



Study of Lip Print Patterns Distribution and Their Stability in Time Pass

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Abstract

Background: Cheiloscopy is a forensic investigation technique based on the identification of lip traces. This study sought to assess the distribution of lip print patterns and their stability during the time.

Methods: Lip prints were obtained from 133 dental students and the distribution of patterns was evaluated, using the Five-stage Suzuki and Tsuchuhashi's classification. Six months later, lip prints were obtained again from 40 out of 133 students who were chosen accidentally to assess the stability. The individual lip formula was determined by Paired T-test and ANOVA at $p < 0.05$.

Results: Type I was the most common pattern in the lips. Lip formulas were found to be unique for each individual. No significant difference existed in the distribution of lip print patterns between males and females, or between the upper and lower lips. In terms of stability, 73.8% of lip print patterns remained unchanged during a 6-month period.

Conclusion: Lip print patterns are unique to each individual and have medium stability over time. Therefore, cheiloscopy may be considered a useful identification tool in forensic dentistry. However, the lip print pattern cannot indicate the sex of people.

Keywords: Forensic dentistry, Lip, Students

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Introduction

In forensic medicine, the identification of individuals is extremely important. Although DNA testing and fingerprinting are reliable means of identification, the equipment required for these assessments is not always available. Moreover, most criminals are now aware of most advanced crime detection techniques and therefore, take precautions to leave no traces and often use gloves to leave no fingerprints (1). In such cases, alternatives, or less commonly known techniques must be used for identification (2).

The wrinkles and grooves on the lips, known as sulci laborium, form a unique, characteristic pattern, which is specific for each individual as is the fingerprint. The study of lip traces for identification purposes is a forensic investigation technique referred to as cheiloscopia, which is a Greek term (Cheilos=lips, Skopein=see) (3,4). This method is based on the characteristic arrangement of wrinkles and lines on lip vermilions (5).

Lip prints are important due to their uniqueness and stability (6). Stability is the condition of being stable or in equilibrium, and thus resistant to change. Lip prints are identifiable as early as in the sixth gestational week and remain constant afterward. Weather changes, small traumas, inflammation, or even herpetic ulcers do not significantly change the lip prints (7). However, severe trauma to the lips that leads to scar formation, or complex corrective surgeries may change the size and form of lips and consequently, the morphological pattern of the lip print (8). At a crime scene, lip prints found on a glass or cup, cloth, tissue, or napkins or on a smoked cigarette can greatly help trace and identify the subjects involved (9). Lipstick smears are frequently used as forensic evidence in forensic medicine labs and are among the most important and reliable evidence used in courts (10).

Furrows on the red part of the lips were first described in 1902; but their use for identification of individuals was first suggested in 1932 (11). In 1960 Dr. Santos proposed a simple classification system for the use of lip prints in personal identification (5). Suzuki and Tsuchihashi in 1970 proposed a comprehensive classification system for lip prints, which is still the most used technique for this purpose (12).

Evidence shows that lip prints provide valuable data regarding sex, race, habits, and blood type of

individuals (5). The commonly used lipsticks by women provide a lipstick smear, which can be easily studied and identified (3). Lips can be analyzed without lipsticks; however, coating the lips with lipstick allows better observation of wrinkles and grooves (7). Moreover, lip prints can be recorded using a cellophane tape or a piece of paper without wearing a lipstick (8,13).

Considering the importance of lip print in forensic medicine and the necessity of remaining unchanged over time for use by legal authorities, there was a need to prove its stability. For practical purposes, this may be useful in a criminal search where the unchanged pattern even for a 6-month period would be helpful (6).

Regarding the need for an adjunct technique for human identification and the gap of information on the pattern and stability of lip prints in the Iranian population, this study aimed to assess the distribution of different patterns of lip prints and their stability in a defined group of Iranian patients.

Materials and Methods

This present descriptive study was conducted on 140 dental students selected by accidental convenience sampling. The study design was approved by the institutional ethics committee (code: IR.SBMU.REC.1395.270) and was in accordance with the Helsinki Declaration of Human Rights. Each participant was included in the study after reading, understanding, and completing the written informed consent document. The participants were ensured about the secrecy of information. The sample size was calculated based on a pilot study to be 132 ($\alpha=5\%$ and power=80%), which was increased to 140 to improve the validity of the study and compensate for possible sample loss during the study.

