Content available at: https://www.ipinnovative.com/open-access-journals

IP Indian Journal of Orthodontics and Dentofacial Research

Journal homepage: https://ijodr.com/

Original Research Article

Assess the relationship of lip pattern in different types of skeletal malocclusion

Vikas Kumar[1], Abhishek Singha Roy[1], Shraddha Sinha[2]*, Shivangi Kumari[1], Archana Bhagat[1], Priyanka Raj[1]

[1]Dept. of Orthodontics, LNMU, Bihar, India
[2]Dept. of Oral and Maxillofacial Surgery, Mithila Minority Dental College and Hospital, LNMU, Bihar, India

Abstract

Aim and Objective: The objective of this study was to explore the correlation between lip print patterns and various types of skeletal malocclusion.

Materials and Methods: A total of 132 individuals with confirmed skeletal malocclusions—Class I, Class II Division 1, Class II Division 2, and Class III—were selected based on ANB angle assessment using lateral cephalograms. Lip prints were obtained using the standard lipstick and cellophane tape technique. Each print was examined and classified according to the Tsuchihashi system, which includes Types I, I′, II, III, IV, and V.

Results: The partial vertical groove (PVG) pattern was the most frequently observed across all types of skeletal malocclusions. Among individuals with skeletal Class I, the branched lip pattern appeared most frequently. In cases of skeletal Class II Division 1 and Division 2, the partial vertical groove pattern was dominant. For individuals with skeletal Class III, the complete vertical groove pattern was more prevalent.

Conclusion: Lip print analysis has potential applications in personal identification, especially in forensic cases and mass disaster situations. Furthermore, identifying specific lip print patterns in relation to skeletal malocclusion assist in early diagnosis, thereby enhancing the effectiveness of preventive and interceptive orthodontic treatments.

Keywords: Cheiloscopy, Class II, Class III

Received: 14-06-2025; **Accepted:** 23-07-2025; **Available Online:** 14-10-2025

1. Introduction

Cheiloscopy is a forensic science technique that analyzes the unique grooves on the vermilion border of the lips, known as lip prints. These patterns are distinct to each individual, remain stable throughout life, and can aid in personal identification, especially in forensic investigations. Lip patterns are located where the outer lip skin meets the inner labial mucosa and are considered permanent and unchanging from birth, much like fingerprints and palatal rugae, Lip patterns begin to form as early as the sixth week of pregnancy[1] and are resistant to infection and alteration. The smallest area of the lips that displays these characteristic grooves is called the Klein's zone.

1.1. A brief history of cheiloscopic studies

The presence of characteristic furrow patterns on the vermilion border of the lips was first reported by anthropologist R. Fischer in 1902.[2] The potential application of lip prints in personal identification was later recognized by the French criminologist Edmond Locard in 1932.[3] In 1950, Snyder, in his book *Homicide Inquiry*, stated that lip prints exhibit individuality comparable to that of fingerprints[4] Further progress in this field was made in 1960, when Dr. Martins Santos proposed the forensic use of lip features for identification and introduced a preliminary classification system for lip prints.[5,6]

The initial European research into lip prints took place in Hungary in 1961, sparked by the discovery of lip prints on a door at a murder scene. Meanwhile, researchers in Japan had already begun extensive studies on lip print analysis during the 1950s. Japanese researchers Kazuo Suzuki[7] and Yasuo Tsuchihashi conducted forensic odontological investigations involving the interaction of lipstick with lip surfaces, even before Santos introduced his classification system. Suzuki,

*Corresponding author: Shraddha Sinha
Email: Doc.sinha63@gmail.com

https://doi.org/10.18231/j.ijodr.24104.1760446610

in particular, conducted a study in 1967 focusing on lip measurements, the application of lipstick, and how to obtain the most informative prints.

