

Cheiloscopy patterns in Indian population and their efficacy in sex determination: A randomized cross-sectional study

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Abstract

Background: Cheiloscopy or the study of lip prints is an important tool in forensic dentistry which is gaining popularity in current times. Not only has it proven effective in identification of individuals, but its role in sex determination has also been investigated. There are six different types of cheiloscopy/lip print patterns according to Tsuchihashi. **Aims:** The present study was conducted to find the prevalence of cheiloscopy/lip print pattern in 755 individuals and also to assess their efficacy in sex determination. **Materials and Methods:** According to classification by Tsuchihashi, the lip prints were analysed. Sex determination using lip print was done by method given by Vahanwala *et al.* **Results:** It was found that Type I was the most prevalent cheiloscopy pattern. Based on the method of sex determination using lip prints by Vahanwala *et al.*, the percentage of individuals correctly identified was less. **Conclusion:** Although cheiloscopy holds promise as a supplementary tool along with other modes to recognize the sex of an individual, there is need for further studies using standardized methods to evaluate the same in larger population sizes.


Key words: Cheiloscopy, forensic dentistry, lip prints, lipstick, sex determination

Introduction

A part from the routine professional obligation of a dental surgeon to examine, investigate, diagnose, and treat oral and oro-facial lesions, sometimes his/her services are called for in community services and legal matters. The role played by a dental surgeon in the discipline of forensics is quite significant in terms of age and sex determination, personal identification of unknown deceased persons, analyzing bite marks as evidence, participating in mass disaster,

giving evidence in child abuse, etc.^[1] Cheiloscopy (from the Greek words, Cheilos = lips, Skopein = see) or the study of lip prints, which is an integral part of forensic odontology, is the forensic investigation technique that deals with identification of humans based on lip traces.^[2] The wrinkles and grooves on the labial mucosa, called as sulci laborium, form the characteristic lip print pattern. These wrinkles and grooves have been named as "sulci labiorum rubrorum" by Tsuchihashi.^[3] The lip prints are unique^[4] and can be identified as early as the sixth week of intrauterine life.^[5] There are no changes in lip prints during the life of a person.^[4] After undergoing alterations due to minor trauma, inflammation, and diseases like herpes, lip prints have been found to recover in some time.^[5] However, scarring of the lips secondary to major trauma, pathosis, and surgical treatment may affect the size and shape of lips, thereby altering the pattern and morphology of the grooves.^[6]

Lip prints were first described by Fisher in 1902.^[4,7-9] In 1932, French criminologist Edmond Locard recommended the

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Website: www.jfds.org	Quick Response Code 
DOI: 10.4103/0975-1475.156192	

use of lip prints for the first time, while Le Moyne Snyder mentioned the use of lip prints in the identification of individuals in his book "Homicide Investigation" written in 1950.^[10]

This study was conducted with the aim of finding the prevalence of cheilosopic/lip print patterns among 755 individuals of Indian origin and assessing their efficacy in sex determination.

Materials and Methods

Ethical clearance for conducting this study was obtained from the Ethical Committee of Vydehi College of Dental Sciences and Research Center.

Study sample

A total of 755 subjects of Indian origin (375 males and 380 females) were included in our study. The subjects were aged between 1 year and 80 years and were divided into three groups depending upon their age as shown in Table 1.

Group 1: 1–20 years (114 subjects)

Group 2: 21–40 years (483 subjects)

Group 3: 41 years and above (158 subjects).

Inclusion criteria

Individuals aged above 1 year with lips free from any pathology, and having absolutely normal transition zone between the mucosa and skin were included in the study after obtaining an informed consent.

Exclusion criteria

Individuals with known allergy to lipstick, inflammation of lips, trauma, malformation, deformity, surgical scars, facial palsy, and active lesions of the lips were excluded.

Study materials/armamentarium [Figure 1] consisted of the following:

- Brown- and pink-colored lipstick
- Lipstick applicator
- Cellophane tape (2 inch wide)
- Executive bond paper
- Magnifying lens
- Lipstick remover liquid
- Cotton balls
- Scissors.