For determination of the stability, approximately 30% (1/3) of the total sample size was randomly chosen. The exclusion criteria consisted of any congenital lip anomaly; any active pathology, surgical scar, wound, or deformity on the lips; history of trauma to the lips; any lip chewing habits; esthetic lip treatments; smoking cigarette; and allergy to lipsticks. Due to the aim for analysis of lip pattern stability in 40 randomly selected samples, the participants were requested to avoid any treatments for their lips during the study

period.

For obtaining lip prints, the participants were requested to rinse a chlorhexidine gluconate 0.12% antiseptic mouthwash (Peridex™, 3M Corporate Headquarters, St. Paul, MN, US), their lips were cleaned using a cotton pellet dipped in povidone-iodine and wiped clean thereafter. The participants were then requested to apply a solid lipstick (Eternity®, au naturale™, Green Bay, WI, USA). The lipstick was sharpened for use by each individual to prevent cross-contamination. After applying the lipstick, the subjects were asked to allow 30 seconds for the lipstick to dry. To obtain lip prints, cellophane tapes (Bopp Adhesive Tapes, Foshan Inder Adhesive Product Co, Guangdong, China) with 14 mm width and 50 mm length were utilized. The tape was gently inserted in-between the lips, first at the center and then on the sides. Since the lips are highly mobile, even the slightest pressure in the wrong direction could interfere with the correct recording of the lip print. Thus, the subjects were requested to stay steady and maintain the position of their lips during the process of obtaining their lip print. Next, the cellophane tape was removed from one side, and the lips were cleaned. The obtained lip print was fixed on an A4 paper, coded, and scanned at 300 dpi resolution using Adobe Photoshop version 2015 (Adobe, San Jose, CA, USA). In order to prevent any Intra- and inter-observer variability, a single observer performed all the observations. The classification described by Suzuki and Tsuchihashi (12) was used for classification of lip print patterns as follows:

Type I: Clear-cut grooves go vertically across the lip.

Type I': The grooves are straight but disappear in midway instead of covering the whole breadth of the lip.

Type II: The grooves fork in their course.

Type III: The grooves intersect.

Type IV: The grooves are reticulate.

Type V: The grooves do not classify into any of the types I-IV and cannot be differentiated morphologically.

In general, three issues were investigated in the present study: types of lip prints and their prevalence, lip print specificity and method for its evaluation, lip print stability and method for its evaluation. For this purpose, each lip print was divided into three sections.

In each section, 10 columns were drawn. The lip print pattern in each column was scored according to the classification described by Suzuki and Tsuchihashi (12). For instance, type I pattern was given a score of 1 and type II was given a score of 2 and so on. These scores were written down next to one another in an orderly fashion to yield the 30-digit lip formula. Lip formula was first calculated separately for each section and then for the entire lip. This process was repeated for all the subjects and the obtained formulas were compared.

To study the lip print stability after six months, 40 participants were randomly chosen (28) for re-evaluation of their lip prints. Their lip prints were obtained as described above and their lip formula was calculated using the same method. Since there were no similar studies in the literature assessing the stability of lip prints, four groups were defined for classification of lip print stability during the time pass:

Group 1: 0-25% stability during time (no stability)

Group 2: 25-50% stability during time (low stability)

Group 3: 50-75% stability during time (medium stability)

Group 4: 75-100% stability during time (high stability)

Data were analyzed using SPSS software version 19 (IBM Corp., Armonk, New York, USA) ($\alpha=0.05$) (confidence interval=95%). Multiple comparisons were performed using Kruskal-Wallis test.