Lip prints can serve as valuable forensic evidence, especially in criminal investigations. They can confirm a suspect's presence at a crime scene if lip prints are found on objects like tissues, glass, or clothing. In cases of sexual assault, a suspect's lip print found on the victim's body or clothing can support claims of unwanted contact. Rm Rani[8] et al. aimed to explore the correlation between skeletal malocclusion types and lip and dermal print patterns, as well as to assess gender-based differences. A total of 120 individuals participated in a study exploring the relationship between lip print patterns and skeletal malocclusions. Each type of skeletal malocclusion—Class I, Class II, and Class III—was represented by a group of 40 participants.The results indicated that vertical groove patterns were more frequently seen in individuals with Class III malocclusion, while branched patterns were predominantly observed in Class I and Class II cases. Cheiloscopy offers a practical, non-invasive, and cost-efficient approach that may assist in early identification of genetic tendencies toward malocclusion. However, its diagnostic accuracy may be influenced by environmental and ethnic variables.

In another study, Das et al.[9] assessed lip print pattern variations in individuals with skeletal Class I and Class II malocclusions. The study included 160 subjects aged 12 years and older, with 80 individuals in each group. Lip prints were obtained using dark-colored lipstick and cellophane tape, which were then transferred onto white bond paper for analysis. Tsuchihashi's classification system was employed to examine a 10 mm region on both sides of the midline. Type I patterns were significantly more frequent among participants with Class I malocclusion, whereas Type II patterns were commonly observed in Class II malocclusion. A strong association was established between specific lip print types and sagittal skeletal classifications, suggesting the potential role of cheiloscopy in early detection of skeletal malocclusions. Nevertheless, further studies with larger and more diverse samples are recommended to validate these observations.

1.2. Classification of lip prints

According to the classification proposed by Suzuki and Tsuchihashi in 1970, lip prints can be divided into six distinct types:

1. **Type I:** Long, continuous vertical grooves
2. **Type I′:** Short, partial vertical grooves
3. **Type II:** Branched or bifurcated grooves
4. **Type III:** Intersecting grooves
5. **Type IV:** Reticular or mesh-like grooves
6. **Type V:** Irregular grooves that do not fit into the above categories.[6]

2. Aims and Objective

The objective of this research was to investigate the correlation between lip print patterns in various classifications of skeletal malocclusion in individuals from the Mithilanchal region, and to explore the potential of cheiloscopy as a non-invasive, early diagnostic tool in orthodontics. The study involved recording clear and reproducible lip prints from each participant using a standardized method, by analysis of their lateral cephalograms to determine skeletal malocclusion classification based on the ANB angle (Class I, II, and III). Lip prints were categorized using Tsuchihashi's classification (Types I, I', II, III, IV, and V), and their distribution was compared across different malocclusion groups to identify any significant associations. The present study also aimed to analyze gender-specific variations in lip print patterns and their correlation with different skeletal malocclusion types. In addition, it evaluated the feasibility of utilizing lip prints as a supplementary diagnostic tool in orthodontics and as an identification tool in forensic investigations. The study further intended to enhance the understanding of population-specific associations between lip print characteristics and skeletal patterns, thereby contributing to the broader fields of forensic odontology and anthropological research.

3. Materials and Methods

This cross-sectional observational study was conducted in the Department of Orthodontics and Dentofacial Orthopaedics at Mithila Minority Dental College and Hospital, Darbhanga, Bihar, from July 2023 to January 2025. The study included 132 participants (68 males and 64 females) aged between 18 and 30 years, who were selected from individuals visiting the orthodontics and oral medicine clinics. Ethical clearance was granted by the institutional ethics committee, and written informed consent was obtained from all participants prior to their inclusion in the study.

Only individuals native to the Mithilanchal region defined as residents for at least two generations within districts such as Darbhanga, Madhubani, Sitamarhi, Samastipur, and near by areas—were included. Subjects with developmental anomalies, cleft lip/palate, systemic illnesses, or unwillingness to participate were excluded.

