/2012/494623
16. A. B. Acharya, S. Mainali. Univariate sex dimorphism in the Nepalese dentition and the use of discriminant functions in gender assessment. Forensic Sci Int. 2007; 173: 47-56