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MANDIBULAR CANINE INDEX (MCI);
ITS ROLE IN DETERMINING GENDER

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ABSTRACT... Introduction: Dental evidence is valuable in identification of individuals, especially following mass disasters; estimation of age at death of skeletonised remains and establishing guilt in cases of criminal injury by biting. Mandibular canines are found to exhibit the greatest sexual dimorphism amongst all teeth. **Objective:** To investigate the accuracy with which gender can be differentiated by using the mandibular canine index in the Punjabi – Pakistani population. **Setting:** Independent Medical College and Punjab Medical College, Faisalabad. **Period:** Dec. 2008 to Dec. 2009. **Material and Methods:** The present study was performed on 200 students, between the age group of 18-25 years, randomly sampled with informed consent (Through 3rd party). Mandibular canine width and intercanine distance were measured with the help of Vernier caliper after observing aseptic conditions. Mandibular canine index was calculated and the observed MCI was compared with the standard MCI value. The data was then analyzed using student's "t" test. **Results:** No significant statistical difference was noted between the right and left mandibular canines amongst males and females (same sex) but when comparing between males and females, there was highly statistical significant difference ($P < 0.001$). The calculated standard MCI for canines of males and females found to be 0.2504. With these calculations we could predict sex correctly at 75.97% in this study (Male: 71.67% and Female: 78.72%). **Conclusion:** MCI is a quick and reliable method for sexual identification when a standard for the population is available. With these calculations, we could predict the sex correctly at 75.97 % in this study. This method can be used as adjunct to other available tools for sex determination. DNA studies can reveal sex accurately. Availability of comprehensive database with "NADRA" can also be used as adjunct to "MCI" to enhance the accuracy in determination of sex and identity of the person in Pakistan.

Key words: Mandibular Canine, Sexual Dimorphism, Canine Width, Intercanine Distance.

INTRODUCTION

Gender determination of skeletal remains is a part of archaeological and many medico-legal examinations. The methods vary and depend on the available bones and their condition. The only method that can give a totally accurate result is the DNA technique, but in many cases for several reasons it cannot be used. Anthropological measurements of the skeleton and the comparison with existing standard data must then be applied and may help to differentiate between male and female remains. On an individual basis however, gender differences are not always distinctive, when taken collectively they can give a good indication in the majority of cases[1].

In forensic medicine, dental evidence is valuable in identification of individuals, especially following mass

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disasters; estimation of age at death of skeletonised remains and establishing guilt in cases of criminal injury by biting[2].

Teeth are extremely durable even at high temperature and may be identified even when the rest of the body has undergone decomposition. Of all the teeth in the human dentition, the canines are the least frequently extracted teeth (possibly because of the relatively decreased incidence of caries and periodontal disease). Also, canines are reported to withstand extreme conditions and have been recovered from human remains even in air disasters & hurricane[3].

The identification of sex is of significance in case of major disasters where bodies are often damaged beyond recognition. Teeth of various species are known to exhibit sexual dimorphism. "Sexual Dimorphism" refers to those differences in size, stature and appearance between male and female that can be applied to dental identification because no two mouths are alike[4]. Garn et al and Nair et al have found the mandibular canines to exhibit the greatest sexual dimorphism amongst all teeth[5,6].

Mandibular canines are found to exhibit the greatest sexual dimorphism amongst all teeth. The mandibular canines have a mean age of eruption of 10.87 years[7]. The mandibular canines are not only exposed to less plaque, abrasion from brushing, or heavy occlusal loading than other teeth, they are also less severely affected by periodontal disease and so, usually the last teeth to be extracted with respect to age. These findings indicate that mandibular canines can be considered as the "key teeth" for personal identification[8,9].

Mandibular canine index was employed in numerous studies on large populations as it is simple, reliable, inexpensive and easy to perform. This is of definite significance, as tooth morphology is known to be influenced by cultural, environmental and racial factors[10].

Studies performed on the lower canines using the ratio between the maximum crown width & inter-canine width, resulting in a mandibular canine index (MCI), have shown an ability to determine gender with an accuracy of 84.3% in males & 87.5% in females & 83.3% in males & 81% in females by comparing the observed MCI with a standard MCI value respectively[11].

The purpose of this study was to investigate the accuracy with which gender can be differentiated by using the mandibular canine index in the Punjabi – Pakistani population.

MATERIALS AND METHODS

The study population involved the students of Independent Medical College and Punjab Medical College, Faisalabad. Two hundreds students (100 males & 100 females) between the age group of 18-25 years were randomly sampled with informed consent (Through 3rd party) during the year 2008-2009.

INCLUSION CRITERIA

Subjects with following status of teeth were included in the study:

- Healthy state of gingiva & periodontium.
- Caries free canine teeth.
- Normal overjet & overbite (2-3 mm).
- Absence of spacing in the anterior teeth.
- Normal molar and canine relationship.

