(RESEARCH ARTICLE)

Lip print patterns in forensic investigation: Detectability, sex differentiation, and reliability

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Abstract

Lip print patterns are increasingly recognized as a vital resource within forensic investigations, providing a distinctive means for identifying individuals. This extensive investigation examines the detectability, possibility for sex distinction and forensic consequences of lip print patterns. Through both direct visualization and scoring procedures, a comprehensive examination was undertaken to analyze the intricate patterns of lip prints exhibited by male and female participants in Indonesia. The results of our study provide clear evidence for the infrequency of similar lip print patterns among individuals, confirming previous research conducted by Suzuki and Tsuchihashi. It is worth mentioning that type II lip print type was the prevailing type in Indonesian males and females. Furthermore, noticeable variances based on sex were seen in the upper left (UL) and lower middle (LM) quadrants.

This research emphasizes the crucial significance of lip prints in criminal investigations, emphasizing their wide range of uses and relevance in diverse forensic contexts. The distinctiveness, singular nature, consistency, genetic transmission, and wide range of lip lines establish them as dependable means for personal identification. Lip print analysis has promise as a prospective means of scientific validation in forthcoming legal procedures, with the capacity to augment forensic methodologies and offer valuable contributions to the judicial process. The results reported in this study provide a foundation for creating a comprehensive set of criteria for assessing the lip line, which can serve as a valuable tool for the progression of forensic science and the pursuit of justice.

1. Introduction

Lip prints, which refer to the complex patterns and crevices on the external and internal labial mucosa, present a fascinating opportunity for personal identification [1]. These patterns, similar to fingerprints, palm prints, and footprints, possess distinct characteristics that enable the differentiation of individuals. It is worth mentioning that the durability of lip prints over an individual's lifespan remains unchanged, unaffected by external variables [2–7].

Numerous studies have shown the validity of lip prints as a means of identifying sex. This determination is made by analyzing the predominant lip print type present on the surface of the lips. Suzuki and Tsuchihashi's classification is the most extensively utilized way to study lip prints among the existing range of known methodologies [6, 8–10]. In a previous study conducted by Krishan et al. (2016), which examined the Indian population, the findings indicated that type I and I' patterns were more prevalent among females, whilst type IV emerged as the predominant pattern among males [11]. Moreover, previous studies have documented sex-based differences in lip print patterns within European Caucasians, Negroes, and Orientals populations [12, 13].

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The present study utilized Suzuki and Tsuchihashi's classification system to evaluate the possible efficacy of lip print patterns in facilitating the process of sex determination among individuals within the Indonesian community. Two unique methodologies, scoring and direct observation, were utilized to thoroughly examine the differences in lip print patterns between males and females.

2. Material and methods

2.1. Subjects enrolment

The present study was conducted under the approval of the Ethical Committee Faculty of Dental Medicine Universitas Airlangga, Indonesia. One hundred sixty-one subjects (101 females and 60 males, ages 18 – 20 years) with normal lip surfaces voluntarily participated in this study. The study did not include individuals who exhibited lip abnormalities, congenital developmental, and medical history of lipstick allergies.

2.2. Collection of lip prints

All participants who provided their consent to partake in the current study were administered informed consent. At the outset of the lip print acquisition process, the lip surface of each subject underwent meticulous cleaning using wet tissue paper and was thoroughly dried to ensure optimal conditions before lipstick application. A uniform, single layer of lipstick was then delicately applied, commencing from the vermilion border. Subsequently, subjects were instructed to gently rub their upper and lower lips to distribute the lipstick evenly. Following a two-minute interval, a piece of cellophane tape (measuring 50 mm x 12 mm) was meticulously pressed onto the lip surface and methodically peeled away in a single, left-to-right motion. The resulting impression was carefully transferred onto white paper and subsequently divided into six distinct compartments for analysis, denoted as upper right (UR), upper median (UM), upper left (UL), lower left (LL), lower median (LM), and lower right (LR).

2.3. Data analysis

The lip print patterns were determined following the classification system proposed by Suzuki and Tsuchihashi (Figure 1) [14]. Subsequently, the patterns were assigned scores based on the established criteria (Table 1).

Table 1 Scoring for Suzuki & Tsuchihashi's lip print pattern used in the present study

Suzuki & Tsuchihashi classification	Description	Score
TYPE I	Complete straight grooves	1
TYPE I'	Partial straight grooves	2
TYPE II	Branched grooves	3
TYPE III	Intersected grooves	4
TYPE IV	Reticular grooves	5
TYPE V	Undifferentiated pattern	6