Results

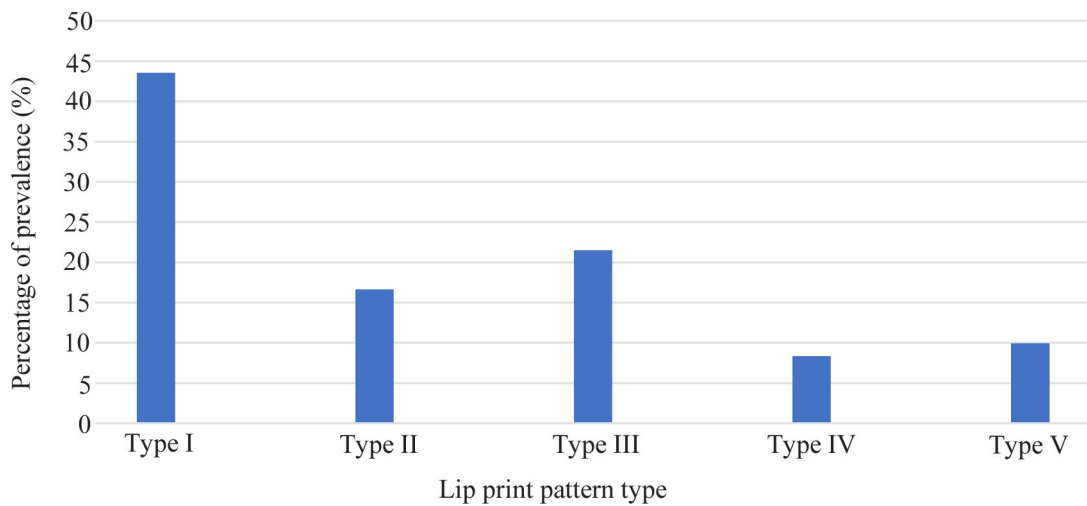
A total of 140 participants were initially selected using accidental sampling. However, seven of them were excluded due to sampling problems. A total of 133 participants were finally evaluated including 69 males (51.88%) and 64 females (48.12%). The overall average age was 21.08 years (21.31 in males and 20.84 in females).

Distribution of lip print patterns

The distribution of lip print patterns based on Suzuki and Tsuchihashi's classification is shown in table 1 and figure 1. Type I was the most common pattern in the present study, followed by types III, II, V and IV. In males, the most common pattern was the type I followed by types V, IV, II and III. In females, type

Table 1. Percentage and number distribution of lip print pattern types among the male and female participants

Lip print pattern type	I	II	III	IV	V	Total
Male percentage (number)						
Upper lip	42.5% (880)	17.2% (356)	19.8% (410)	10.4% (215)	10.1% (209)	100% (2070)
Lower lip	43.3% (897)	18.9% (391)	22.6% (468)	8% (165)	7.2% (149)	100% (2070)
Female percentage (number)						
Upper lip	42.1% (808)	16.2% (311)	19.9% (382)	8.1% (155)	13.7% (264)	100% (1920)
Lower lip	46% (883)	13.7% (263)	24.2% (465)	6.8% (131)	9.3% (178)	100% (1920)

**Figure 1.** Percentage distribution (%) of lip print patterns in subjects. The X-axis represents different types of lip print patterns based on the Suzuki and Tsuchihashi classification. The Y-axis represents the prevalence of lip print patterns in percentage.

I was the most common followed by types IV, V, II and III. The most common pattern in the upper lip was type I, followed by types IV, V, II, and III. In the lower lip, the most common pattern was type I, followed by IV, V, II, and III.

The comparison between male and female participants is illustrated in figures 2 and 3, and figure 4 shows the distribution of lip print patterns in the upper lip and lower lip. According to the non-parametric tests (Kruskal Willis test) (due to the absence of normal distribution of variables), no significant difference existed in the distribution of lip print patterns between males and females, or between the upper and lower lips.

Specificity of lip print patterns

The results showed that the lip formulas were unique for individuals. Each lip formula comprised of 30 digits and this 30-digit number was specific for each individual. The 60 digit-formula of both (upper and lower) lips was also unique.