Lateral cephalograms were taken using a VATECH Model 2500[10] (Korea) cephalometric machine with standard head positioning and safety measures. Skeletal malocclusion was assessed using the ANB angle according to Riedel's classification: Class I (0° – 4°), Class II (>4°), and Class III (<0°). Cephalometric tracings were done manually on acetate tracing sheets using a 0.3 mm lead pencil, protractor, and ruler. **(Figure 1A)**

Lip impressions were recorded using a standard lipstick and cellophane tape method. Participants were first asked to cleanse and dry their lips thoroughly. A single, even coat of dark lipstick was then applied. The impression was taken by pressing a strip of transparent cellophane tape onto the lips, and then affixed to white glossy photographic paper for analysis **(Figure 1B)** and **(Figure 1C)**. Each lip print was examined with a magnifying lens and categorized according to Tsuchihashi's classification, which includes Types I, I′, II, III, IV, and V.

Table 1: Distribution of lip print types by gender across malocclusion classes

Malocclusion Class	Gender	Type 1 (%)	Type 1A (%)	Type 2 (%)	Type 3 (%)	Type 4 (%)
Class I	Male	33.3	33.3	0	33.3	0
	Female	30.0	25.0	35.0	10.0	0
Class III	Male	75.0	25.0	0	0	0
	Female	33.3	0	33.3	0	33.3
Class II Div 1	Male	25.0	25.0	0	50.0	0
	Female	0	66.7	0	33.3	0
Class II Div 2	Male	0	100.0	0	0	0
	Female	0	100.0	0	0	0

Figure 1A : Armamentarium used to find ANB angle

Figure 1B : Armamentarium used to record and analyse lip print

Figure 1C : Recorded lip print

Statistical analysis was conducted using SPSS version 22.0 [13]. The Chi-square test was used to compare categorical variables across different groups[12], while one-way ANOVA was applied to analyze quantitative parameters such as the atd angle and ab ridge count. A p-value of less than 0.05 was considered statistically significant. **(Table 1)**

4. Result

The analysis of lip print types among males and females across different malocclusion classes (N=132) revealed a significant association between lip pattern and malocclusion type (Chi-square = 56.575, p = 0.001). Class I showed a balanced distribution of Types 1, 1A, and 3 among males, while females displayed greater variability, including Type 2. In Class III, males predominantly exhibited Type 1 (75%), whereas females showed an equal distribution among Types 1, 2, and 4, indicating a gender-based difference (Chi-square = 22.409, p = 0.001). In individuals with Class II Division 1 malocclusion, a statistically significant difference was observed between males and females (Chi-square = 14.475, p = 0.005). Type 1A lip print patterns were more common among females, while males more frequently exhibited Type 3 patterns. In contrast, no gender-based variation was noted in Class II Division 2 cases, where both genders consistently displayed the Type 1A pattern. These results indicate that gender may play a significant role in lip print pattern distribution, especially in Class I, Class III, and Class II Division 1 malocclusion categories.

5. Discussion

Lip prints are formed by the grooves and wrinkles found in the transitional zone between the inner labial mucosa and the outer skin of the lips. Although they were first documented in 1902, their significance in forensic science[13] was only recognized after lip prints were discovered at a crime scene. Similar to fingerprints, lip prints are unique and remain unchanged over time unless altered by trauma or pathology. As a result, they have become increasingly valuable in forensic investigations for purposes such as personal identification and gender determination.

The development of the lips, alveolar ridge, and palate starts around the 24th week of fetal development, with all three structures arising from a common embryonic origin.Because of this shared origin, any developmental disturbances affecting one structure can potentially impact

the others. This connection has prompted researchers to investigate whether lip print patterns may reflect changes in the alveolus, suggesting possible links to dental or skeletal conditions such as malocclusion. Over the past thirty years, scientists have extensively studied the associations between lip prints, dermatoglyphic patterns[14], and various medical or dental abnormalities in both forensic and orthodontic fields.

Several factors, including genetic influences, environmental exposures, and physical or chemical trauma, can affect the development of teeth, jaws, and lip prints. Since these facial structures develop simultaneously from the ectoderm during intrauterine life, changes in structure may correspond to changes in another. This observation supports the exploration of potential relationships between lip print patterns and types of malocclusion, providing insight into craniofacial development and dental disorders.

Lip prints remain unchanged after formation unless they are affected by disease or injury, making them useful as stable markers. Our study aimed to correlate specific lip print patterns with different classes of malocclusion, as defined by Angle's classification.[15] The findings suggest that specific lip print types are associated with particular molar relationships. This suggests that lip prints may serve as early indicators of malocclusion, helping orthodontists diagnose and treat such conditions more effectively.

