Original Article

A study of lip prints and its reliability as a forensic tool

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ABSTRACT

Introduction: Lip prints, like fingerprints, are unique to an individual and can be easily recorded. Therefore, we compared direct and indirect lip print patterns in males and females of different age groups, studied the inter- and intraobserver bias in recording the data, and observed any changes in the lip print patterns over a period of time, thereby, assessing the reliability of lip prints as a forensic tool. Materials and Methods: Fifty females and 50 males in the age group of 15 to 35 years were selected for the study. Lips with any deformity or scars were not included. Lip prints were registered by direct and indirect methods and transferred to a preformed registration sheet. Direct method of lip print registration was repeated after a six-month interval. All the recorded data were analyzed statistically. Results: The predominant patterns were vertical and branched. More females showed the branched pattern and males revealed an equal prevalence of vertical and reticular patterns. There was an interobserver agreement, which was 95%, and there was no change in the lip prints over time. Indirect registration of lip prints correlated with direct method prints. Conclusion: Lip prints can be used as a reliable forensic tool, considering the consistency of lip prints over time and the accurate correlation of indirect prints to direct prints.

Key words: Cheiloscopy, forensic, identification, indirect prints, lip prints

INTRODUCTION

The need for human identification has unfortunately risen in the new millennium owing to the growing challenges of terrorism, natural disasters, and high crime rates. Identification by dental means is made by comparing the antemortem and postmortem records, which include details of dental hard and oral soft tissues. Anatomical structures like rugae, pigmentation, and lip prints remain constant and this can be included in the antemortem records, to be used as evidence in personal identification and criminal investigation. Research documentation on the use of lip prints in forensic dentistry is scanty, in comparison to literature on the widespread practice of relying on fingerprints for personal identification. The study of lip prints termed as ‘Cheiloscopy’ is derived from the Greek words ‘CHELIOS’ (lips) and ‘SKOPEIN’ (see).[1] The importance of cheiloscopy lies in the fact that lip prints are unique for each person, like fingerprints and palatal rugae. Furthermore, lip grooves are permanent and unchangeable, as observed in the literature.[1-4] In this study we attempt to assess the reliability of lip prints as a forensic tool. We have compared and studied the lip print patterns in males and females of different age groups, assessed inter- and intraobserver bias in recording this data, assessed the changes in patterns over a period of time, and indirectly registered lip prints from objects and matched them with directly registered patterns.
MATERIALS AND METHODS

Study sample
The subjects employed for the study included 50 males and 50 females in the age group of 15 to 35 years. The lips of the subjects were first cleaned thoroughly and examined clinically for any deformity, scars or abnormalities [Figure 1]. Lips free from all these disturbances were selected for the study after a signed informed consent. Ethical clearance was taken from the ethical committee of the institution.

Armamentarium
The materials used were dark shaded lipstick and brush, cellophane tape, preformed registration sheet, magnifying lens with an inbuilt light source, and glass slides for an indirect impression.

Methodology
The lip prints were registered as direct and indirect lip registrations, transferred to a preformed registration sheet, and printed on a white bond paper. This registration sheet had three columns, the first two for initial and six-month direct registrations, respectively, and the third column for indirect lip print recording. Only the middle portion of the lower lip was taken into account for the study, since this portion was consistently visible in any trace.[2]

Direct lip print registration
Both lips were cleaned with wet cotton gauze and a thin layer of lipstick was applied with a brush[Figure 2]. The lipstick was allowed to dry for about two minutes, and then a lip impression was made on a strip of cellophane tape on the glued portion [Figure 3], which was transferred to the first column of the registration sheet [Figure 4]. The same technique was repeated by a second observer and the print was registered to the lower half of the first column of the registration sheet. The same procedure was repeated after six months by both observers and direct lip prints (as previously explained) were recorded in the second column of the registration sheet.

Indirect lip print registration
For the indirect impression, the lipstick was applied onto the lips and lip prints were recorded directly onto a glass slide by moving the glass slide from one corner to the other corner of the lip [Figure 5]. This print on the glass slide simulated any trace found at a crime site [Figure 6]. This impression was then lifted onto the glued surface of the cellophane tape [Figure 7] and transferred to the third column of the registration sheet by the first observer [Figure 8]. The filled registration sheets were scanned in order to preserve them permanently for future use [Figure 9]. All lip prints were then studied using a magnifying lens with an inbuilt light source. We classified lip prints, based on the pattern of lines on the red part of the lip, as proposed by Tsuchihashi Y.[5] The determination of the pattern was dependent on the numerical superiority of the properties of the lines in the study area — vertical, intersected, branched or reticular pattern. If more than one pattern was observed, it was considered as undetermined.
Statistical analysis
The collected data was entered using the ‘Microsoft Excel’ software and checked for any inconsistency. The differences in proportions were tested by using the Chi-square test. The scores were compared using the unpaired t-test. A P value of < 0.05 was considered to be significant. The entire analysis was carried out using the SPSS Version 15.0.

