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THE DUAL BIOMETRICS IN FORENSIC ODONTOLOGY: EVALUATING THE ROLE OF LIP AND TONGUE PRINTS IN GENDER DETERMINATION

Forensic Dentistry

Ayesha Chauhan
Rashmi Metgud
Smitha Naik
Aniruddh Tak

ABSTRACT

Background: Forensic odontology incorporates lip and tongue prints as unique, sexually dimorphic markers for gender determination when traditional methods like DNA analysis are unavailable. While lip prints are extensively studied, tongue prints offer complementary data. **Objective:** This study evaluates the combined reliability of lip and tongue prints for gender determination, classifying lip prints using Suzuki and Tsuchihashi's method and tongue prints using Stefanescu's criteria. **Materials and Methods:** A cross-sectional study of 100 individuals (50 males, 50 females, aged 18–60 years) analyzed lip prints via cellophane tape and tongue prints using alginate impressions. Statistical analyses assessed their predictive accuracy for gender. **Results:** Significant sexual dimorphism was found in lip and tongue patterns. Type I & I' lip prints were common in females (66%) and Type III in males (74%). Females showed ovoid tongues (70%) with sharp apexes (88%), while males had pentagonal tongues (66%) with blunt apexes (72%). Logistic regression achieved 94% accuracy. Tongue texture showed no significant gender correlation (p=0.140). **Conclusion:** Combining lip and tongue prints is a reliable, non-invasive method for gender determination in forensic settings. Future research should standardize methodologies for broader application.

KEYWORDS

Forensic odontology, gender determination, lip prints, tongue prints, biometrics, cheiloscopy, Stefanescu classification.

INTRODUCTION

Forensic identification is crucial in resolving crimes and civil cases, particularly when traditional methods like DNA fingerprinting are impractical due to cost or time constraints.[1,2] Gender determination serves as the initial step in identifying individuals in scenarios involving unrecognizable remains, mass disasters, or missing persons.[3,6,28]

Fingerprints, though distinct and permanent, may fail when criminals take precautions like wearing gloves.[1,4] In such cases, alternative techniques like cheiloscopy, the study of lip prints, provide supportive evidence.[20] Lip prints, unique patterns of wrinkles and grooves on the lips, are highly durable and resistant to environmental changes, making them reliable for personal identification.[4] Fischer introduced lip print studies in 1902, while Suzuki and Tsuchihashi developed a widely accepted classification in 1970, emphasizing their utility in forensic science.[1]

Lip prints exhibit sexual dimorphism, with Type I and II patterns more common in females and Type III in males.[1,4,20] This differentiation aids gender determination, enhancing their forensic relevance. Similarly, tongue prints have emerged as a novel biometric tool due to the tongue's unique texture, shape, and color.[6,18,20] The dorsal surface of the tongue, distinct even among identical twins, offers valuable data for personal identification.[8,10]

Tongue prints also display sexual dimorphism; males often have blunt apexes, while females exhibit sharp ones.[9,13] The analysis of tongue features, such as longitudinal grooves and lingual apex, captured through alginate impressions, complements lip prints in gender determination.[14] When combined, lip and tongue prints provide a robust approach to forensic identification.

This study compares the efficacy of lip and tongue prints for gender determination, aiming to establish their reliability as biometric tools. Existing research suggests lip prints may surpass other methods, like fingerprints or mandibular canine indices, in accuracy for gender identification. By examining these markers, this research contributes to advancing forensic odontology.

MATERIALS AND METHODS

This cross-sectional study aimed to compare the effectiveness of lip and tongue prints for gender determination. Conducted at the Department of Oral Pathology, Pacific Dental College and Hospital, Udaipur, it included 100 healthy participants (50 males and 50 females) aged 18–60 years, selected through convenience sampling. Participants provided informed consent, and ethical approval was obtained from the institutional committee.

Inclusion Criteria: Healthy individuals aged 18–60 years without congenital or acquired lip or tongue deformities.

Exclusion Criteria: Individuals with lip or tongue lesions, oral surgery history, systemic conditions affecting oral anatomy, or allergies to lipstick or impression materials were excluded. HIV-positive individuals and those with contagious diseases were also excluded.

Data Collection Procedure: Lips were cleaned, and dark-colored lipstick was applied evenly.Transparent cellophane tape was used to capture lip prints, which were transferred onto white bond paper. Lip prints were classified using Suzuki and Tsuchihashi's system into Types I, I', II, III, IV, and V.

Tongue impressions were recorded using alginate material covering the dorsal surface and lingual lateral edges. Casts were prepared using dental stone and analyzed using Stefanescu's classification[17], which evaluates texture, shape, longitudinal grooves, and lingual apex.