Procedure for recording lip prints

The procedure for recording lip prints is given in Figure 1.

The lips of the individuals who were already wearing lipstick were cleaned with a cotton ball dipped in lipstick remover. After obtaining the consent, lipstick was applied with a lipstick applicator evenly, starting from center and moving laterally in a single motion. The individuals

were asked to retain a relaxed position of their lips. After 2 min, once the lipstick had dried, the glued portion of the cellophane tape strip was placed and the individual was asked to make a lip impression in the normal rest position of the lips by dabbing it in the center first and then pressing it uniformly toward the corners of the lips. The cellophane strip was then stuck to the executive bond paper for permanent record purpose and then visualized by magnifying lens. The lip prints were coded based on the name and the sex of the individuals. To avoid bias, all the lip prints were compiled, analyzed, and interpreted only once by researcher no. 2 to determine the sex of the individuals.

Determination of lip print pattern

In order to determine the lip print pattern, each individual's lips were divided into four compartments, i.e. two compartments on each lip [Figure 2]. The classification system by Tsuchihashi^[5] was used. According to this classification [Figures 3–9], lip print patterns are divided using a magnifying lens as follows:

Type I: Clear-cut vertical grooves that run across the entire lips

Type I': Similar to Type I, but do not cover the entire lip

Type II: Branched grooves

Type III: Intersected grooves

Type IV: Reticular grooves

Type V: Grooves do not fall into any of the types, i.e. Type I–IV, and cannot be differentiated morphologically.

For sex determination using lip prints

For assessing the sex of the individuals using their lip prints, the description given by Vahanwala *et al.*^[11,12] was used. According to this description,