Results
The most predominant pattern in the entire study population was vertical, followed by branched, reticular, undetermined, and the intersected type [Table 1]. Males had more vertical and reticular patterns, whereas, the branched pattern predominated in females. This association
between the lip print pattern and gender was statistically significant [Table 2]. There was a high interobserver agreement of 95% [Tables 3 and 4]. A statistically insignificant change of 7% (observer 1) to 11% (observer 2) was observed in the patterns from the initial reading at baseline to the reading at six months [Tables 5 and 6]. Out of the 100 indirect lip prints, 26 were not clear enough to reach any conclusion, and thus, were excluded from our study material. We matched the pattern indirectly recorded on the glass slide with the directly registered pattern at different time intervals done by both observers. Indirect lip-print registrations of 79.73% done by the first observer matched with their direct registrations; while after six months the consistency remained at 79.73% [Tables 7 and 9]. In case of the second observer, there was 78.37% traceability of the indirect lip print recordings at the initial reading, whereas, after six months this went up to 82.43% [Tables 8 and 10].

**Discussion**

Lip prints are very useful in forensic investigation for personal identification, as they are considered to be the most important form of transfer evidence, and are analogous to fingerprints. The predominance of the vertical pattern in our study is similar to the findings of Vahanwalla and Parekh in the Mumbai population. However, a predominance of intersected pattern in Chennai,[1] reticular pattern in Kerala,[7] and branched pattern in a Indo-Chinese population,[7] suggest the probable role of race or geographical distribution, on the specific pattern of lip prints. Sharma *et al.,*[8] have reported a predominance of vertical, branched, and intersected types in females and a predominance of intersected and reticular patterns in males. Although

**Table 1: Overall pattern at the time of enrollment**

| Pattern | Total subjects (n = 100) |
|---------|-------------------------|
|         | Number | Percentage |
| Vertical | 30     | 30.0       |
| Branched | 28     | 28.0       |
| Intersected | 6     | 6.0       |
| Reticular | 24     | 24.0       |
| Undetermined | 12    | 12.0       |

**Table 2: Pattern by gender at the time of enrollment**

| Pattern | Male (n = 50) | Female (n = 50) |
|---------|--------------|-----------------|
|         | Number | Percentage | Number | Percentage |
| Vertical | 18     | 36.0 | 12 | 24.0 |
| Branched | 6     | 12.0 | 22 | 44.0 |
| Intersected | 3     | 6.0 | 3 | 6.0 |
| Reticular | 18     | 36.0 | 6 | 12.0 |
| Undetermined | 5     | 10.0 | 7 | 14.0 |

$X^2=16.88, P=0.002$ (significant)

**Table 3: Overall pattern by observer 1 and observer 2 at baseline (enrollment)**

| Observer 2 | Vertical | Branched | Intersected | Reticular | Undetermined |
|-----------|---------|---------|-------------|----------|-------------|
| observer 1 | 28      | 0       | 1           | 1        | 0           |
| Branced   | 0       | 28      | 0           | 0        | 28          |
| Intersected | 0     | 0       | 6           | 0        | 6           |
| Reticular | 1       | 0       | 0           | 23       | 0           |
| Undetermined | 1    | 1       | 0           | 10       | 12          |
| Total     | 30      | 29      | 7           | 24       | 10          |

| Observer 2 | Vertical | Branched | Intersected | Reticular | Undetermined |
|-----------|---------|---------|-------------|----------|-------------|
| Vertical | 26      | 0       | 3           | 0        | 29          |
| Branched | 0       | 24      | 0           | 3        | 27          |
| Intersected | 0   | 0       | 7           | 0        | 7           |
| Reticular | 2       | 22      | 0           | 10       | 11          |
| Undetermined | 0  | 0       | 1           | 10       | 11          |
| Total     | 30      | 28      | 7           | 29       | 10          |
similar results were observed by us regarding the common occurrence of a branched pattern in females and a reticular pattern in males, the intersected pattern, predominantly seen among males in the Sharma et al., study, was least seen in our study. These discrepancies could be attributed to differences in the sample size. In the past, some researchers had worked on the lip print pattern to prove that gender differences exist in lip prints. A recording of the lip prints after a six-month interval and matching it with the baseline (record of first day), in our study, revealed a statistically insignificant change, probably implying that over a period of time, the pattern would remain the same. As the lip patterns do not change with time, this finding promises the use of lip prints in personal identification. The minimal insignificant change in the lip print pattern over a time period in our study could be attributed to the recording of the print from a substantially mobile portion of the lip, and thus, the same person producing different lip prints depending on the pressure, direction, and method used for recording the lip print. The significant high interobserver agreement in our study implies the reproducibility and reliability of lip prints as a reliable forensic tool. The high percentage of matching of lip patterns obtained from the object with the subject pattern in our study is a positive observation that could have forensic implications. However, it is difficult to determine the exact individual using lip print patterns, as many subjects can present similar or overlapping lip patterns. However, we can exclude the suspect or groups of suspects from a larger group by lip print–based identification. Many studies established the fact that arrangement of lines on the red part of the human lips is unique for each human being, like the bar code system, which consists of only black lines. However, the details retrieved are based on the variation in the number, thickness, and the combination of the lip prints. Furthermore, the lip prints may also exhibit numerous variations, produced by the difference in the number of lines, thickness, length, branching, positioning, and combinations. Thus to recognize an individual, besides the overall pattern, we will also need more individual features of the patterns like the 23 types of individual features that have been reported by Kaspzrak et al., based on their microscopic examination of lip prints collected from 1500 individuals. The lip prints on the site of the crime can be correlated to the culprit successfully by their pattern, individual features of the line, thickness, length branching, position, print outline, and combination, in a case where the prints are appropriate. In case of an inappropriate print, we can search for the material configuration by which the print was produced or can extract the DNA to relate the suspect to the crime scene.

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