Stability of lip print patterns

Evaluation of lip print stability after six months in 40 randomly selected participants revealed that 73.8% of lip print patterns remained unchanged. In 4.15%, conversion to type V or vice versa had occurred. In 22.04%, other changes had occurred. According to the suggested classification for lip print stability during the time, medium stability was observed after

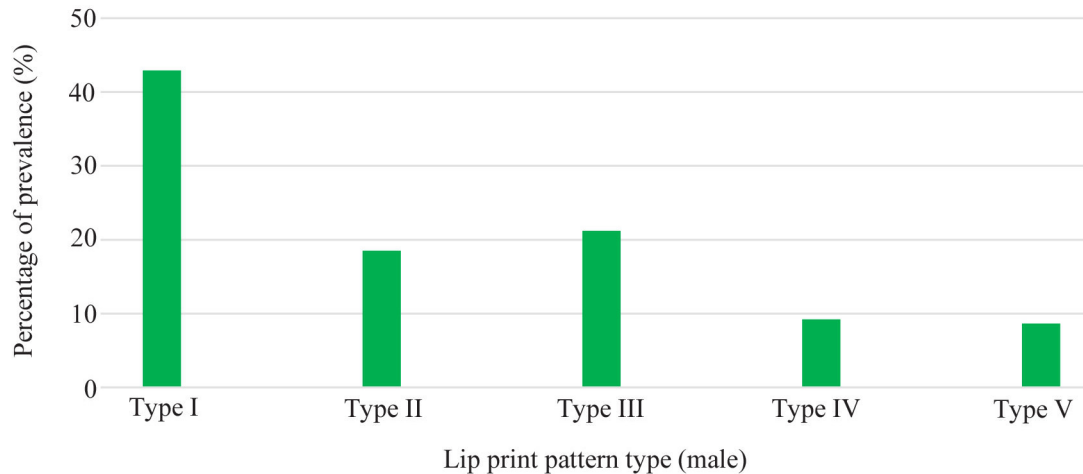


Figure 2. Percentage distribution (%) of lip print patterns in Male subjects. The X-axis represents different types of lip print patterns based on the Suzuki and Tsuchihashi classification. The Y-axis represents the prevalence of lip print patterns in percentage.

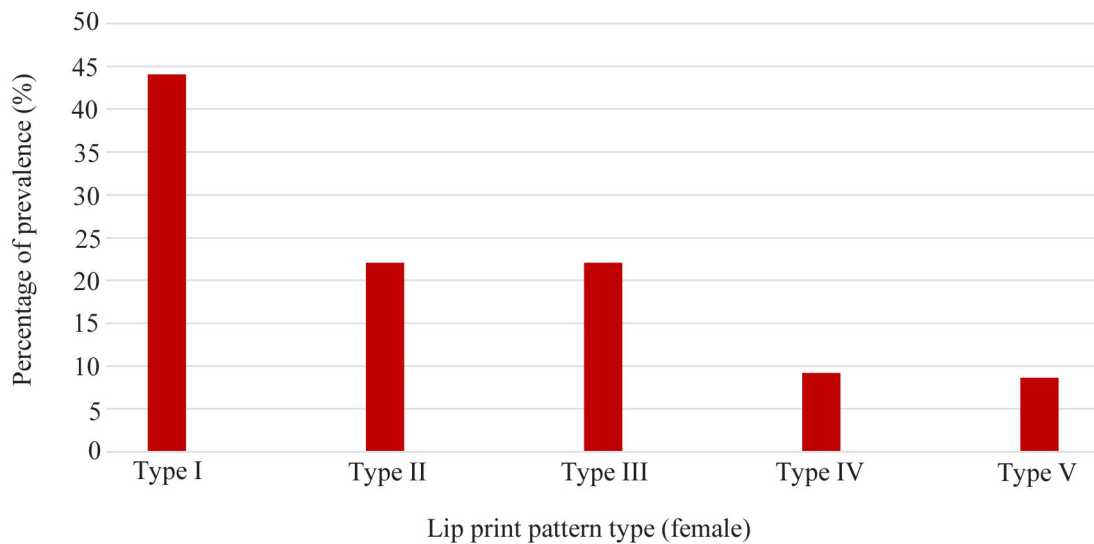


Figure 3. Percentage distribution (%) of lip print patterns in female subjects. The X-axis represents different types of lip print patterns based on the Suzuki and Tsuchihashi classification. The Y-axis represents the prevalence of lip print patterns in percentage.

six months.

