Cheiloscopic Identification Across Age Groups 18–60 years in North India

Abstract:

Background: Cheiloscopy, the study of lip print patterns, is an emerging field in forensic odontology, recognized for its potential in personal identification due to the uniqueness and permanence of lip grooves. Despite its relevance, limited data exists for North Indian populations, particularly Uttar Pradesh.

Aim: To evaluate the uniqueness, distribution, and forensic relevance of lip print patterns, including gender- and quadrant-based variations, among individuals from the North Indian population.

Materials and Methods: This prospective observational study involved 120 participants (60 males, 60 females) aged 18–60 years. Lip prints were collected using cellophane tape and analyzed by dividing the lips into four quadrants. Classification was based on the Suzuki and Tsuchihashi system. Data were analyzed using descriptive statistics and chi-square tests; $p < 0.05$ was considered statistically significant.

Results: Type II (branched) was the most frequent lip print pattern (32.92%), followed by Type I (linear). Significant gender differences were noted in Type III (intersected) and Type IV (reticular) patterns, with higher prevalence in males. Pattern distribution also varied significantly across quadrants, with the exception of the lower-left and lower-right comparison. Type V (miscellaneous) was the rarest but exhibited the highest uniqueness, particularly among females. Age-related differences were statistically significant for Type II and Type IV patterns.

Conclusion: Lip prints demonstrate high uniqueness and forensic value, with significant variations by gender, age, and lip quadrant. Patterns such as Type III and V offer enhanced identification accuracy. These findings reinforce cheiloscopy as a reliable supplementary biometric tool in forensic science, especially for personal and gender identification.

Key-words: Lip prints, Cheiloscopy, Forensic odontology, Gender identification, Pattern uniqueness, North Indian population.

Introduction:

Forensic odontology aids identification when fingerprinting or DNA fails, especially in mass disasters.[1] Cheiloscopy, the study of lip prints, is gaining attention for its unique and permanent patterns,[2,3] first classified by Suzuki and Tsuchihashi in 1970.[4] Lip prints, located in the transitional lip zone, are individualized like fingerprints.[5,6] Locard and Santos advanced its forensic use in 1932 and 1967, respectively.[7,8] While India sees regional studies, North India, especially Uttar Pradesh, remains underexplored.[9] This study fills that gap, enhancing identification accuracy through population-specific databases for forensic applications.[10,11]

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Materials and Methods:

Study Setting and Design:

This prospective observational study was conducted in the Department of Oral Pathology and Microbiology, Chandra

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Dental College & Hospital, Safedabad, Barabanki, Uttar Pradesh, India. The research aimed to analyze the uniqueness and distribution of lip print patterns for personal identification, particularly their correlation with gender, using cheiloscopy.

Ethical Approval and Consent:

Prior approval for the study was obtained from the Institutional Ethical Committee of Chandra Dental College & Hospital. Written informed consent was obtained from all participants prior to data collection. Participants' confidentiality and anonymity were strictly maintained throughout the study.

Sample Selection:

Inclusion Criteria:

- Healthy individuals aged 18–60 years without any pathological conditions or deformities of the lips.
- Subjects with intact, clearly defined vermilion borders and zones suitable for cheiloscopic analysis.
- Individuals with no history of dermatological or allergic conditions affecting the lips.

Exclusion Criteria:

- Individuals with congenital lip anomalies (e.g., cleft lip), inflammation, trauma, or surgical scars on the lips.
- Participants allergic to lipstick or adhesive materials.
- Those with systemic or localized conditions affecting the perioral region.

Sampling Technique and Sample Size:

Participants were selected using simple random sampling. A total of 120 individuals (60 males, 60 females) were included.

Data Collection Procedure:

Lip Preparation and Print Collection:

- Participants' lips were cleansed using wet tissues.
- A uniform layer of red-colored, non-metallic lipstick (Lakmé™) was applied.
- The lip print was recorded by pressing the lips onto a strip of transparent cellophane tape, which was then mounted on white bond paper (Figure 1).
- The lips were divided into four quadrants (upper right, upper left, lower right, and lower left) for detailed analysis (Figure 2).

Tools and Materials Used:

- **Lipstick:** Red, non-glossy, non-metallic (Lakmé™).
- **Cellophane Tape:** 50 mm width, transparent, for lip impression transfer.
- **Bond Paper:** For permanent recording and labeling.
- **Wet Tissues:** For pre-cleaning lips.
- **Magnifying Glass:** 10× magnification for pattern analysis.
- **Scissors and Pen:** For labeling and handling samples.

