



CHEILOSCOPIC ANALYSIS OF LIP PRINT PATTERNS IN RELATION TO CRANIOFACIAL GROWTH PATTERNS: A CROSS-SECTIONAL STUDY IN ORTHODONTIC PATIENTS.

Forensic Dentistry

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ABSTRACT

Background: Cheiloscopia, the study of lip print patterns, has gained recognition in forensic identification due to the unique characteristics of lip prints. While previous studies have explored correlations between lip prints and sagittal malocclusions, the relationship between lip print patterns and craniofacial growth patterns remains unexplored. **Objective:** To investigate the correlation between lip print patterns and craniofacial growth patterns (vertical, average, and horizontal) in orthodontic patients and explore potential applications in orthodontic diagnosis and forensic identification. **Materials and Methods:** This cross-sectional study included 112 subjects aged 10-18 years from the Department of Orthodontics, Sree Anjaneya Institute of Dental Sciences. Craniofacial growth patterns were classified using Y-axis angles from lateral cephalometric radiographs (vertical: $>66^\circ$, average: $59-66^\circ$, horizontal: $<59^\circ$). Lip prints were collected using the lipstick-cellophane technique and analyzed according to Tsuchihashi's classification system, focusing on the middle 10mm of the lower lip. Statistical analysis was performed using chi-square test with significance set at $p < 0.05$. **Results:** The sample comprised 60 females (54%) and 52 males (46%). Vertical growth pattern was most prevalent (46.4%), followed by average (33.9%) and horizontal (19.6%) patterns. Class 2 (branched) lip prints were most common overall (36.6%), followed by Class 1 (29.5%) and Class 4 (18.8%). Class 5 patterns occurred exclusively in vertical growth subjects (1.8%). No statistically significant association was found between lip print patterns and craniofacial growth patterns ($\chi^2 = 13.23$, $p = 0.21$). **Conclusion:** While no significant correlation was established, the study provides foundational methodology for future research exploring cheiloscopia applications in orthodontic diagnosis and forensic identification.

KEYWORDS

Lip prints, Craniofacial growth patterns, Orthodontic diagnosis, Tsuchihashi classification

INTRODUCTION

The boundaries of dental compensation for underlying jaw discrepancies are determined by various factors, including pressures exerted by the lips, cheeks, and tongue; limitations of the periodontal attachment; neuromuscular influences on mandibular positioning; and the contours of the soft tissue facial mask [1]. Conversely, the skeletal pattern plays a pivotal role in shaping the soft tissue profile, influencing both facial aesthetics and functional outcomes. Among soft tissue components, lip and chin morphology are critical determinants of the orofacial profile and are therefore integral to orthodontic diagnosis and treatment planning [2].

Several diagnostic modalities—such as cephalometry, anthropometry, and cheiloscopia—rely heavily on lip characteristics to evaluate orofacial balance and harmony [2–7]. Cheiloscopia, derived from the Greek words *cheilos* (lips) and *skopein* (to see), refers to the examination of lip prints. These prints are composed of characteristic lines, fissures, and grooves located in the transitional zone between the inner labial mucosa and the outer skin surface [8]. Similar to fingerprints, lip prints are considered unique to each individual and exhibit a strong hereditary component, positioning cheiloscopia as a valuable tool in forensic dentistry [8].

The biological significance of lip prints was first noted by R. Fischer in 1902, with their forensic application later proposed by Edmond Locard in 1932 [9]. Le Moyne Snyder observed that lip prints possess unique individual features akin to thumbprints, a finding later supported by Renaud's study of 4,000 lip prints in 1972, which confirmed their singularity [9]. These studies collectively underscore the potential of lip prints in personal identification [10].