The following parameters were determined in males and females.

- Intercanine Distance.
- Right & Left Mandibular Canine Width.
- Right & Left Mandibular Canine Index.

Mandibular canine width was measured as the greater mesio-distal dimension of mandibular canine on either side of the jaw using a Vernier caliper after observing aseptic conditions. The inter canine distance was measured as the linear distance between the cusp tips of right and left mandibular canines.

The observed mandibular canine width and intercanine width were recorded on an excel spread sheet and subjected to statistical analysis to assess sex difference

using student's "t-test". The observed mandibular canine index (MCI) was calculated using the formula below[1,11,12]:

$$\text{Observed mandibular canine index} = \frac{\text{Mesio-distal crown width of mandibular canine}}{\text{Mandibular canine width}}$$

The standard MCI value is used as a cut-off point to differentiate males from females, which is obtained from the measurements taken from the samples by applying the following formula:

$$\text{Standard mandibular canine index} = \frac{(\text{Mean male MCI} - \text{SD}) + (\text{Mean female MCI} + \text{SD})}{2}$$

The observed MCI was the compared with the standard MCI value obtained in this study and correlated with previous studies like Ready VM[1], Rao et al[11], Muller et al[12] and Hashim and Murshad[15].

RESULTS

It is evident that the inter-canine distance, mandibular canine's width and MCI measured for males and females when compared are statistically significant. There is no significant statistical difference between the right and left mandibular canines amongst males and females (same sex) but when comparing between males and females, there is highly statistically significant difference ($P < 0.001$).

The calculated standard MCI for canines of males and females found to be 0.2504. With these calculations we could predict sex correctly at 75.97% in this study (Male: 71.67% and Female: 78.72%).

DISCUSSION

It is a known fact that teeth provide excellent models for the study of relationship between ontogeny and phylogeny. Eimerl and De Vore 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 this aggressive function occurred from the teeth to the fingers in man and until this transfer was completed, survival was dependent on canines especially in males. Canines differ from other teeth with respect to survival and sex dichotomy. Thus in the present day humans, sexual dimorphism in mandibular canines is not merely a coincidence but can be expected to be based on functional activity[13].

The determination of sex makes identification easier and it is of immense forensic importance. In fact, it has been suggested that the first reported crime in the history of mankind was solved when bite marks were discovered in the remains of forbidden fruits in the garden of Eden and identified as those of Adam and Eve[14].

The usefulness of the canines as an aid in gender determination by odontometric analyses, in forensic dentistry for example, is supported by their high level of survival in the dentition. The notable difference between canine in determining sex was noted to be due to the influence of the Y- chromosome which was not uniform in all teeth. On the other hand the X-linked genetic influence on tooth width was rather uniform for all teeth. It is the Y-chromosome which intervenes most in the size of teeth by controlling the thickness of dentine, whereas the X-chromosome, for a long time considered to be the chromosome responsible, only comes into play concerning the thickness of enamel[5].

Garn & Lewis and Lysell & Myrberg concluded that the mandibular canine with 6.4% and 5.7%, respectively demonstrates the greatest sexual dimorphism amongst all teeth[5,16]. Nair et al in their study on South Indian subjects concluded that the left mandibular canine with 7.7% followed by the right mandibular canine with 6.2% shows the maximum sexual dimorphism[6].

Gabriel has stressed that any measurement of teeth unaccompanied by age, race and sex must be treated with great reserve. Amongst the significant findings that can be obtained from teeth are race, age, sex, habits and racial customs[17]. Robinson has pointed out that in Burma buccally displaced canines are considered lucky[18]. Molnar found the existence of a positive correlation between tooth wear and cultural factors. The incidence of dental caries is greater in civilized countries due to large intake of sugar in their diet while the Eskimos are known to show the least susceptibility to dental caries[19].

A study by Kaushal et al., found a statistically significant

dimorphism in the mandibular canines in 60 subjects in a North Indian population, where the mandibular left canine was seen to exhibit greater sexual dimorphism. They also concluded that if the width of the canine is greater than 7 mm, the probability of the sex of the person under consideration being male was 100%[7]. In our study no such criteria could be established.

The present study establishes the existence of a definite statistically significant sexual dimorphism in mandibular canines. It is consistent with Hashim and Murshid who conducted a study on Saudi males and females in the age group of 13-20 years and found that the canines were the only in both jaws to exhibit a significant sexual difference while the other teeth did not. They also determined that there was no statistically significant difference between the left and right sides suggesting that measurements of teeth on one sided could be truly representative when the corresponding measurements on the other side was unobtainable[15]. Similar findings were observed in our study also.

Our study which was performed on males and females in a definite age group in the population of Punjab province of Pakistan indicates the probability of sex determination to an extent as high as 75.97 % (Male: 71.67 % and Female: 78.72 %) which was based on calculated "MCI" of 0.2504 for both males and females. These findings in the Punjabian population is of definite forensic importance. Ready VM et al[1] calculated standard MCI for both male and female as 0.256. With these calculations, he could predict sex correctly at 72.5 % which is comparable to our study.