Figure 1: Taking impression of lips and transferring to the bond paper for further study

Figure 2: Showing different patterns of lip print observed in each quadrant

Lip Print Classification:

Lip prints were categorized based on Suzuki and Tsuchihashi'sclassification,[1] which includes (Figure 3):

- **Type I:** Clear-cut vertical grooves covering the full lip length.
- **Type I′:** Partial vertical grooves.
- **Type II:** Branched grooves.
- **Type III:** Intersected grooves.
- **Type IV:** Reticular or mesh-like patterns.
- **Type V:** Undifferentiated or atypical patterns.

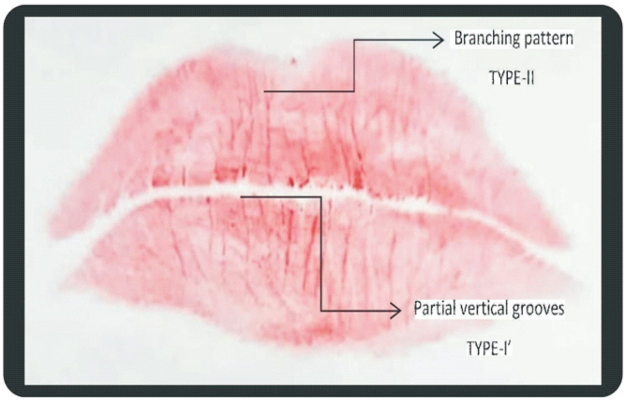

Figure 3a: Showing lip pattern type I' & II

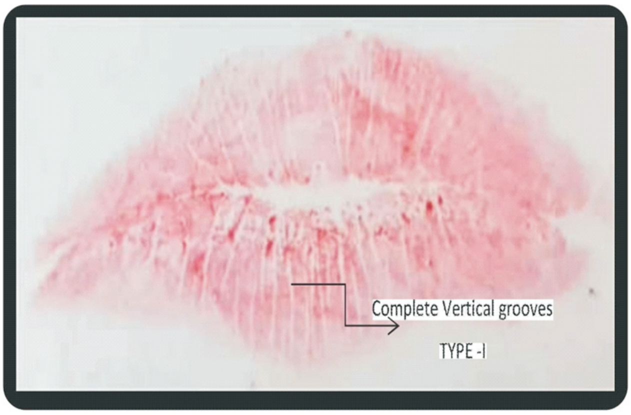

Figure 3b: Showing lip pattern type I,

Figure 3c: Showing lip pattern type IV

Figure 3d: Showing lip pattern type III

Figure 3: a. Showing lip pattern type I' & II, b. Showing lip pattern type I, c. Showing lip pattern type IV & d. Showing lip pattern type III

Data Analysis:

Lip print patterns and demographic data were recorded systematically, with each quadrant's dominant pattern documented. Descriptive statistics (frequencies and percentages) were used to summarize pattern types. Chi-square tests assessed associations between lip print types and gender, with $p < 0.05$ considered significant. Microsoft Excel was used for data entry, and SPSS/R software performed statistical analyses.

Results:

The study involved 120 participants (60 males and 60 females) from Uttar Pradesh, aged 18–60 years, with lip prints analyzed using the Suzuki and Tsuchihashi classification. Subjects were evenly split by gender and grouped into three age categories: 18–30 (37.5%), 31–45 (37.5%), and 46–60 years (25%). A higher proportion of younger males and middle-aged females was observed.

Distribution of Lip Print Patterns by Quadrant:

Lip prints, examined across four distinct quadrants per individual, revealed a total of 480 impressions. Among these, the Type II (branched) pattern emerged as the most dominant, accounting for nearly one-third of all observations (32.92%), underscoring its prevalence. In stark contrast, the Type V (miscellaneous) pattern appeared least frequently (10%), highlighting its rarity. The intermediate patterns followed in descending order: Type I (linear), Type III (intersected), and Type IV (reticular).

To explore spatial variations, quadrant-wise comparisons using chi-square tests demonstrated statistically significant differences in pattern distribution across nearly all pairs ($P < 0.05$), with the sole exception being the lower-left versus lower-right quadrants. This suggests notable variation in pattern occurrence depending on lip region, reinforcing the value of quadrant-specific analysis in cheiloscopic studies (Table 1).

Table 1: Comparison of lip print pattern distribution across quadrant pairs (Chi-square test)

Quadrant Pair	χ^2 Value	p-Value	Result
Upper-left vs Upper-right	5.567	0.018*	Significant
Upper-left vs Lower-left	9.234	0.002*	Significant
Upper-left vs Lower-right	7.812	0.020*	Significant
Upper-right vs Lower-left	4.561	0.033*	Significant
Upper-right vs Lower-right	6.192	0.013*	Significant
Lower-left vs Lower-right	2.321	0.128	Not significant

$p < 0.05$ indicates statistical significance.

