Gender determination using cheiloscopy

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Abstract

Background: Although lip prints have been used as an evidence for human identification in forensic science, there exists a doubt about its role in gender determination. Aims: The present study was designed for documenting common patterns, as well as their variation in the study population, with objective of evaluating uniqueness of the lip print pattern among the study population, as well as to evaluate the possibility of gender determination.

Study Design: Two hundred and thirty five lip prints were collected from volunteers among out patients of Darshan Dental College and Hospital, as well as community dental care camps of rural areas around Udaipur. Materials and Methods: Lip prints were recorded with transparent overlay and transferred on to a bond paper. It was then photographed using a Canon EOS 550D 16 mega pixel digital camera. Software Picasa 3.6 and Microsoft Picture Manager were used to digitally enhance the quality and magnify the image bearing the groove pattern. Lip prints were later analyzed.

Statistical Analysis: Pearson chi square test was adopted for statistical analysis and probability (P value) was calculated. Conclusion: In our study, none of the lip prints were identical, thus confirming the role of lip prints in individual identification. Dots, reticular and complex patterns were significant in gender determination.

Key words: Forensic, gender, lip

Introduction

In forensic identification, the mouth allows for a myriad of possibilities. In fact, lips, as well as hard palate are known to have features that can lead to a person’s identification. The study of lip prints is known as cheiloscopy.[1] Lip prints are similar to fingerprints, palm prints and footprints in that individual characteristics are used for identification.[2] Lip prints are unique and do not change during the life of a person. It has been verified that they recover after undergoing alterations like trauma, inflammation and diseases like herpes and also the disposition and form of the furrows does not vary with environmental factors.[3]

Two Japanese scientists, Y. Tsuchihashi and T. Suzuki in the period 1968-71, established that the arrangement of lines on the red part of the human lip is individualistic and unique for each human being. They named the grooves as Sulci Labiorum and lip prints consisting of these grooves as “Figura linearum labiorum rubrorum”. [4] It was also observed in Tsuchihashi’s study that no two uniovular twins had exactly identical lip print patterns.[5] Studies have also observed that lip prints behold the potential for recognition of the sex of an individual.[6-7]

The oily and moist secretions from sebaceous and salivary glands located at the vermilion border and subsequent moisturization from the tongue enables the formation of a latent lip print. Various physical evidences at the crime scene, such as photographs, letters, glass, window panes, cutlery, cigarette butts, clothing, and even biological materials such as skin may bear latent, visible, or both types of lip prints.[5] Latent lip prints can be developed by using lysochrome,[9] REDescent reagent,[10] Nile Red,[11] aluminium powder, cobalt oxide and magnetic powder.[12]

Traditional lipsticks produce a lip print that can easily be studied i.e., visible lip print.[13] Although lips can be
photographed directly, covering them with lipstick allows better groove visualization.[1] The lip prints can be recorded with cellophane tape[3] or paper.[14]

The present study was conducted to document and evaluate different lip groove patterns in the study population of Gujarat and Rajasthan, with an attempt to evaluate the probability of gender determination based on lip groove pattern.

Materials and Methods

The study group consisted of 250 volunteers from the outpatients of Darshan Dental College and Hospital and the community dental care camps conducted in rural areas of Udaipur. Patients with hypersensitivity to cosmetics and lip lesions were not included in the study.

A single coat of dark colored lipstick (Lakme 353) was applied evenly on the vermilion border of lips. Lip impressions were recorded on the glued portion of cellophane tape by placing the tape over the lips and applying light pressure. It was then stuck onto a white bond paper.[3] These preparations were photographed using a Canon EOS 550D 16 mega pixel digital camera maintaining a standard distance of three feet using a tripod stand. The images were later transferred onto a computer and were digitally enhanced to adjust the contrast, brightness and sharpness using Picasa 3.6 software. This served as a permanent record. The images were magnified to 100% using Microsoft Picture Manager Software for analyzing the groove patterns.