Type I, I': Pattern dominant in female

Type II: Pattern dominant in male



Figure 1: Study material/Armamentarium and procedure of recording lip prints

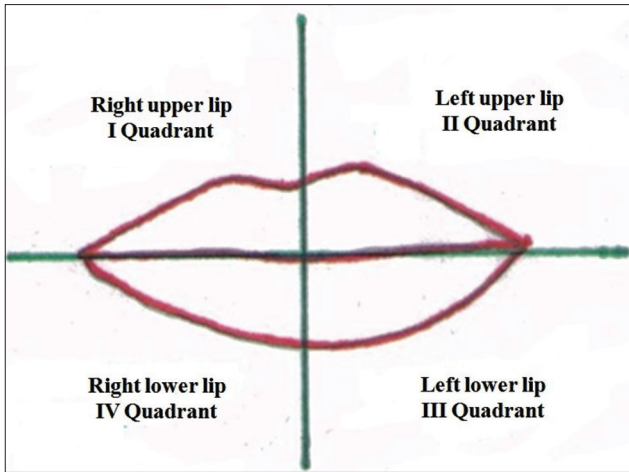


Figure 2: Division of lip into compartments

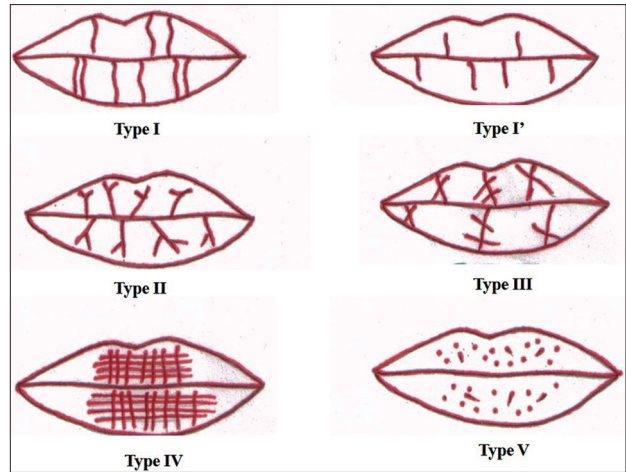


Figure 3: Diagrammatic representation of types of lip prints



Figure 4: Type I lip print pattern



Figure 5: Type I' lip print pattern



Figure 6: Type II lip print pattern



Figure 7: Type III lip print pattern



Figure 8: Type IV lip print pattern

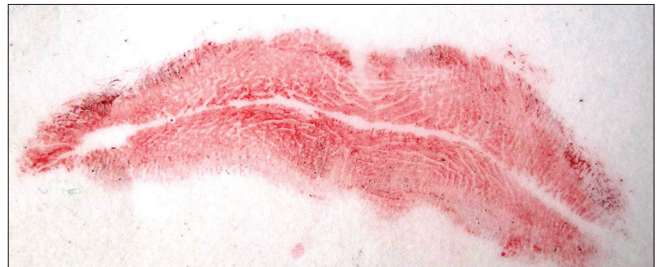


Figure 9: Type V lip print pattern

Type III: Pattern present in male
 Type IV: Male
 Type V: Male (varied pattern).

Same patterns in all quadrants – Female

The frequency of each type of lip print was tabulated and the percentage of each type was calculated.

The statistical software, namely SAS 9.2, SPSS 15.0, Stata 10.1, MedCalc 9.0.1, Systat 12.0, and R environment ver. 2.11.1, were used for the analysis of the data, and Microsoft word and Excel were used to generate graphs, tables, etc., Descriptive and inferential statistical analyses were used. Chi-square and Fisher’s exact test were used to find the significance of study parameters on categorical scale.

Results

The examination of lip print patterns revealed that no two cheiloscopy/lip prints matched with each other, thus establishing the uniqueness of the lip prints. The most predominant cheiloscopy/lip print pattern in the entire study population was Type I (36.5%). This was followed, in order, by Type II (22.6%), Type III (17.4%), Type V (10.6%), Type I’ (8.2%), and Type IV (4.5%) [Table 2].

In females, Type I (35.5%) lip pattern was most commonly found, followed by Type II (26.1%) and Type III (16.3%). In males, Type I (37.9%) lip pattern was predominant, followed by Type II (19.2%) and Type III (18.4%). Therefore, the most common cheiloscopy/lip print pattern for both females and males in the present study was Type I [Table 3, Figure 10].

One hundred and thirty-one males out of 375 were correctly identified and 267 females out of 380 females were correctly identified. The accuracy of lip print patterns in sex determination was 17.4% in males and 35.4% in females. A low kappa value of 0.05 was obtained signifying that lip prints were not effective in sex determination [Table 4, Figure 11]. The Chi-square test applied to test significant difference between males and females for different types of lip patterns did not show a significant difference [Table 5].

Discussion

Identification of unknown individuals has been of importance to the society from times unknown.^[13]

Cheiloscopy, a genuine subspecialty of forensic odontology, is analogous to fingerprint analysis.^[14] Lip prints are very useful in forensic investigations and personal identification. Potential places where lip prints may be found and used in investigation of a crime are on a tape used to gag or bind a person, on a glass used to drink from, cigarette butt, or windows/glasses against which they have been pressed. Sometimes lip prints may be seen as lipstick smears. Lipsticks are composed of several compounds, oils or waxes. In recent times, lipsticks that do not leave any visible trace after contact with surfaces like glass, clothing, cutlery, or cigarette butts have been developed. These lip prints, characterized by their permanence and referred to as “persistent lip prints,” can be lifted using materials like aluminium powder or magnetic powder.^[15,16] However, it is also to be noted that the use of lipstick is not indispensable for leaving lip prints. The edges of the lips have sebaceous glands with sweat glands in between, the secretion of which enable the development of “latent lip prints.”^[19] These lip prints can be obtained up to 30 days after being produced.^[16] Also, where identification is concerned, it is not only the Klein zone, which is the mucosal area of lips covered with wrinkles and grooves forming lip prints, that is to be considered alone. In cheiloscopy, one should also analyze lip anatomy, considering its thickness and position. The lips can be horizontal, elevated, or depressed in position. According to their thickness, lips can be of four types: thin lips (common in European Caucasian), medium lips (from 8 to 10 mm, the most common type), thick or very thick lips (usually with an inversion of the lip cord, commonly seen in African Americans), and mix lips (usually seen in Orientals).^[7]