Discussion

Assessment of lip print patterns and lip traces, known as cheiloscopy, is a relatively new technique for human identification (14). The lip vermilion has minor salivary glands, and the lip borders contain sebaceous glands. Lipid and fluid secretions from these glands enable recording the lip prints similar to fingerprints (15). Lévêque and Goubanova stated that some of the lines on the lips are the continuation

of lines on the adjacent skin, that can indicate their shared origin (16). Therefore, some specifications of fingerprints may also apply to lip prints, forming the basis for the theory of uniqueness of lip prints just like the fingerprints, which was also confirmed in the present study.

Sivapathasundharam *et al* stated that the lip furrows are created due to the posture of lip muscles at rest (17). Lévêque and Goubanova discussed that lip wrinkles are the pathways for the flow of saliva on the lip surface to keep it moist and that the upper lip

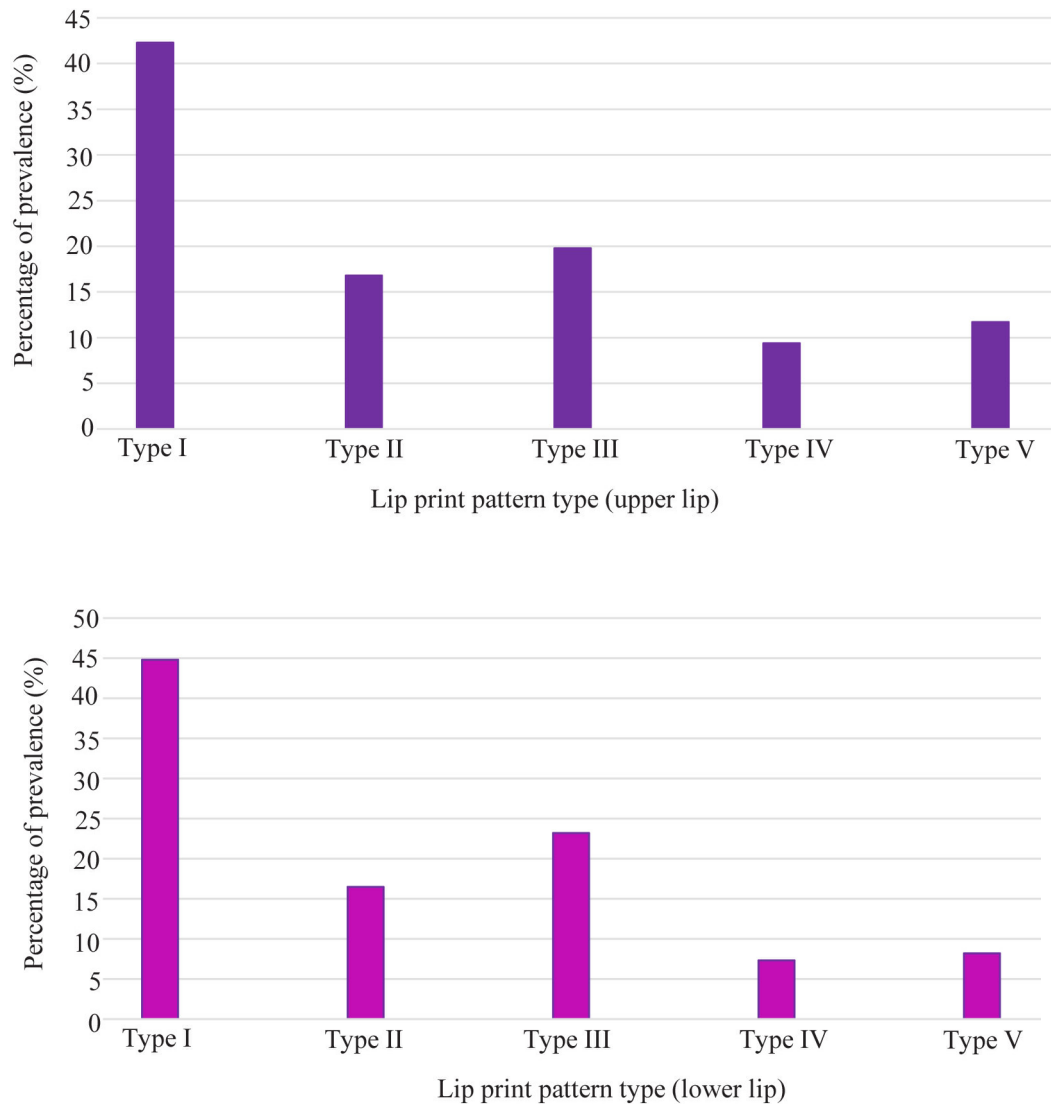


Figure 4. Percentage distribution (%) of lip print patterns in upper and lower lip. The X-axis represents different types of lip print patterns based on the Suzuki and Tsuchihashi classification. The Y-axis represents the prevalence of lip print patterns in percentage.

is moistened more than the lower lip (16).