Existing research has identified correlations between thumbprints and sagittal dental malocclusion [11], as well as between lip prints and sagittal jaw relationships [12]. However, the influence of craniofacial growth patterns—categorized as vertical, average, or horizontal—on lip morphology remains unexplored. Since lip development varies not only by gender but also by facial growth type, investigating this

relationship may provide clinically valuable insights. Understanding the correlation between lip print patterns and growth patterns could improve diagnostic precision in orthodontics and enhance forensic identification, particularly in scenarios where traditional identifiers like fingerprints are unavailable, such as mass disasters or criminal investigations.

This study aims to explore the correlation between lip print patterns and craniofacial growth patterns in orthodontic patients. By integrating cheiloscopia into orthodontic evaluation, this research seeks to bridge the disciplines of orthodontics and forensic science, offering novel applications for both personalized treatment planning and individual identification.

MATERIALS AND METHODS

Study Population

This study was conducted at the Department of Orthodontics and Dentofacial Orthopedics, Sree Anjaneya Institute of Dental Sciences, Calicut District, with ethical clearance from the Institutional Ethics Committee. A total of 120 subjects aged 10–18 years were selected based on craniofacial growth patterns (vertical, average, or horizontal), with each group comprising 40 subjects. Growth patterns were classified using the Y-axis angle measured from digital lateral cephalometric radiographs obtained for pretreatment purposes (vertical: Y-axis $>66^\circ$, average: $59-66^\circ$, horizontal: $<59^\circ$). Exclusion criteria included known hypersensitivity to lipstick, developmental anomalies or pathologies of the lips or jaws, previous orthodontic treatment or maxillofacial surgery, and restricted mouth opening. Written informed consent was obtained from all participants as per ethical committee guidelines.

Data Collection

Lip prints were collected using the lipstick-cellophane technique, a standard method in forensic cheiloscopia for its accuracy and reproducibility [13]. Participants were seated comfortably on a dental chair, and their lips were cleaned with wet cotton. A portion of red lipstick was cut with a Parker knife, placed into a dappen dish, and then

applied to the lips using a lip brush. Participants were instructed to rub their lips together to evenly distribute the lipstick. The adhesive side of a cellophane tape strip (3M, or specify brand) was gently applied to the lips, starting at the center and extending to the corners, to capture the lip impression, then affixed to white bond paper for a permanent record (Fig. 1a–1b). Single-use brushes and sterilized tools were used to prevent cross-contamination. Digital lateral cephalograms were obtained using standard orthodontic protocols.

Lip Print Analysis

Lip prints were analyzed by trained orthodontists using a magnifying lens, focusing on the middle 10 mm of the lower lip, selected for its consistent groove patterns [13]. Prints were classified according to Tsuchihashi's system [13]:

- Class I: Clear-cut vertical grooves running across the entire lip.
- Class II: Branched grooves (Y-shaped patterns).
- Class III: Intersected grooves (crisscross or transverse patterns).
- Class IV: Reticular grooves.
- Class V: Undetermined grooves not fitting Types I–IV.

Lip prints were categorized according to their corresponding growth pattern (vertical, average, or horizontal) and recorded in a classification table (Fig. 2). Records were stored in a secure, dry environment to maintain integrity



Armamentarium used
Fig : 1-a

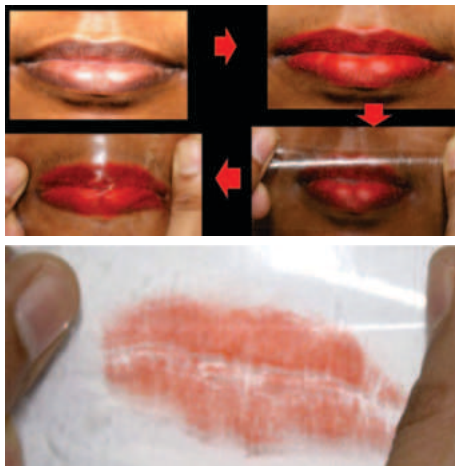


Fig – 1-b



Fig-2
Statistical Methods

Sample Size Calculation

The minimum required sample size was estimated to be 112 subjects, based on a prevalence of 47% from previous studies, with a 95% confidence level and a permissible error of 20%. The calculation accounted for a two-tailed hypothesis using a standard normal deviate

of 1.96. Statistical analysis was performed using IBM SPSS Statistics for Windows, Version 20.0. The power of the study was set at 80%, and calculations were verified before commencement of data collection. Descriptive statistics were used to summarize categorical variables and expressed as frequencies and percentages. Chi-square test (χ^2) was applied to assess the association between lip print types and craniofacial growth patterns. A p-value < 0.05 was considered statistically significant.