The present study was carried out to find the prevalence of cheiloscopy/lip print patterns and to assess their efficacy in sex determination. The lip prints were recorded with the lips in closed and relaxed position using the classification system by Tsuchihashi.^[5] The uniqueness of lip print patterns depends on the way the lip muscles

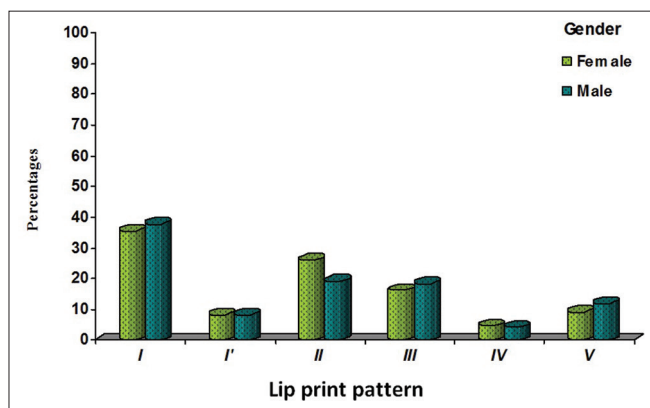


Figure 10: Distribution of cheiloscopy/lip print patterns among males and females

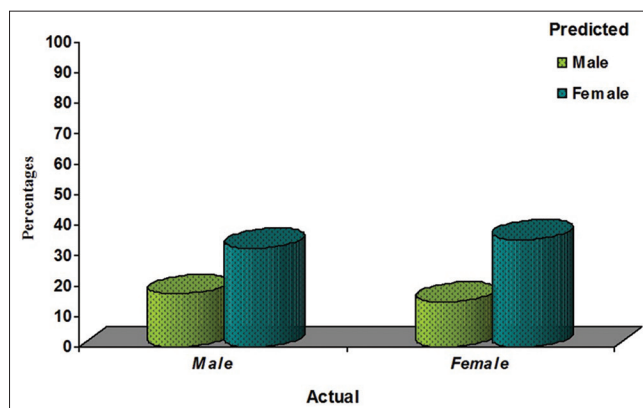


Figure 11: Comparison of actual and predicted sex based on cheiloscopy/lip print patterns

Table 1: Age distribution of subjects

Age in years	No. of subjects	Percentage
1-20	114	15.1
21-40	483	63.9
41 years and above	158	20.9
Total	755	100.0

Table 2: Cheilosopic/lip print pattern

Lip print pattern	No. of patients	Percentage
I	277	36.7
I'	62	8.2
II	171	22.6
III	131	17.4
IV	34	4.5
V	80	10.6
Total	755	100.0

Table 3: Cheilosopic/lip print pattern in males and females

Lip print pattern	Gender (%)	
	Female	Male
I	135 (35.5)	142 (37.9)
I'	31 (8.2)	31 (8.3)
II	99 (26.1)	72 (19.2)
III	62 (16.3)	69 (18.4)
IV	18 (4.7)	16 (4.3)
V	35 (9.2)	45 (12)
Total	380 (100)	375 (100)

Table 4: Correlation of actual and predicted sex determination with kappa value

Actual	Predicted (%)		Total (%)
	Male	Female	
Male	131 (17.4)	244 (32.3)	375 (49.7)
Female	113 (14.9)	267 (35.4)	380 (50.3)
Total	244 (32.3)	511 (67.8)	755 (100.0)
Inference	$\chi^2=2.300$; $P=0.127$; $\text{kappa}=0.05$		

are relaxed to produce a particular pattern.^[4] Also, in closed mouth position lips exhibit well-defined grooves, while in an open mouth position the grooves are not well defined and hence are difficult to interpret.^[17] To study the lip prints, each individual's lips were divided into four compartments, two compartments on the lower lip and two on the upper lip, following the method advocated by Vahanwala^[18] and used by Saraswathi *et al.*^[19] Each compartment was studied and the overall type of groove patterns was recorded as the lip print. It was observed that in the entire study population, Type I lip print pattern was the most prevalent (36.5%). Also, in both males and females, Type I remained the most prevalent type of lip print pattern (males 37.9%, females 35.5%). This finding is similar to the one obtained in a study comprising 600 individuals that was conducted by Randhawa *et al.*^[20] Also, similar observations were

