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Sex determination using cheiloscopy and mandibular canine index as a tool in forensic dentistry

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Abstract

Introduction: Establishment of a person's individuality is important for legal as well as humanitarian purpose and gender determination is an essential step in identifying an individual. In forensic odontology the sum total of all the characteristics of teeth and their associated structures provide a unique totality and forms the basis for personal identification. **Aims and Objectives:** To investigate the accuracy of various methods employed in sex determination such as cheiloscopy and mandibular canine index (MCI). **Materials and Methods:** The study group comprises adults between 20 and 25 years of age, who were assessed for gender identification using lip prints and MCI. The results were subjected to statistical analysis. **Results:** MCI and lip prints were found to be accurate and specific for sex determination. **Conclusion:** There is scope for use of these methods in criminal investigations, personal identification, and genetic studies. Thus, dental tissues make good witnesses although they speak softly, they never lie and they never forget.

Key words: Cheiloscopy, forensic odontology, mandibular canine index, sex determination

Introduction

Establishment of a person's individuality is important for legal as well as humanitarian purpose and gender determination is an essential step in identifying an individual. Dental, fingerprint and DNA comparisons are probably the most common techniques used in this context, allowing fast and secure identification processes. However, in certain circumstances related to the scene of the crime, these techniques might be unavailable, so there is still an increasing need for reliable alternative methods of establishing identity.[1]

The grooves present on the human lips are unique to each person and can be used to determine identity of the individual. The study of these grooves or furrows present on the red part or the vermilion border of the human lips is known as cheiloscopy.[2] Lip prints are unique and do not change during the life of a person.[3] This biological phenomenon was first noted by anthropologists. R. Fischer and was the first one to describe it in 1902.[2,4]

Teeth are extremely durable even at high temperature and may be identified even when the rest of the body has undergone decomposition.[5] Mandibular canines are found to exhibit the greatest sexual dimorphism amongst all teeth.[5-7] "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.[5,6] It was for these reasons that Rao *et al*.

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proposed the exclusive use of mandibular canines in sex identification. The authors developed an index, which they named mandibular canine index (MCI).[7]

The purpose of the study was to investigate the accuracy with which gender can be differentiated by using cheiloscopy and MCI.

Materials and Methods

Study sample

A study sample comprised 60 students of Teerthanker Mahaveer Dental College and Research Centre, 30 males and 30 females aged between 20 and 25 years. Cheiloscopy and MCI both were performed in each student to investigate the accuracy of both the sex determination parameters. Informed consent of all the students was obtained prior to the study.

For cheiloscopy

Inclusion/Exclusion criteria

- Lips free from any pathology
- Absolutely normal transition zone between the mucosa and the skin
- Individuals with known hypersensitivity to lipstick were not included in this study

A dark colored lipstick was applied with the single stock, evenly on the vermillion border. The subject was asked to rub both the lips, to spread the lipstick evenly. After 2 mins, lip impressions were made, on a strip of cellophane tape on glued portion, which was then stuck to a white bond paper. This served as a permanent record. The impression was visualized using a magnifying lens.

The lip prints were classified (Tsuchihashi's classification) in the year 1974 into six types, according to the shape and course of grooves:[2,8]

Type I: Clear-cut grooves running vertically across the lip
Type I'': The grooves are straight but disappear half-way instead of covering the entire breadth of the lip.
Type II: The grooves fork in their course
Type III: The grooves are branched
Type IV: The grooves are of criss crossed pattern and reticular
Type V: The grooves do not fall into any of the types I to IV and cannot be differentiated morphologically

For Mandibular Canine Index

Inclusion criteria

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

- Healthy state of gingiva and periodontium
- Caries free teeth
- Normal over-jet and overbite
- Absence of spacing in the anterior teeth
- Normal molar and canine relationship

Impressions were made by alginate and study models were prepared in dental stone. Mandibular study models were used for the analysis. On the study model, the following measurements were taken for all the subjects using a digital vernier's callipers. Mandibular canine width was measured as the greatest mesiodistal dimension of mandibular canine on either side of the jaw using a vernier calliper, and the average of this was taken. The intercanine distance was measured as the linear distance between the cusp tips of right and left mandibular canine.