In the present study, the classification described by Suzuki and Tsuchihashi (12) was used for classifying the lip print patterns. This classification is among the mostly used methods for this purpose and has been employed in many previous studies (18-21).

Type I was the most common pattern in the present study, followed by types III, II, V and IV. No significant difference existed in the distribution of lip print patterns between males and females or the upper and lower lips. Thus, the lip print pattern cannot indicate the sex of people. This result is in line with the findings of Padmavathi *et al* (22).

Regarding the frequency of lip print patterns,

conflicting results have been observed in previous studies. Krishnan *et al*, in 2016 evaluated the lip print pattern of 50 students in Chennai, India. The most common pattern in males was IV and in females was I and I' (23). Mutalik *et al*, in 2013 evaluated the patterns of lip prints, palatal rugae, and fingerprints in 100 female dental students between 17 and 22 years and reported the most common pattern to be type IV (24). Singh *et al*, in 2012 evaluated the lip prints of 60 dental students and reported the type I to be the most common pattern, which was similar to the findings of the present study, followed by types III, IV, II and V. The low frequency of type V indicates accurate recording of lip prints in their study (25).

Prabhu *et al*, in 2012 evaluated the lip print patterns of 100 students in India using a digital method and reported that in all four lip quadrants, the most common pattern in males and females was type V (20). In a study by Venkatesh and David in 2011 (21), the most common pattern was type II. Augustine *et al*, in their study on 320 females and 280 males reported the most common type to be type III followed by types II, IV, I and V (13). Moshfeghi *et al*, in 2016 evaluated the lip print patterns of 158 patients in Iran and reported the most common pattern in males and females was type V (26).

Lower frequency of type V pattern in the present study indicates an accurate recording of patterns. Also, the frequency of this pattern decreased from the sides towards the center of the lips and the lowest frequency of type V pattern was noticed at the center of the lips. This indicates the higher reliability of the patterns in the middle part of the lips. Moreover, assessment of lip formulas obtained in our study revealed that the 30-digit formula for each lip and the 60-digit formula for both lips were unique for each individual; this result has also been confirmed in previous studies (14,25,27,28).

Although many studies have discussed the distribution of lip print patterns, this study is among the few studies assessing the lip prints of the same individuals over time. Kapoor *et al* (29) and Coward *et al* (30) similarly executed the stability investigation in which there was a 100% stability of lip print patterns during the six and seven-month follow-ups, respectively. Furthermore, the present study is based on student thesis with code of ethics committee and executor had a time limitation to defend it. Accordingly, a maximum of 6 months was considered for the follow-up.

These findings were confirmed in the present study in the Iranian population, although the stability

was 73.8%. This might be attributed to the ethnic differences between the participants of different studies.

It should be noted that since the lips are naturally mobile, several lip print patterns may be recorded of the same individual depending on the level of pressure for recording the print and the method used. Some limitations of the present study were associated with the manual technique; therefore, it is recommended to utilize digital scanners in future studies. Furthermore, some participants did not take part in the follow-up sessions to evaluate the stability of the lip pattern. Further studies with larger sample size and more extended follow-up period could obtain more definitive conclusions.

Conclusion

Within the limitations of this study, it can be concluded that the lip print pattern is unique to each individual and has medium stability over time. Therefore, it may be considered as a useful identification tool in forensic dentistry. However, the lip print pattern cannot indicate the sex of people.

Acknowledgements

The study design was approved by the institutional ethics committee (code: REC.1395.270) and was in accordance with the Helsinki Declaration of Human Rights. Each participant was included in the study after reading, understanding, and completing the written informed consent document. The participants were ensured about the secrecy of information.

Conflict of Interest

The authors declare that they have no conflict of interest.

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