The study involved the visual observation and scoring of lip print patterns in six compartments to assess potential differences between males and females. The statistical analysis of this study was conducted using the Pearson chi-square and Mann-Whitney U-test in IBM SPSS version 23.0 (Armonk, NY, US).
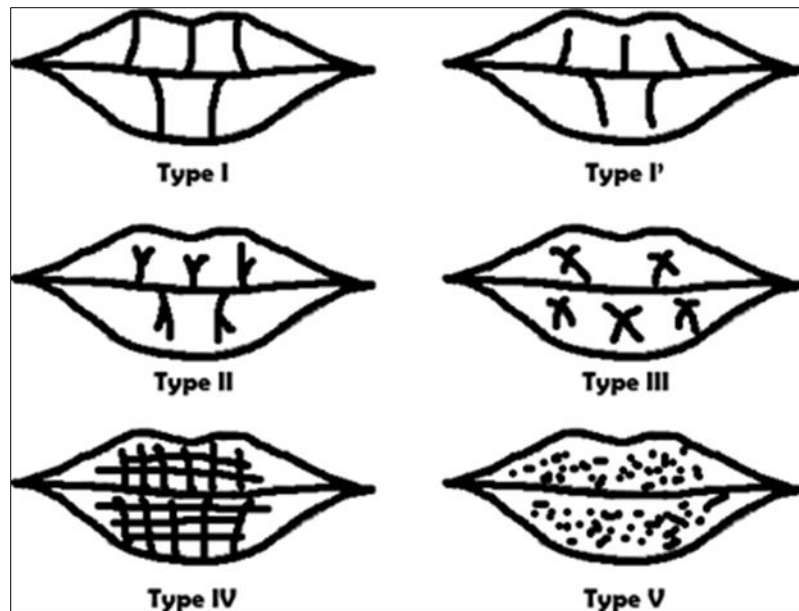
Figure 1 Lip print pattern based on Suzuki & Tsuchihashi classification

3. Results

The lip print pattern of an individual was found to exhibit a variety of several patterns rather than being limited to a single form. Table 2 presents the outcomes of this visual evaluation conducted on lip print patterns, accompanied by a summary of their distribution over all six compartments. In the upper-right quadrant (UR), type II prevalence was 65% among males and 39.6% among females. The prevalent lip print pattern in the second quadrant (UM) was type IV, observed in 40% of males and 42.6% of females. The prevalence of lip prints type II in the upper left (UL) quadrant was 56.7% among males and 51.5% among females. The Type II pattern prevailed in both the LL and LR quadrants. Specifically, 50% of males and 64.4% of females exhibited the Type II pattern in the LL quadrant, while 53.9% of males and 60.4% of females displayed the Type II pattern in the LR quadrant. Type I pattern was observed exclusively in the lower medial (LM) quadrant, with a prevalence of 33.3% in males and 37.6% in females. The lip print pattern most commonly observed in males and females throughout six quadrants was type II, with a prevalence of 46.9% in males and 45.0% in females (refer to Table 3).

Table 2 Distribution of Suzuki & Tsuchihashi's lip print pattern in the Indonesian population

Lips Compartment	Type	Sex		Total	%
		Male	Female		
UR	I	5	6	11	6.8%
	I'	1	10	11	6.8%
	II	39	40	79	49.1%
	III	12	31	43	26.7%
	IV	2	10	12	7.5%
	V	1	4	5	3.1%
UM	I	4	10	14	8.7%
	I'	1	5	6	3.7%
	II	18	28	46	28.6%
	III	9	14	23	14.3%
	IV	24	43	67	41.6%

		V	4	1	5	3.1%
UL	I	3	10	13	8.1%
	I'	3	6	9	5.6%
	II	34	52	86	53.4%
	III	17	20	37	23.0%
	IV	2	10	12	7.5%
	V	1	3	4	2.5%
LL	I	3	9	12	7.5%
	I'	4	5	9	5.6%
	II	30	65	95	59.0%
	III	23	19	42	26.1%
	IV	0	1	1	0.6%
	V	0	2	2	1.2%
LM	I	20	38	58	36.0%
	I'	5	18	23	14.3%
	II	16	27	43	26.7%
	III	12	4	16	9.9%
	IV	4	13	17	10.6%
	V	3	1	4	2.5%
LR	I	4	10	14	8.7%
	I'	3	4	7	4.3%
	II	32	61	93	57.8%
	III	21	18	39	24.2%
	IV	0	1	1	0.6%
	V	0	7	7	4.3%

Additional data analysis was performed to examine the statistical significance of the variations among the six quadrants concerning sex determination. Based on the Pearson chi-square test results, a statistically significant difference was observed in lip print patterns between males and females in the UL and LM quadrants, as shown in Table 4 ($p<0.05$).

Table 3 The overall lip print pattern frequencies in male and female

Lip prints type	Male		Female	
	Frequency	Percent (%)	Frequency	Percent (%)
I	39	10.8	83	13.7
I'	17	4.7	48	7.9
II	169	46.9	273	45.0
III	94	26.1	106	17.5
IV	32	8.9	78	12.9
V	9	2.5	18	3.0

Table 4 Pearson chi-square test of lip print pattern and sexes

Quadrant	*p*-value	Remarks
Upper right (UR)	0.020*	Significant
Upper mid (UM)	0.346	Not-significant
Upper left (UL)	0.416	Not-significant
Lower left (LL)	0.089	Not-significant
Lower mid (LM)	0.007*	Significant
Lower right (LR)	0.070	Not-significant

Table 5 Lip prints scores from six quadrants in males and females

TOTAL SCORE	Sex	N	Mean	Std. Deviation	Std. Error Mean
Maxilla Score	Male	60	10.38	1.923	0.248
	Female	101	10.41	2.833	0.282
Mandible Score	Male	60	9.12	2.344	0.303
	Female	101	8.60	2.328	0.232

The lip print pattern scoring was also utilized to examine the disparity in the overall score in the upper and lower quadrants across males and females (Table 5). The average score of the upper lip in males was 10.38±1.92, while in females it was 10.41±2.83. In males, the measurement of the lower lip was 9.12+2.34, whereas in females, it was 8.60+2.32. The findings of the Mann-Whitney U test suggest no statistically significant distinction between males and females in terms of the overall lip print scores of both the upper and lower lips, with *p*>0.05.

