

Sexual Dimorphism in Lip Prints and Inter canine Distance: A Forensic Perspective

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Abstract

Background: Forensic odontology plays a crucial role in identifying unknown remains in mass disaster, criminal deaths, identification of missing persons, and child abuse cases. For person identification, sex of individual is determined first. Techniques in identification procedures, such as lip prints, rugae patterns, and canine odontometrics, can provide comparatively valid

conclusions regarding a person's identification. Teeth are often the most reliable marker mainly mandibular canines which have consistently shown the highest sexual dimorphism. The pattern of wrinkles on the lips has individual characteristics like fingerprints and helps to identify sex of an individual.

Aim and Objectives: The aim of the study was to evaluate the accuracy by which gender can be determined

using mandibular intercanine distance (MICD) and lip print pattern. Also, to compare and correlate these two parameters among males and females.

Materials and Methods: The study comprised of 300 participants (150 males and 150 females) between 18–30 years of age. MICD was measured using a vernier calliper on cast models, while latent lip prints were recorded and visualised using Nile Red. MICD and common lip pattern among two groups (males, females) were assessed.

Results and Observations: There was a statistically significant difference in analysis of MICD and in the different lip print patterns between males and females, but there was no significant correlation between lip print pattern and MICD. MICD was more for males than females. Also, it was observed that most common type of lip print was Type I in females and Type II in males, with Type II being predominant in overall study individuals.

Conclusion: MICD and lip prints can be used for gender determination as independent variables, but there was no statistical correlation between these two parameters.

Keywords: Forensic odontology, latent lip prints, mandibular intercanine distance, odontometrics

Introduction

The Latin term Forensis refers to a forum or court of law, while Odontology denotes the study of teeth.¹ Forensic odontology, a specialized branch of forensic science that plays a pivotal role in human identification, particularly in cases involving unknown remains, mass disasters, bite mark analysis, age estimation, and dental malpractice evaluation.² DNA profiling remains the most definitive and reliable technique for individual identification. Ancillary forensic techniques such as cheiloscropy (lip print analysis), bite mark evaluation, and dental record comparison serve as valuable adjuncts in person identification.³

Sexual dimorphism, defined as phenotypic differences in morphology between males and females, is a critical parameter in forensic odontology. Variations in dental metrics especially intercanine width, serve as discriminative markers in sex determination.⁴ Teeth are often the most reliable markers for identifying individuals, as they develop before the skeletal system matures.⁵ They exhibit remarkable resistance to thermal, mechanical, chemical, and microbial challenges, and reports has been indicating their ability to endure temperatures up to 1600°C. Mandibular canines demonstrate notable sexual dimorphism, minimal exposure to mechanical irritation, abrasion, and periodontal disease, and are typically the last to be extracted.⁶

Lip prints exhibit consistent morphological patterns throughout an individual's lifetime, reflecting unique anatomical characteristics. The wrinkles and grooves present on the vermilion border of the lips form distinctive configurations collectively referred to as lip prints. Cheiloscropy (from the Greek word cheilos, meaning "lip") is a forensic investigation technique that deals with the identification of humans based on lip traces.⁷ The invisible or latent lip prints are considered as an important tool in criminal identification, and are successfully developed for study purposes using various dyes.⁸ The aim of the study is to evaluate the accuracy with which gender can be determined using mandibular intercanine distance (MICD) and cheiloscropy.

Materials & Methodology

The current study was undertaken at Government Dental College and Hospital, Hyderabad, Telangana, where all participants were informed about the methodological framework, and written consent was obtained in accordance with ethical guidelines. Total samples (N) comprised 300 students (150 males and 150 females)

between the age group of 18–30 years. Individuals with apparently normal lips, who had all anterior teeth erupted without any spacing & any inclination, were included in the study.

Mandibular impressions were obtained using alginate impression material, and the corresponding dental casts were fabricated with dental stone. Intercanine distance, defined as the linear measurement between the cusp tips of the right and left mandibular canines, was recorded using a vernier calliper for precision [Figure 1]. Latent lip prints were captured on bond paper by applying gentle pressure following thorough lip cleansing. The resulting patterns were visualised using Nile red staining and subsequently analysed using a magnifying lens [Figure 2]. They were evaluated by 2 independent observers to minimise inter-observer variability.



Figure 1: Mandibular intercanine distance measurement using vernier calliper



Figure 2: Latent lip prints visualized by Nile red

Interpretation

For classification purposes, a 10 mm wide segment from the central region of the lower lip was selected as the study area, given its consistent visibility in lip traces and its frequent occurrence at crime scenes. Lip print patterns were analysed using Tsuchihashi's classification as follows

1. Type I: A clear-cut groove running vertically across the lip
2. Type I': Partial-length groove of Type I
3. Type II: A branched groove
4. Type III: An intersected groove
5. Type IV: A reticular pattern
6. Type V: Other patterns

Results

The data was analysed with SPSS for Windows 25.0 (SPSS, Chicago Inc., Illinois). Statistical evaluation was performed using the Student t-test and Chi-square test. Confidence intervals were set at 95% and values with p-value ≤ 0.05 were interpreted as statistically significant.

The mean \pm standard deviation (SD) of MICD calculated between males and females using student t-test were found to be 29.92 ± 3.527 and 25.94 ± 2.510 , respectively with a significant p-value of 0.001. Males exhibited wider mandibular intercanine arch width compared to females (Table 1).