The observed mandibular canine index (MCIO) was calculated using the formula below:[5,7]

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

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 compared with the observed MCI value obtained in this study and correlated with previous studies like Reddy LVK, Rao *et al*., Muller *et al*., and Hashim *et al*.

Results

The Table 1 shows that the overall mesio-distal width of mandibular canine was found to be 6.57 ± 0.29 mm among the study group in which males had a more mesio-distal width in both right (6.79 ± 0.29) and left (6.78 ± 0.30) mandibular canines when compared to females and was found to be significant ($P = 0.000$, HS). The observation was similar for the mandibular inter-canine distance also with maximum intercanine distance (32.89 ± 1.29) in males which was found to be significant ($P = 0.000$, HS) when compared to females (30.6 ± 1.39). There is no variation in MCI of males and females and was found to be not significant in the present study group.

Table 2 shows that Type I (46.7%) lip print was most commonly seen in females followed by type II (30.0%), type IV (16.7), type III (3.3%), and type V (3.3%), respectively. Type III (43.3%) was seen most commonly in males followed by type IV (30.0%), type II (13.3%), and type I (6.7%), and V (6.7%), respectively. The difference is statistically significant.

This relation of gender propensity to type of lip print distribution was found to be significant with a likelihood ratio of 25.8.

Table 3 reveals that right mandibular canine shows more sexual dimorphism as compared to mandibular left canine.

In Table 4, there was not much of difference in the mesio-distal width of mandibular canines on both right and left side among different types of lip print patterns and was found to be significant and the variation was present between type 1 and type 3 lip print pattern as confirmed by the Bonferroni`s *post hoc test* (0.025, S) where in the type 1 (6.43 ± 0.26) and type 3 (6.82 ± 0.33) lip print pattern subjects had a varied mesio-distal distance. However, the mean MCI and inter canine distance with lip print patterns were found to be non-significant and their mean values did not vary much among different type of lip prints.

Table 1: Overall mesio-distal width

	Sex	Number	Mean	Std. deviation	Sig. (*P*-value)	
Right mandibular canine(r ma ca-c)	Male	30	6.79	0.284	0.000*	HS
	Female	30	6.31	0.252		
Left mandibular canine(lmc-cast)	Male	30	6.78	0.298	0.000*	HS
	Female	30	6.40	0.306		
Intercanine mandibular (IC-CAST)	Male	30	32.89	1.291	0.000*	HS
	Female	30	30.60	1.390		
MCI for right side	Male	30	0.21	0.012	0.931	NS
	Female	30	0.21	0.011		
MCI for left side	Male	30	0.21	0.012	0.335	NS
	Female	30	0.21	0.012		

*Highly significant

Table 2: Distribution and comparison of lip print with gender

Lip print	Sex		Total (%)	Chi-square	Sig. (*P*-value)
	Male (%)	Female (%)			
Type 1	2	14	16	Pearson chi-square value -22.685	0.000*,HS
	6.7	46.7	26.7		
Type 2	4	9	13		
	13.3	30.0	21.7	Likelihood ratio - 25.8	
Type 3	13	1	14		
	43.3	3.3	23.3		
Type 4	9	5	14		
	30.0	16.7	23.3	Linear-by-linear association - 13.011	
Type 5	2	1	3		
	6.7	3.3	5.0		
Total	30	30	60		
	100.0	100.0	100.0		

*Highly significant

Table 3: Sexual dimorphism in mandibular canines

Tooth	Sexual dimorphism
Right Canine	6.926%
Left Canine	5.498%

Discussion

Human identification has always been of paramount importance to society.[9] Noting, as providing an additional tool for personal identification is the series of studies on the morphology of the lips and the pattern produced when they are impressed onto a variety of surfaces.[8]

The lip prints were classified using the classification proposed by Suzuki and Tsuchihashi in 1974, also known as Tsuchihashi's classification.[2] This is the most widely used classification in literature. It was found to have a clear description of nearly all of the commonly encountered lip patterns and was easy to interpret. Its resemblance to the dental formula was also familiar to the forensic dentist. The fact that a minimum number of type V patterns were observed in the present study was evidence to the complete coverage of patterns in this classification.