RESULTS

A total of 112 subjects (52 males, 60 females) aged between 10 and 18 years participated in the study. Females comprised 54% of the sample, while males accounted for 46% (Table 1).

Table 1: Distribution of Study Subjects Based on Gender

Gender	No	Percentage
Males	52	46
Females	60	54
Total	112	100

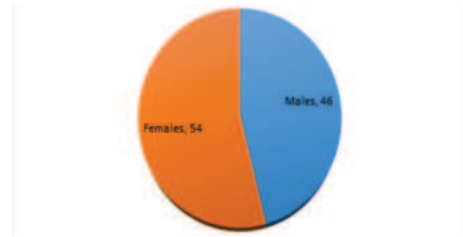


Fig 1

Of the 112 participants, 60 (54%) were females and 52 (46%) were males. Table 2 shows the vertical growth pattern was the most prevalent overall (46.4%), observed in 38.3% of females and 55.8% of males. The horizontal growth pattern was seen in 19.6% of participants, being more common in females (30%) than in males (7.7%). The average growth pattern accounted for 33.9% of the sample, with similar distribution between females (31.7%) and males (36.5%).

Table 2: Distribution of Growth Pattern with Respect to Gender

Growth pattern	Female	Male	Total
	No (%)	No (%)	
Vertical	23 (38.3)	29 (55.8)	52 (46.4)
Horizontal	18 (30.0)	4 (7.7)	22 (19.6)
Average	19 (31.7)	19 (36.5)	38 (33.9)
Total	60 (100)	52 (100)	112 (100)

Table 3: Association Between Lip Print Classification and Craniofacial Growth Patterns

Lip pattern	Horizontal growth pattern No (%)	Normal growth pattern No (%)	Vertical growth pattern No (%)	Chi square test	p value
Class 1	2 (9)	17 (45)	14 (24)	13.23	0.21
Class 2	12 (55)	9 (24)	20 (34)		
Class 3	1 (5)	4 (11)	10 (17)		
Class 4	7 (32)	8 (21)	6 (10)		
Class 5	0	0	2 (3)		
Total	22	38	58		

The most common lip print type overall was Class 2 (36.6%), followed by Class 1 (29.5%) and Class 4 (18.8%). Class 5 was the least common, occurring only in 1.8% of the sample and exclusively among participants with vertical growth patterns. In the horizontal growth group, Class 2 was predominant (54.5%), while the average growth group showed a higher frequency of Class 1 (44.7%). Among vertical growth participants, Class 2 was most frequent (34.5%). The association between lip print class and craniofacial growth pattern was not statistically significant ($\chi^2 = 13.23, p = 0.21$).

DISCUSSION

This study represents the first attempt to investigate the correlation between lip print patterns and craniofacial growth patterns in orthodontic patients, with implications for both clinical orthodontics and forensic identification. While the association between lip print classification and craniofacial growth patterns was not statistically significant ($\chi^2 = 13.23, p = 0.21$), several noteworthy findings emerged that warrant further discussion.

Growth Pattern Distribution and Gender Variations

The predominance of vertical growth patterns (46.4%) in our sample aligns with previous orthodontic studies, where vertical facial types are commonly observed in populations seeking orthodontic treatment. The gender-specific distribution revealed interesting patterns, with vertical growth being more prevalent in males (55.8%) compared to females (38.3%), while horizontal growth patterns showed an inverse trend, occurring more frequently in females (30%) than males (7.7%). This finding corroborates established orthodontic literature indicating sexual dimorphism in facial growth patterns, potentially attributed to hormonal influences and genetic predisposition affecting craniofacial development.