Studies performed on the lower canines using the ratio between the maximum crown width and canine arc width, resulting in a mandibular canine index (MCI), have shown an ability to determine gender when performed on 384 females and 382 males of the South Indian population in the age-group of 15-21 years with an accuracy of 84.3% in males and 87.5% in females by comparing the observed MCI with a standard MCI value[11].

In a similar study by Muller et al., the population involved the students enrolled in the University of Nice-Sophia Antipolis. Two hundred and ten girls and 214 boys were randomly sampled. The results were found to be statistically significant[12]. In the present study both these parameters as measured in males and females were compared and the difference was found to be statistically significant.

Any measurement of teeth unaccompanied by information about age, race and sex must be treated with great caution. In the present study, sex could be predicted to an extent of about 75.97 %. But such a method of sex determination has its limitations due to variations of this parameter with geographic distribution.

CONCLUSION

The emerging field of forensic odontology in Pakistan depends upon a lot of inexpensive and easy means of identification of sex. MCI is a quick and reliable method for sexual identification when a standard for the population is available. Krogman ranks accuracy of sex determination using the pelvis at 95 % followed by the skull at 90 %, the pelvis and skull at 98 % and long bones at 80%[20]. As the accuracy of MCI in identification of sex have been exceeded 75.97%, so its impact can only be used as a supplement tool.

Microscopic examination of teeth can confirm sex by the presence or absence of "Y" chromatin. DNA studies can reveal sex accurately. Availability of comprehensive database with "NADRA" can also be used as adjunct to "MCI" to enhance the accuracy in determination of sex and identity of the person in Pakistan.

REFERENCE

1. Reddy VM, Saxena S, Bansal P. **Mandibular canine index as a sex determinant: A study on the population of western Uttar Pradesh.** J Oral Maxillofac Pathol 2008; 12:56-9.

2. Standring S: **Gray's Anatomy – The anatomical basis of clinical practice.** In: Teeth. 40th Edn, Churchill Livinstone, London, p. 516 (2008).

3. Boaz K, Gupta C. **Dimorphism in human maxillary and**

mandibular canine in establishment of gender. J forencis Dent Sc: 2009; 1:42-4.

4. Kiesu, J.A.: **Human adult odontometrics. In: The study of variation in adult tooth size.** Cambridge University Press. (1990).

5. Garn SM, Lewis AB, Swindler DR, Kerewsky RS. **Genetic control of sexual dimorphism in tooth size.** J Dent Res 1967; 46:963-72.

6. Nair P, Rao BB, Annigeri RG. **A study of tooth size, symmetry and sexual dimorphism.** J Forensic Med Toxicol 1999; 16: 10-3.

7. Kaushal S, Patnaik VV, Agnihotri G, **Mandibular canines in sex determination.** J Anat Soc India 2003; 52: 119-24.

8. Anderson DL, Thompson GW. **Interrelationships and sex differences of dental and skeletal measurements.** J Dent Res 1973; 52:43-8.

9. Dahlberg AA. **Dental traits as identification tools.** Dent Brog 1963; 3: 155-60.

10. Halim A: **Regional and clinical anatomy for dental students.** In: General principles of Anthropology. 1st Edn; Modern Publishers. N. Delhi p 362. (2001).

11. Rao NG, Rao NN, Pai ML, Kotian MS. **Mandibular canine index: A clue for establishing sex identity.** Forensic Sci Int 1989; 42:249-54.

12. Muller M, Lupipegurier L, Quatrehomme G, Balla M. **Odontometrical method useful in determining gender and dental alignment,** Forensic Sci Int 2001; 121: 194-7.

13. Eimerl, S. and De Vore, L. **The Primates Times Inc.** New York (1965).

14. Danielsen, K. (1973): Guest Editorial. **International Journal of Forensic Denistry.** 1(1):2.

15. Hashim HA, Murshid ZA. **Mesiodistal tooth width: A comparison between Saudi males and females.** Egypt Dent J 1993; 39:343-6.

16. Lysell L, Myrberg N. **Mesiodistal tooth size in deciduous and permanent dentitions.** Eur J Orthod 1982; 4:113-22.

17. Gabriel, A.C. (1958): **Some anatomical features of the mandible.** Journal of Anatomy. 92(4): 580.

18. Robinson, S.I.M. (1972): **Children's Dentistry in Burma.** British Dental Journal.

19. Molnar, S. (1971): **Human tooth wear, tooth function and cultural variability.** American Journal of Physical Anthropology 34(1): 175-190.

20. Krogman WM. **The human skeleton in Forensic medicine.** In: Sexing skeletal remains. 3rd printing, Charles C Thomas, USA, p. 149 (1978).