Lip prints, also known as cheiloscopic patterns, have become a valuable tool in forensic investigations, especially when conventional identifiers such as fingerprints or DNA are unavailable. These prints can be recovered from surfaces such as glass, cigarette butts, or textiles, and may serve as vital evidence in cases involving theft, assault, or homicide. Nevertheless, their evidential value in legal settings remains limited, largely due to the lack of standardized classification methods and insufficient validation studies.

Over the years, several systems for categorizing lip prints have been proposed, with the Suzuki and Tsuchihashi classification being the most widely accepted. This system classifies lip prints into types such as vertical, intersected, branched, and reticular patterns. Beyond their forensic relevance, lip prints also provide insights in fields such as anthropology, heredity, and clinical diagnostics. Numerous studies have indicated that lip patterns have a genetic component, with similar patterns observed among family members, suggesting a heritable trait. This suggests their potential application in population genetics and hereditary research. Additionally, some studies have explored connections between lip prints and medical anomalies, including cleft lip and palate, dermatoglyphic markers, and other congenital conditions, showcasing the diagnostic relevance of cheiloscopy.

In orthodontics, the study of lip prints has gained momentum due to their possible relationship with craniofacial structures. The lips play a significant role in shaping the soft tissue profile of the face, influencing both facial esthetics and treatment planning.[16] Studies have focused on the association between cheiloscopic patterns and Angle's malocclusion classes, revealing potential links that could assist in diagnosis and treatment. While traditional cephalometric evaluations primarily assess skeletal structures, they do not always align with soft tissue behavior. Modern orthodontics emphasizes harmonious facial appearance and soft tissue balance, where lip print analysis may offer a supplementary, non-invasive diagnostic method.

Craniofacial growth and occlusion are shaped by both hereditary factors and environmental influences. Since the lips, alveolar ridge, and palate originate from the same embryonic tissue, developmental changes in one may affect the others. This shared embryological origin provides a strong basis for examining the correlation between lip prints and occlusal development. Our findings reveal notable associations between specific cheiloscopic patterns and permanent molar relationships, suggesting the potential of lip prints in identifying craniofacial anomalies and guiding early orthodontic intervention.

Our literature review supports these findings. Rani et al.reported that vertical lip patterns were most prevalent in Class III malocclusion cases, whereas branched patterns were more commonly associated with Class II malocclusion. In our study, vertical patterns were strongly linked with Class III as well. However, unlike Rani's report, we observed that Class II malocclusion cases also showed vertical lip patterns, though these were localized rather than covering the entire lip area—possibly reflecting the vertical growth pattern typical in Class II malocclusion patients.

Similarly, Nayak and colleagues[17] concluded that the branched lip pattern was most common in skeletal Class I malocclusion, while vertical patterns predominated in Class III. This aligns with our findings, particularly in female subjects with Class I malocclusion, where branched patterns were dominant. Jain et al. observed that in females with Class II malocclusion, Type II lip prints (branched) were most frequent, while Class III males predominantly exhibited Type I (vertical) prints, and Type II was again dominant in Class III females. Our observations reflect these patterns, reinforcing the reproducibility of these associations across populations.

Sapasetty and colleagues[18] found that branched patterns were most frequently seen in Class I malocclusion without skeletal discrepancies and in Class II malocclusion with skeletal discrepancies. In contrast, vertical patterns were more prevalent in Class III malocclusion with skeletal discrepancies. Our findings corroborate this, showing higher occurrences of branched prints in Class II skeletal malocclusion and vertical patterns in Class III. Additionally, Das et al. reported that vertical lip prints (Type I) were commonly associated with skeletal Class I malocclusion, while branched prints (Type II) were frequently observed in skeletal Class II cases. This is consistent with our results as well.

Cheiloscopy offers an accessible, low-cost, and non-invasive method for evaluating lip morphology. Since lip prints develop during intrauterine life—prior to the full establishment of dental occlusion or jaw relationships—they may provide early clues about future orthodontic concerns.