These images were divided into central half and lateral 1/4th on either sides.[3] Lateral parts of both upper and lower lips were not used in the analysis as they had only very fine lip grooves and some exhibited immediate tapering. In the present study, the lip prints were considered as the following description [Figure 1]:

- U - Center half of upper lip
- U1 - Upper segment of U
- U2 - Lower segment of U
- L - Center half of lower lip
- L1 - Upper segment of L
- L2 - Lower segment of L

Statistical analysis

A master chart was prepared by assigning numerical values for all the variables of the study. Statistical analysis was done using Pearson Chi square test (SPSS version 16.0). Probability (P value) of calculated values occurring by chance in case of ‘χ²’ was determined.

Results and Discussion

During analysis of lip prints, the authors came across irregular, large non-lipstick areas or plain areas [Figure 2]. When the lips of these patients were examined, these plain areas appeared as depressions [Figure 3]. These areas took up the lip stick [Figure 4] but recorded as non-lip stick.
bearing areas. Dots were another pattern noted in the study. Dots were considered when multiple in number or clustered together [Figure 5]. They were not counted individually. Dots have not been included in any lip groove classification. Lip groove patterns less than 2 mm in size other than dots were not considered for analysis. Complex pattern includes three or more different types of lip patterns and multiple in number [Figures 6 and 7].

The classification used in the present study is based on Suzuki and Tsuchihashi's classification,[15-17] but also includes two other patterns, namely dots and complex pattern [Figure 8]. Thus, the following classification was elaborated in the present study:

1. Complete vertical (CV)
2. Incomplete vertical (IV)
3. Branching (B)
4. Reticular pattern (R)
5. Dots (D)
6. Complex pattern (CP).

It was also noted that, the six lip groove patterns found in the present study had a different pattern of distribution. CV, IV and B were not limited to any particular segment and were spread over entire lips (U and/or L). D, R and CP patterns were distributed differently. In some lip prints D, R and CP patterns were spread over the entire lips (U and/or L) and in others they were predominantly present either in U1, U2, L1 or L2 [Tables 1-3, Figure 7].

**Distribution and variation of lip groove patterns**

The total number of lip groove patterns in the upper lip considering U, U1 and U2 together was 571 (48.3%) and the total number of lip groove patterns in the lower lip considering L, L1 and L2 together was 609 (51.6%) [Tables 1-3]. The difference in the number of lip groove patterns between upper and lower lip was not found to be significant. It has been 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.[9]
Table 1: Comparison of total number of CV, IV and B in U and L

| Lip groove pattern | Total number | P value | P value |
|--------------------|--------------|---------|---------|
| CV U               | 4            | 0.063 (NS) |         |
| CV L               | 12           |         |         |
| IV U               | 151          | 0.997 (NS) |         |
| IV L               | 165          |         |         |
| B U                | 71           | 0.465 (NS) |         |
| B L                | 70           |         |         |
| Total number U     | 226          | 0.157 (NS) |         |
| Total number L     | 247          |         |         |

CV: Complete vertical, IV: Incomplete vertical, B: Branching, U: Upper lip, L: Lower lip, NS: Not significant

Table 2: Total number of D, R and CP patterns in U and L

| Lip groove pattern | Total number | P value | P value |
|--------------------|--------------|---------|---------|
| D U                | 9            | 0.721 (NS) |         |
| D L                | 6            |         |         |
| R U                | 14           | 0.073 (NS) |         |
| R L                | 7            |         |         |
| CP U               | 9            | 0.620 (NS) |         |
| CP L               | 7            |         |         |
| Total number U     | 32           | 0.821 (NS) |         |
| Total number L     | 21           |         |         |

D: Dots, R: Reticular pattern, CP: Complex pattern, U: Upper lip, L: Lower lip

Most common lip groove pattern was found to be IV, when both upper and lower lips were considered. Study conducted by Augustine et al.,[3] and Saraswathi et al.,[18] found intersected pattern to be most predominant in number, when both upper and lower lips were considered. In a study conducted, Magda Ahmed El Domiaty et al.,[14] found ‘horizontal with other forms’ and complete bifurcated patterns to be predominant in number and Dr. Annie J. Verghese et al.,[16] had found reticular to be the predominant lip groove pattern, when both upper and lower lips were considered.