4. Discussion

Lip prints are frequently and effectively-identified at crime scenes, particularly when lipstick prints are involved. However, in some cases, the use of aluminium powder or similar chemicals may be necessary to capture the impression of the lip pattern on soft tissue. Although there may be slight variations in lip patterns, our research findings indicate that lip patterns among twins are remarkably similar. Chieloscopy, the specialized discipline focused on the investigation of lip prints, demonstrates a noteworthy ability to differentiate individuals based on their gender. Moreover, this particular discipline exhibits a notable degree of pattern consistency throughout an individual's lifespan [15, 16].

This study comprehensively examines lip print patterns among male and female individuals in Indonesia. This study included a comprehensive analysis of lip print patterns in order to examine the disparities observed between individuals of males and females. This study employed two approaches, namely direct visualization and scoring, to thoroughly investigate the topic matter. The results of this investigation definitively demonstrated the absence of identical lip print patterns among the participants involved in our research. It is noteworthy to observe that even in instances where two subjects exhibited identical lip print types inside a specific quadrant, there persisted a noticeable distinction in the groove pattern. The findings derived from this investigation exhibit a robust association with the scholarly inquiry carried out by Suzuki and Tsuchihashi, furnishing more substantiation for the proposition that the occurrence of identical lip print patterns across individuals is infrequent. Moreover, the previous studies carried out by Suzuki and Tsuchihashi underscored the uniqueness and enduring nature of these patterns, hence suggesting their potential utility in the realm of criminal inquiries. The distinctive attributes of fissures and cross lines present on the surfaces of lips, exhibiting variations across individuals, can serve as a critical foundation for precise identification [14, 17–19].

The results obtained from the direct visualization technique revealed that type II was the prevailing category noticed in both Indonesian males and females who were part of the study. The highest prevalence of type II was observed in the UR quadrant of males and the LL quadrant of females. Although both respondents exhibited similar types of lip prints,

the statistical analysis revealed a significant difference in lip print patterns between males and females in the upper left (UL) and lower middle (LM) quadrants. The finding indicated above has the potential to make significant contributions to the field of lip print pattern analysis, specifically in regard to the investigation of variances based on sex. This finding is in line with prior research conducted on people from Malaysia, Nigeria, and Mangalore [20–22].

The analysis of lip print patterns using the scoring method did not reveal any statistically significant difference between the male and female populations. The lack of statistical significance shown in this study can be due to the utilized methodology, which involved summing the entire lip print score across all quadrants. As a result, the overall score presented does not adequately capture the subtle variations in lip print patterns that are connected to sex-related characteristics.

The present study highlights the potential use of lip prints as a valuable tool in forensic identification, with a specific emphasis on its application in determining the sex of an individual. The feasibility and reliability of utilizing lip prints for individual identification purposes are attributed to the specificity, uniqueness, stability, heredity, and extraordinary diversity and individuality of lip lines [15]. Moreover, it is essential to acknowledge that lip prints have the potential to be present on a diverse range of objects, such as photographs, cigarette butts, drinking glasses, cups, letters, and windowpanes. The prints possess the advantageous capability of being scrutinized and captured through photography prior to the commencement of any additional forensic exams. This attribute renders them a useful preliminary instrument in the realm of forensic investigations [23].

The examination of lip prints undoubtedly holds significant importance within the field of forensic science, yet it is essential to acknowledge and confront the inherent limits associated with this practice. The application of lip print analysis in forensic science is subject to various limits, which encompass the availability of antemortem data, the quality of lip prints, and the representation of samples in research studies [24–26].

5. Conclusion

In summary, this study elucidates the significance of lip print patterns in forensic investigations. It was observed that the lip prints of individuals exhibit distinctiveness, with type II being the prevailing pattern. The distinctiveness of lip prints contributes to their significant utility in accurately identifying individuals. Forensic methodologies have the potential for enhancement, hence enabling their utilization as scientific evidence in judicial proceedings. The standardization of lip print evaluation holds great potential for enhancing the precision and credibility of lip print analysis in forensic research. This study underscores the significance of incorporating lip prints into criminal investigations in a broader framework, highlighting their capacity to augment the administration of justice and judicial proceedings as forensic science progresses.

Compliance with ethical standards

Disclosure of conflict of interest

The author has no conflict of interest to disclose.

Statement of ethical approval

This study was approved by the Ethical Committee Faculty of Dental Medicine Universitas Airlangga, Indonesia (number: 302/HRECC.FODM/V/2019).

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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