Lip Print Pattern Frequencies:

Considering all participants together, Type II (branched) patterns were most frequent (158 prints, 32.9%), followed by Type I (126 prints, 26.3%). The order from highest to lowest was: Type II > Type I > Type III > Type IV > Type V. The predominant branched pattern and scarcity of miscellaneous types mirror the overall sample distribution.

When stratified by gender, similar patterns emerged. Among males, Type II prints accounted for 72 of 240 prints (30.0%), Type I for 60 (25.0%), Type III for 48 (20.0%), Type IV for 40 (16.7%), and Type V for 20 (8.3%). Among females, Type II accounted for 86 of 240 (35.8%), Type I for 66 (27.5%), Type V for 32 (13.3%), Type IV for 26 (10.8%), and Type III for 30 (12.5%). In summary, for both sexes combined, the rank order was Type II > Type I > Type III > Type IV > Type V.

Gender Differences in Pattern Distribution:

Chi-square analysis (Table 2) indicated that pattern distributions differed significantly between males and females for Type III and Type IV. Specifically, Type III prints showed $\chi^2 = 5.12$ ($P = 0.024$) and Type IV prints showed $\chi^2 = 3.92$ ($P = 0.047$), both below the 0.05 threshold. In contrast, Types I, II, and V did not show significant gender differences (all $P > 0.05$). This suggests that intersected and reticular patterns vary by gender while linear, branched, and miscellaneous patterns do not.

Table 2:Chi-square test for differences in pattern distribution by gender

Pattern Type	Male (%)	Female (%)	χ^2	p-value
Type I (Linear)	60 (25.0%)	66 (27.5%)	0.48	0.488
Type II (Branched)	72 (30.0%)	86 (35.8%)	2.26	0.132
Type III (Intersected)	48 (20.0%)	30 (12.5%)	5.12	0.024*
Type IV (Reticular)	40 (16.7%)	26 (10.8%)	3.92	0.047*
Type V (Miscellaneous)	20 (8.3%)	32 (13.3%)	3.76	0.052

$P < 0.05$ indicates statistical significance.

Pattern Uniqueness:

The lip print patterns were categorized by their inherent uniqueness. Types I and II (linear and branched) were labeled "low uniqueness" due to their relatively common occurrence (26.3% and 32.9%, respectively). Types III and IV (intersected and reticular) were "moderate uniqueness" (16.3% and 13.8%), and Type V (miscellaneous) was "high uniqueness" (10.8%). Thus, Type V prints, although least frequent, were designated as most unique, whereas the most common patterns (Types I and II) were considered least unique.

Analysis of uniqueness by gender (Table 3) showed that "low uniqueness" patterns were more common in males, whereas the "high uniqueness" pattern was more common in females. For example, 31.7% of males had a Type I pattern compared to 28.3% of females, while 23.3% of males had a Type V pattern versus 26.7% of females. This indicates that the frequent (less unique) patterns tended to occur more in males, and the rare (more unique) pattern occurred slightly more in females.

Table 3: Frequency of high and low uniqueness patterns by gender

Pattern Type	Male Frequency (n=60)	Male (%)	Female Frequency (n=60)	Female (%)
Type I (Linear, low)	19	31.7%	17	28.3%
Type II (Branched, low)	9	15.0%	8	13.3%
High uniqueness (Type V)	14	23.3%	16	26.7%

Note: Only Type V is high uniqueness; Types I and II are low uniqueness.

Age Group Differences (ANOVA):

One-way ANOVA was performed to compare each lip print pattern type across the three age groups (Table 4). The analysis revealed significant age-group differences for Type II (branched) and Type IV (reticular) patterns. Type II yielded $F = 4.92$ ($P = 0.008$) and Type IV $F = 5.33$ ($P = 0.006$), both $P < 0.01$, indicating significant variation by age. In contrast, Types I, III, and V showed no significant differences (all $P > 0.05$). These results suggest that the frequency of branched and reticular patterns varies with age, whereas the others remain stable across age groups.

Table 4:One-way ANOVA for lip print pattern types across age groups

Pattern Type	F-Value	p-Value	Significant
Type I (Linear)	1.91	0.151	No
Type II (Branched)	4.92	0.008*	Yes
Type III (Intersected)	0.63	0.531	No
Type IV (Reticular)	5.33	0.006*	Yes
Type V (Miscellaneous)	1.10	0.339	No

$P < 0.05$ indicates statistical significance.