As such, integrating lip print analysis into routine orthodontic records may enhance the early diagnosis and management of skeletal discrepancies.

Traditional approaches to personal identification encompass a wide array of biometric and biological techniques, including anthropometry, dactyloscopy (fingerprint analysis), DNA profiling, sex determination, age estimation, stature reconstruction, postmortem examination, and blood group analysis. These methods are extensively validated and have become foundational tools in forensic science. In contrast, cheiloscopy—the study of lip print patterns—has received comparatively limited scientific scrutiny. Although lip print evidence has been admitted in legal proceedings in select instances, its reliability and evidentiary value remain underexplored. This highlights a pressing need for comprehensive empirical investigations to evaluate the reproducibility, validity, and forensic applicability of lip print analysis within the broader framework of forensic science.

5.1. Lip prints and sexual dimorphism

One of the notable studies in the field, conducted by Vahanwala and Parekh (2000, 2001), explored the sexual dimorphism evident in lip print patterns. Their findings revealed significant differences between males and females:

1. Type I and Type I′ patterns were predominantly found in females, especially in the third and fourth quadrants, corresponding to the lower lip regions.
2. Type II patterns were more frequently observed in males, particularly in the second quadrant (left upper lip).
3. Males exhibited greater variability in lip print patterns across all four quadrants, while females tended to demonstrate uniformity, often presenting the same pattern throughout.
4. Overall, Type I and Type I′ were the dominant patterns among female subjects.

These findings suggest that lip prints may be useful as a supplementary method for sex determination, which could be particularly beneficial in scenarios where other identification markers are unavailable or compromised.

5.2. Lip prints and dental malocclusion

Recent studies have expanded the potential application of cheiloscopy into the domain of dental diagnostics, particularly regarding skeletal malocclusion patterns. Anuradha et al. examined the relationship between lip print patterns and skeletal classes and found that:

1. Skeleton Class I individuals exhibited a higher frequency of branching structures in their lip prints.
2. In Skeleton Class II subjects, branched patterns were most frequent, followed by intersected, reticular, and vertical patterns.

Further, a study by Govindarajan et al. reported the highest prevalence of dental caries among individuals with Type II branching patterns, suggesting a possible link between lip morphology and oral health risk factors.

Vignesh et al. further corroborated the role of lip prints in predicting dental anomalies. Their research demonstrated that Type I lip patterns were the most prevalent overall and particularly common among individuals with Class I malocclusion. Notably, gender-specific associations were also observed:

1. Males with Class III malocclusion had an increased frequency of Type III lip patterns.
2. Females with the same malocclusion class showed a higher occurrence of Type IV patterns.

Despite its promise, cheiloscopy faces several limitations. The clarity and reproducibility of lip prints can be affected by external variables like dryness, injuries, or improper collection techniques. Furthermore, although many studies point to correlations between lip prints and various skeletal malocclusions, larger-scale research is necessary to establish validated clinical protocols and enhance the scientific credibility of cheiloscopy in both forensic and orthodontic domains.

6. Conclusion

Cheiloscopy—the scientific examination of lip print patterns—has shown promise beyond forensic identification, extending its utility to orthodontic diagnostics and broader medical investigations. The findings of the current study highlight a notable association between distinct cheiloscopic patterns and various classes of malocclusion based on Angle's classification. These unique lip print configurations may act as early indicators of developing malocclusion, supporting proactive orthodontic screening and early therapeutic intervention. Moreover, the gender-specific distribution of lip patterns observed across malocclusion types hints at underlying genetic and developmental influences. Incorporating cheiloscopic evaluation into standard orthodontic diagnostic protocols[19] could provide clinicians with supplementary data on craniofacial growth trends and occlusal anomalies, thereby refining diagnosis and optimizing treatment strategies.

7. Source of Funding

None.

8. Conflict of Interest

None.