Presence of D, R and CP lip groove patterns in U1, U2, L1, L2 were compared and their predominance in numbers in any segment was noted. Significant number of dots was found to be present in L2 part of lower lip when compared with L1 part of lower lip. Complex pattern was predominantly present in L1 part of lower lip when compared with L2. There was no other significant predominance of any other lip groove pattern in a particular segment [Table 3].

Table 3: Total number of lip groove patterns in U1, U2, L1 and L2 segments

| Lip groove pattern | Total number | P value | P value |
|--------------------|--------------|---------|---------|
| D U                | 89           | 0.432 (NS) |         |
| D U                | 78           |         |         |
| L1                 | 42           | 0.002 (S) |         |
| L2                 | 94           |         |         |
| R U                | 70           | 0.632 (NS) |         |
| R U                | 68           |         |         |
| L1                 | 62           | 0.892 (NS) |         |
| L2                 | 89           |         |         |
| CP U               | 35           | 0.01 (S) |         |
| CP U               | 20           |         |         |
| Total number U     | 163          | 0.303 (NS) |         |
| Total number L     | 150          |         |         |

D: Dots, R: Reticular pattern, CP: Complex pattern, U1: Upper segment of upper lip, U2: Lower segment of upper lip, L1: Upper segment of lower lip, L2: Lower segment of lower lip, NS: Not significant, S: Significant

Lip groove pattern in forensic identification

In the present study, none of the lip prints were identical. Lip prints are invariable, permanent and allow establishing a classification. Latent or chance impressions located on smooth surfaces are encountered in a majority of the investigations, which require comparative analysis. These impressions may arise from a number of sources, the most frequently encountered being impressions of areas of skin bearing friction ridges, predominantly those from the fingers. The possibility of impressions arising from an area of the skin devoid of friction ridges has been noted. Cases in which impressions devoid of friction ridges have been used for evidential purposes, have primarily involved lip impressions.[3]

Lip groove pattern in gender determination

In our study, CV, IV and B did not show any significant difference in numbers between genders. When comparison was made between U1, U2, L1 and L2 of males with U1, U2, L1 and L2 of females, D and R patterns were found to be present significantly in U1 and U2 of males. D pattern was found more in number in the L1 segment of both male and females when compared with L2. R pattern was more evenly distributed in L1 and L2 of males and females [Tables 4 and 5].

Study conducted by Preeti Sharma et al.,[7] and Satyanarayana Naik et al.,[19] had found complete and incomplete vertical to be predominant in females, undetermined pattern to be most common in males. They had considered central part of lower lip for analysis.

When comparison was made between complex patterns
of U1, U2, L1 and L2 of males with U1, U2, L1 and L2 of females, CP pattern was found to be predominantly present in upper lip of females. CP pattern was more evenly distributed in L1 and L2 of males and females [Table 6].

Thus, upper lip played a definite role in gender determination in the present study. Lower lip did not help in gender determination. Though the lip patterns were distributed in U1, U2, L1, L2 segments, it was found that D and R patterns were commonly found in upper lip (U1 and U2) of males and CP pattern in upper lip (U1 and U2) of females.

**Lip morphology for gender determination**

Differences in lip morphology has been noted amongst various races such as European Caucasian, Negroes, Orientals.\(^{11}\) In the present study, different types of lip outlines noted in both upper and lower lips were bow, curve, straight and wave. Curved lip outline was most commonly found.

Differences in size and symmetry of lip prints were also analyzed. Lower lip was larger in a majority of the sample and only one half of the sample had symmetry of lips between right and left sides. Lip morphology did not vary significantly between genders.

**Conclusion**

In the present study, lip morphology did not vary significantly between genders. However, new patterns such as dots and complex patterns helped in gender determination. Lip prints in gender determination promise an avenue yet to be fully explored. A large database defined by geographical boundaries and a standardized lip impression technique would play an important role in cheiloscopy and forensic identification.

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