Discussion:

The present study aimed to evaluate the uniqueness, distribution, and potential forensic value of lip print patterns in 120 individuals from the North Indian population, equally distributed by gender and categorized into three age groups. This demographic structure aligns with previous studies such as those by Vergheseet al.[12] and Vahanwala and Parekh,[2] ensuring methodological consistency and comparability.

Distribution of Lip Print Patterns by Quadrant:

A total of 480 lip prints (four quadrants per individual) were examined, with Type II (branched) being the most prevalent pattern (32.92%) and Type V (miscellaneous) the least (10.00%). These findings corroborate results from Vergheseet al.,[12] Caldas et al.,[13] and Easwaran& Rajendran,[14] who also identified Type II as the dominant pattern. The observed distribution order (Type II > Type I > Type III > Type IV > Type V) indicates a consistent hierarchy across diverse populations, though minor regional variations exist.[12-14]

Chi-square analysis revealed statistically significant differences in lip print patterns across most quadrant pairs, with the exception of the lower-left and lower-right comparison (p = 0.128). These findings suggest quadrant-wise asymmetry in lip print distribution, similar to prior observations by Lathaet al.,[15] Saini et al.,[16] and Gunduz et al.,[17] who reported variation in pattern type and density across different lip regions. This quadrant-specific diversity strengthens the use of cheiloscopy in forensic identification.

Gender Differences in Lip Print Patterns:

In both males and females, Type II remained the predominant pattern. However, significant gender-based variations were noted in Type III (Intersected) and Type IV (Reticular) patterns, which were more frequent in males (p = 0.024 and p = 0.047, respectively). These findings align with previous studies by Singh et al.,[18] Chawla et al.,[19] and Latha et al.,[20] who associated more complex patterns with male lip morphology. In contrast, linear and branched patterns (Type I and II) were more frequent in females, though not statistically significant. Saini et al.[21] and Tiwari et al.[22] suggested that simpler groove formations in females may result from smoother lip structures and greater elasticity.

These results support the growing body of literature that suggests sexual dimorphism in lip print patterns, reinforcing the forensic applicability of cheiloscopy in gender identification.[17, 20-22]

Uniqueness of Lip Print Patterns:

Based on pattern frequency, Type I and II were classified as low uniqueness patterns due to their high occurrence (26.25% and 32.92%, respectively), while Type III and IV represented moderate uniqueness. Type V, although least frequent (10.83%), exhibited high uniqueness, highlighting its value for forensic differentiation. Similar interpretations were drawn by Agnihotri et al.[23] and Gunduz et al.,[17] who emphasized the relevance of rare patterns for precise individual identification.

Interestingly, males showed a greater prevalence of low uniqueness patterns (Type I and IV), suggesting uniformity and structural consistency, whereas females demonstrated a higher occurrence of high uniqueness patterns (Type V), indicative of greater variation and complexity.[17,19,21] These observations confirm the potential of lip print analysis for individual profiling in forensic investigations.

Age-Related Differences in Lip Print Patterns:

Analysis of variance revealed significant age-related differences in the distribution of Type II and Type IV patterns. Type II was more common in the younger group (18–30 years), likely due to increased skin elasticity and groove definition in younger individuals, as also reported by Tiwari et al.[22] and Gunduz et al.[17] Conversely, Type IV showed higher prevalence in the 46–60 years group, possibly due to age-associated dermal changes such as collagen loss, which affect groove visibility and structure.[20,21]

No significant age-related variation was observed in the distribution of Types I, III, and V, indicating their relative stability across the lifespan. These findings suggest that age influences specific lip print patterns and that cheiloscopy could aid in approximate age estimation when combined with other forensic parameters.[21,22,24]

Conclusion:

This study confirms that lip prints are unique, diverse, and forensically valuable biometric markers. The analysis of 120 participants from the North Indian population demonstrated that no two individuals shared identical lip print patterns. While common patterns like Type I (Linear) and Type II (Branched) were frequently observed, rarer patterns such as Type III (Intersected) and Type V (Miscellaneous) offered greater forensic precision due to their distinctiveness.

Significant quadrant-wise and gender-based differences were identified. Type III and IV patterns were more prevalent in males, while Type V occurred more frequently in females. Additionally, pattern distribution varied significantly across the four quadrants, emphasizing the importance of comprehensive analysis.

These findings reinforce the role of lip prints in personal identification and suggest their utility in gender estimation within forensic investigations. Future studies with larger, more diverse populations and the integration of advanced imaging and analytic tools are recommended to further validate and enhance the application of cheiloscopy in forensic science.

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