In our study, the upper lip showed a predominance of type I pattern (26.7%) followed in order by type III (23.3%) and type IV (23.3), type II (21.7%) and type V (5.0%).

Sivapathasundharam *et al*. (2001)[10] stated that the uniqueness of patterns depended on the way the lip muscles relaxed to produce a particular pattern. Lévêque and Goubanova (2004)[11] suggested that the furrows and grooves on the lips seemed to be privileged routes for saliva to spread over the lips and maintain good hydration. They also found the upper lip to be more hydrated than the lower one. The variations in pattern between the upper and lower lip may be attributed to these factors and might have a functional significance. Lévêque and Goubanova also noted that some continuity appeared to exist between the lips and adjacent skin lines and suggested a common origin.

As early as 1950, Snyder suggested that the normal lines and fissures of the lips were an individual characteristic, much the same as finger ridges.[8,12-16] Since then, numerous studies give evidence to the fact that lip prints are unique and characteristic of an individual. However, at the initial classification stage, as in the case of fingerprints, there are similarities among the broadly classified groups of lip prints.

Canines differ from other teeth with respect to survival and sex dichotomy. These differences are probably related to their function, which is different on an evolutionary basis from other teeth. Although canine sex differences and enhanced canine survival are not related to each other, both are probably related to the need for successful use of canines as weapons for total body survival.

The present study establishes the existence of a definite statistically significant sexual dimorphism in mandibular canines. This is consistent with the findings of Hashim

Table 4: Comparison of mandibular canine index and type of lip print patterns

Canine index (Measurements in mm)	Lip print patterns	Mean	Std. deviation	ANOVA value (F)	Sig.
Mesio-distal width of mandibular canine					
Right	Type 1	6.43	0.26	3.139	0.021, S
	Type 2	6.48	0.34		
	Type 3	6.82	0.33		
	Type 4	6.47	0.39		
	Type 5	6.66	0.49		
Left	Type 1	6.52	0.27	2.017	0.105, NS
	Type 2	6.50	0.38		
	Type 3	6.82	0.34		
	Type 4	6.54	0.37		
	Type 5	6.54	0.40		
Mandibular inter-canine distance					
	Type 1	30.96	1.59	2.179	0.083, NS
	Type 2	31.53	1.77		
	Type 3	32.75	1.56		
	Type 4	31.88	1.75		
	Type 5	31.51	2.42		
The mandibular canine index					
Right	Type 1	0.21	0.01	0.576	0.681, NS
	Type 2	0.21	0.01		
	Type 3	0.21	0.01		
	Type 4	0.20	0.01		
	Type 5	0.21	0.00		
Left	Type 1	0.21	0.01	0.404	0.805, NS
	Type 2	0.21	0.02		
	Type 3	0.21	0.01		
	Type 4	0.21	0.01		
	Type 5	0.21	0.01		

and Murshid who conducted a study on 720 Saudi males and females in the age group of 13-20 years. Their study showed that the canines were the only teeth to exhibit dimorphism.[17]

Similar findings were given by Lew and Keng in their study on an ethnic Chinese population with normal occlusions.

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%.[18,19]

Conclusion

The emerging field of forensic odontology in India relies a lot on inexpensive and easy means of identification of persons from fragmented jaws and dental remains. It is in such situations that the dentist can be called upon to render expertise in forensic science.

The present study establishes the existence of a definite, statistically significant, sexual dimorphism in mandibular canines as well as cheiloscopy. We conclude that the standard MCI is a quick and easy method for sex identification. This is of particular significance when more advanced methods for sex determination are not readily available. However, as the accuracy of MCI in identification of sex has never exceeded 87.5%, it can only be used as a supplemental tool.

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