References

1. Venkatesh R, David MP. Cheiloscopy: An aid for personal identification. *J Forensic Dent Sci*. 2011;3(2):67–70. doi: 10.4103/0975-1475.92147.
2. Sivapathasundharam B, Prakash PA, Sivakumar G. Lip prints (cheiloscopy). *Indian J Dent Res*. 2001;12(4):234–7.
3. Saraswathi TR, Mishra G, Ranganathan K. Study of lip prints. J *Forensic Dent Sci*. 2009;1(1):28–31. doi: 10.4103/0974-2948.50885

4. Synder LM. Homicide investigation. Springfield (IL): Charles C Thomas; 1950. p. 65. Available from: https://ia801503.us.archive.org/4/items/in.ernet.dli.2015.145916/2015.145916.Homicide-Investigation.pdf
5. Caldas IM, Magalhães T, Afonso A. Establishing identity using cheiloscopy and palatoscopy. *Forensic Sci Int*. 2007;165(1):1–9. doi: 10.1016/j.forsciint.2006.04.010.
6. Dineshshankar J, Ganapathi N, Yoithapprubhunath TR, Maheswaran T, Kumar MS, Aravindhan R. Lip prints: Role in forensic odontology. *J Pharm Bioallied Sci*. 2013;5(Suppl 1):S95–S97.
7. Suzuki K, Tsuchihashi Y. *New attempt of personal identification by means of lip print. J Indian Dent Assoc*. 1970;42(1):8–9.
8. Vatchala Rani RM, Jeergal VA, Jeergal PA, Gami KS, Mankar S, Mankar S. Lip Prints and Dermal Prints as a Tool to Detect the Skeletal Malocclusion: A clinical study. *J Pharm Bioallied Sci.* 2022;14(Suppl 1):S888–S892. doi: 10.4103/jpbs.jpbs_89_22.
9. Das V, Pai VS, Krishna S, Gaonkar S, Kalladka G, Rajaram S. Cheiloscopy: An early indicator of Class I and Class II Malocclusion. *RGUHS J Dent Sci.* 2019;11(2):42–48. doi: 10.26715/rjds.11_2_8
10. Riedel RA. The relation of maxillary structures to cranium in malocclusion and in normal occlusion. *Angle Orthod*. 1952;22(3):142–145.
11. IBM Corp. IBM SPSS Statistics for Windows, Version 22.0. Armonk (NY): IBM Corp.; 2013.
12. Altman DG. Practical statistics for medical research. 1st ed. New York: Chapman and Hall/CRC; 1990. doi: https://doi.org/10.1201/9780429258589
13. Thomas CJ, van Wyk CW. The palatal rugae in an identification. *J Forensic Odontostomatol*. 1988;6(1):21–7.
14. Allani S, Setty JV, Srinivasan I, Jawa A, Lalitya D. Determination of relationship between lip prints and skeletal malocclusion in children of age 9–14 years. *Int J Clin Pediatr Dent*. 2019;12(6):494–499. doi: 10.5005/jp-journals-10005-1684.
15. Angle EH. Classification of malocclusion. *Dent Cosmos.* 1899;41:248–64.
16. Sharma P, Saxena S, Rathod V. Cheiloscopy: The study of lip prints in sex identification. *J Forensic Dent Sci*. 2009;1(1):24–27. doi: 10.4103/0974-2948.50884
17. Nayak SC, Mohanty P, Garabadu A, Bai MP, Jena S, Pradhan RK. Skeletal malocclusion and cheiloscopic pattern in Odisha population. *J Chem Health Risks*. 2024;14(1):3034–38.
18. Sapasetty S, Gandikota C. Assessment and correlation of dactyloscopy, cheiloscopy, and rugoscopy among individuals with different skeletal malocclusion: A cross sectional study. *J Indian Orthod Soc*. 2023;57(3):156–170. doi:10.1177/03015742221122628.
19. Raghav P, Kumar N, Shingh S, Ahuja NK, Ghalaut P. Lip prints: the barcode of skeletal malocclusion. *J Forensic Dent Sci.* 2013;5(2):110–7. doi: 10.4103/0975-1475.119777.

Cite this article: Kumar V, Roy AS, Sinha S, Kumari S, Bhagat A, Raj P. Assess the relationship of lip pattern in different types of skeletal malocclusion. *IP Indian J Orthod Dentofacial Res.* 2025;11(3):191–196.