Table 5: Correlation of actual and predicted gender according to cheilosopic/lip print pattern

Lip print pattern	Actual	Predicted (N=755) (%)		Total (%)	P
		Female	Male		
I	Female	0	1 (0.13)	1 (0.13)	1.000
	Male	0	0	0	
	Total	0	1 (0.13)	1 (0.13)	
I'	Female	30 (3.9)	0	30 (3.9)	1.000
	Male	31 (4.1)	0	31 (4.1)	
	Total	61 (8.1)	0	61 (8.1)	
II	Female	103 (13.6)	0	103 (13.6)	0.243
	Male	75 (9.9)	1 (0.13)	76 (10.1)	
	Total	178 (23.6)	1 (0.13)	179 (23.7)	
III	Female	0	62 (8.2)	62 (8.2)	1.000
	Male	0	67 (8.9)	67 (8.9)	
	Total	0	129 (17.1)	129 (17.1)	
IV	Female	0	17 (2.3)	17 (2.2)	0.279
	Male	1 (0.13)	14 (1.9)	15 (1.9)	
	Total	1 (0.13)	31 (4.1)	32 (4.2)	
V	Female	0	34 (4.5)	34 (4.5)	1.000
	Male	0	49 (6.5)	49 (6.5)	
	Total	0	83 (10.9)	83 (10.9)	

made in the studies conducted by Vahanwala *et al.*^[11] and Sandhu *et al.*^[21] In the past, some researchers have worked with the idea of utilizing lip print patterns in sex determination. In our study, only 17.4% males and 35.4% females could be correctly identified. Due to low kappa value, we cannot consider lip print patterns effective in sex determination.^[22] Lips reach their maturity in late adolescence. Females attain upper lip maturity at 14 years and lower lip maturity at 16 years, while in males, both upper as well as lower lips mature at 18 years of age.^[23] In mid to late 30s, though age changes begin to occur in the upper face, lips retain their tonicity and do not show any age-related changes.^[24] After 40, due to the occurrence of wrinkles on the adjacent skin and thinning of lips, lip print patterns are affected. Lips and perioral area lose their volume, which diminishes the overall lip anatomy. Also, the inter-commissural distance increases with age and the lip height decreases.^[25] Our study sample comprised 114 and 158 individuals in the age groups of 1–20 years and 41 years and above, respectively. This could probably be a reason for lesser accuracy of sex prediction using lip prints in our study.

In the recent past, focus has shifted to other possibilities of sex determination using DNA detection in latent lip prints. Evidences like photographs, cigarette butts, drinking glasses, letters, etc., that could bear lip prints should be closely examined. They are a source of vital information that helps the investigator in reconstructing the events, establishing versions, checking them, and identifying suspects. Though lip prints have been used in the court of law, their use is not consensual.

Conclusion

Among the large number of tools available to a forensic expert, cheiloscopy is a relatively newer one. Though work on this subject has already elicited useful information, limitations still exist in the use of cheiloscopy. The results obtained in our study do not prove it to be an infallible method. But it still seems to open a small window to a vast unventured field.

In the present study, Type I was found to be the most prevalent cheiloscopy pattern in the entire study population as well as in males and females separately. However, due to the influence of age changes on the size and shape of the lips and the perioral skin, we could not confirm the efficacy of cheiloscopy in sex determination.

According to many studies, cheiloscopy holds promise as a supplementary tool along with other modes to recognize the sex of an individual. The need of the hour is to develop a standardized method to assess and accurately record the cheiloscopy patterns. Further studies are required on the effect of age and seasonal changes on the cheiloscopy patterns.

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How to cite this article: Kaul R, Padmashree SM, Shilpa PS, Sultana N, Bhat S. Cheiloscopy patterns in Indian population and their efficacy in sex determination: A randomized cross-sectional study. *J Forensic Dent Sci* 2015;7:101-6.

Source of Support: Nil, **Conflict of Interest:** None declared