Analysis of lip print patterns confirmed that no two prints were identical, thereby reinforcing the uniqueness of lip prints. The most predominant pattern observed across the study population was type II seen in 78 (26%) individuals, followed by type 1 pattern in 75 (25%) individuals. Among the female study population, the most common lip print pattern was Type I, observed in 39 cases (52%). In contrast, Type II was predominant in males, seen in 48 cases (61%), with the difference being statistically significant (p value 0.015) as per the chi-

square test (Table 2). Correlation between MICD and lip print patterns for both males & females did not show any statistically significant difference (Table 3).

Table 1: Comparison between Males & Females for Inter canine distance using student t-test

Gender	Mean	SD	Number	t value	p value
Males	29.92	3.527	150	-11.25	0.001
Females	25.94	2.51	150		

'p' value < 0.05 was considered statistically significant

Table 2: Comparison between Males & Females for lip prints using chi-square test

Lip prints	Males N (%)	Females N (%)	Total N (%)	Chi-Square	p value
TYPE I	36 (48.0)	39 (52.0)	75 (25.0)	14.043	0.015339
TYPE I'	12 (30.0)	27 (69.0)	39 (13.0)		
TYPE II	48 (61.5)	30 (38.4)	78 (26.0)		
TYPE III	27 (60.0)	18 (40.0)	45 (15.0)		
TYPE IV	21 (46.6)	24 (53.3)	45 (15.0)		
TYPE V	6 (33.3)	12 (66.6)	18 (6.0)		
TOTAL	150 (50.0)	150 (50.0)	300 (100.0)		

'p' value < 0.05 was considered statistically significant

Table 3: Correlation between lip prints, MICD for both Males & Females

Lip prints	Mean MICD	SD	Total (N)	p value
Type I	27.5	3.368405	75	0.47912
Type I'	29.5	2.081666	39	
Type II	29	3.840573	78	
Type III	28.8	3.970726	45	
Type IV	29.4	3.361547	45	
Type V	31	7.071068	18	

'p' value < 0.05 was considered statistically significant

Discussion

Identification of living or deceased individuals relies on distinctive dental and skeletal traits that show both variation and resilience to external influences. These features serve as a vital resource in forensic investigations due to their uniqueness and durability. The most common role of the forensic dentist is to identify deceased individuals.

Forensic dentistry serves as a critical interface between dental science and legal investigation, contributing significantly to the identification of human remains in both criminal and civil contexts. The use of dental and related orofacial structures in human identification is crucial during mass disasters, criminal deaths, identification of missing persons, and child abuse cases. Canines differ from other teeth with respect to sexual dimorphism and their high level of survival in the dentition. Mandibular canines exhibit reduced

susceptibility to plaque deposition, calculus buildup, and brushing-induced abrasion, while effectively withstanding substantial occlusal forces. Their enhanced resistance to periodontal disease contributes to the extended retention of canines within the oral cavity, often rendering them the last teeth to be lost with advancing age, and considered the “key teeth” for personal identification.^{9,10}

Lip prints are considered to be one of the important tools for personal identification and sex determination, as it has an equal value as the finger prints.¹¹ This study employed cheiloscopy to analyse the diversity of lip print patterns and their utility in distinguishing individuals based on sex. The uniqueness of lip prints arises not only from the anatomical grooves and furrows but also from the way lip muscles relax to form distinct patterns. At crime scenes, lip prints are often encountered and can be readily collected as trace evidence. The presence of minor salivary glands and sebaceous glands at the vermilion borders and edges of the lip, along with hair follicles and sweat glands in between, which secrete oils and moisture, leading to formation of latent lip prints. They can be developed using various enhancement techniques, such as aluminium powder, Sudan Black, or Nile Red, to render the patterns clearly. These features collectively reinforce the role of lip prints in forensic investigations, both for personal identification and sex determination.¹²

The age range of the participants in this study was restricted to 18–30 years to minimise the potential influence of age-related changes in facial musculature on lip print patterns. This age group represents a period of relative stability in facial musculature and skin elasticity, which reduces the likelihood of variability in lip print clarity and patterns due to age-related factors.⁹

The MICD is more common in males than in females, which is similar to studies conducted by Krishnan RP et al 2024, Singh S et al 2021, and Adamek A et al 2012.^{13,14,15} This difference is primarily due to larger alveolar processes, more prominent bony ridges, and greater average musculature strength in males. Additionally, increased arch dimensions in men could contribute to the higher MICD noted in male subjects. Its value is also strongly affected by gender, ethnicity, and the individual dental arch shape. Canines are set differently in an ovoid arch (the widest between the cuspids), in a square arch or in one that tapers and is narrow between the canines.

The most predominant lip print pattern in the overall study group was type II, similar to Sarkar D et al 2025.¹¹ In this study, it was found that type I was the most common lip print pattern among female group and in males it was type II, these features are similar to study conducted by Mahajan B et al 2022, Singh J et al 2012.^{9,16} However, in their research found type III pattern to be dominant in males and type I’ pattern to be dominant in females with slight deviation from our study.

Similar to our findings, Mahajan B et al 2022, and Bai JS et al 2018 also observed that lip prints and MICD had their unique criteria, but the correlation between these two parameters are not showing statistically significant difference.^{6,9}

Conclusion

The present study showed that MICD and lip prints can be utilised as independent variables for gender determination, but no statistical difference was observed between the two parameters. Studying on a larger sample and establishing supplementary pattern characteristics will facilitate population subtyping & can be used in criminal scene analysis and human identification.

Abbreviations

Mandibular Intercanine Distance (MICD), Standard Deviation (SD).

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