Lip Print Pattern Distribution

The most prevalent lip print pattern was Class 2 (branched grooves) at 36.6%, followed by Class 1 (vertical grooves) at 29.5%. This distribution differs from some previous studies where Class 1 patterns were more common. The predominance of Class 2 patterns in our sample may reflect population-specific genetic variations or methodological differences in print collection and analysis. Notably, Class 5 patterns (undetermined) were rare (1.8%) and exclusively found in vertical growth subjects, suggesting a potential, albeit weak, association that merits further investigation with larger sample sizes.

Comparison with Previous Studies

Several studies have investigated the relationship between cheiloscopy patterns and orthodontic parameters, providing context for our findings. Raghav et al. (14) conducted a pioneering study examining lip prints as "barcodes of skeletal malocclusion" in 114 subjects aged 18-30 years from a North Indian population. Their study revealed a definite correlation of vertical lip patterns with skeletal Class III malocclusion, suggesting that specific lip print types may indeed correlate with certain skeletal patterns, though their focus was on sagittal rather than vertical growth patterns.

An investigation by Sharma et al. (15) explored correlations between lip print patterns and skeletal Class I and II malocclusions in 90 subjects aged 18-25 years. Their findings showed that branched lip pattern was most prevalent (30%) followed by reticulated pattern (26%), intersected pattern (23%), and vertical lip pattern (15%), which closely aligns with our distribution where Class 2 (branched) patterns were most common at 36.6%. However, their study focused on anteroposterior skeletal relationships rather than vertical growth patterns.

Another significant study by Kumar et al. (16) investigated cheiloscopy as an early indicator of Class I and Class II malocclusions. Their results showed a significant correlation between lip prints and skeletal sagittal malocclusion, and they concluded that cheiloscopy could serve as an early diagnostic indicator, though they acknowledged the need for larger sample sizes for validation.

The work by Venkatesh and David (17) established foundational principles for cheiloscopy in personal identification, demonstrating the uniqueness and hereditary nature of lip prints. Their methodological approach using the lipstick-cellophane technique, which we adopted, has been validated across multiple populations for its reliability and reproducibility.

Geometric morphometric analysis by Smith et al. (18) provided insights into growth patterns among facial types, demonstrating that hyperdivergent growth, particularly restricted growth and positioning of the maxilla, results in a higher potential risk for Class II malocclusion. This finding supports our approach of investigating vertical growth patterns, as it suggests that facial morphology and growth direction have measurable impacts on overall craniofacial development.

Our study's non-significant results ($p = 0.21$) contrast with some previous findings but may reflect methodological differences, particularly our focus on vertical rather than sagittal growth patterns. The exclusive occurrence of Class 5 patterns in our vertical growth subjects, though rare, echoes patterns observed in other studies where certain lip print types showed preferential association with specific skeletal configurations.

Limitations

Several limitations must be acknowledged. The sample size, while

adequate for initial exploration, may have been insufficient to detect subtle associations. The cross-sectional design prevented assessment of how lip print patterns might evolve with facial growth over time. Inter-examiner reliability in lip print classification, though standardized using Tsuchihashi's system, could introduce subjective bias. Furthermore, environmental factors such as lip habits, trauma, or pathology that might influence print patterns were not systematically evaluated.

CONCLUSION

While this study did not demonstrate a statistically significant correlation between lip print patterns and craniofacial growth patterns, it represents an important first step in exploring this relationship. The observed trends, particularly the predominance of specific lip print classes within growth pattern categories, suggest potential clinical utility that warrants further investigation with larger, more diverse populations. The methodology established herein provides a foundation for future research bridging orthodontics and forensic science, potentially contributing to both personalized treatment planning and individual identification protocols.

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