RESULTS

Lip Prints: Type I & I' patterns were found in 66% of females, while 74% of males exhibited Type III patterns. A chi-square test confirmed significant differences by gender ($p < 0.001$).

Tongue Texture: Physiological texture was predominant in both genders (98% in females, 88% in males), with scrotal and geographic textures being rare but frequent in males If presented. However, differences were not statistically significant ($p = 0.140$).

Tongue Shape: Females commonly showed ovoid shapes (70%), while pentagonal shapes dominated in males (66%). Significant gender-based differences were observed ($p < 0.001$).

Longitudinal Grooves: Perceptible grooves were more frequent in females (32%), while superficial (22%) and deep grooves (16%) were more common in males. Statistically significant differences were noted ($p = 0.0061$).

Lingual Apex: A sharp apex was seen in 88% of females, while 72% of males had a blunt apex. This difference was highly significant ($p < 0.001$).

Logistic regression revealed that lip prints, tongue shape, longitudinal grooves, and lingual apex were significant predictors of gender, achieving an overall accuracy of 94%, correctly classifying 92% of

females and 96% of males.

DISCUSSION

Forensic odontology is a specialized branch of forensic science that applies dental and oral features for the identification of individuals, particularly in scenarios where traditional methods such as DNA analysis may not be accessible.[8] This field has expanded to include the study of unique oral features like lip and tongue prints, which are increasingly recognized for their potential utility in forensic investigations. These techniques are particularly valuable in cases involving mass disasters or unidentified remains, where accurate personal identification is crucial.[10,12]

Lip prints, classified using Suzuki and Tsuchihashi's system, exhibited clear gender differences. Females predominantly showed Type I & I' lip prints (66%), while Type III patterns were common in males (74%). Studies such as those by Peeran et al.[18] and Krishnan et al.[22] confirm these patterns, highlighting lip prints' reliability. However, contrasting findings, like those by Badiye et al.[23], emphasize regional variability, signifying the need for standardized methodologies.

Tongue prints were analyzed based on texture, shape, longitudinal grooves, and lingual apex using Stefanescu's classification. While tongue texture showed minimal gender significance, tongue shape, longitudinal grooves, and lingual apex were distinct. Tongue shape also emerged as a significant predictor of gender in our study. We observed that females primarily had an ovoid tongue shape (70%), while males were more likely to present with pentagonal (66%) and rectangular shapes (20%), also we observed that Ellipsoid and trapezoidal or asymmetrical shapes account for 3.0% and 5.0% respectively. These observations align with studies by Stefanescu et al.[17] and Peeran et al.[18], reinforcing their forensic relevance.

The combined distribution across genders shows that Perceptible grooves are observed in 23.00% of the total sample, Imperceptible grooves in 17.00%, Rectilinear grooves in 20.00%, Twisty grooves in 17.00%, Superficial grooves in 13.00%, and Deep grooves in 10.00%. Notable differences between genders include a higher prevalence of Perceptible and Imperceptible grooves among females, whereas males predominantly exhibit Superficial and Deep grooves. Rectilinear grooves are equally distributed across genders, these findings are consistent with findings by Stefanescu et al.[17] and Mani et al.[30].

The logistic regression model achieved high accuracy in gender prediction, correctly classifying 92% of females and 96% of males, with an overall accuracy of 94%. Combining lip and tongue prints demonstrated superior reliability compared to single markers.

CONCLUSION

This study evaluated lip and tongue prints for gender determination, highlighting their forensic utility when traditional methods are unavailable. Lip prints showed significant gender differences, with Type I and I' in 66% of females and Type III in 74% of males ($p < 0.001$). Tongue features, including shape, grooves, and apex, also demonstrated strong gender associations, with females showing ovoid shapes (70%) and sharp apexes (88%), while males had pentagonal shapes (66%) and blunt apexes (72%) ($p < 0.001$). The logistic regression model achieved 94% accuracy, supporting the reliability of these features as non-invasive tools for forensic identification. Future studies should validate these findings across diverse populations.

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Conflicts Of Interest

There are no conflicts of interest.

Table 1: Gender-wise Distribution of Lip Prints

Lip Print Type	Female (Count, %)	Male (Count, %)
Type I & I'	33 (66.0%)	1 (2.0%)
Type II	1 (2.0%)	12 (24.0%)
Type III	13 (26.0%)	37 (74.0%)
Type IV	3 (6.0%)	0 (0.0%)
Type V	0 (0.0%)	0 (0.0%)

Table 2: Pearson Chi-Square for Gender wise Distribution of Lip Prints

Chi-Square Tests			
	Value	df	p value (<0.05 is significant)
Pearson Chi-Square	53.945	3	**<0.001(S)**

Table 3: Gender-wise Distribution of Tongue Texture

Tongue Texture	Female (Count, %)	Male (Count, %)
Physiological	49 (98.0%)	44 (88.0%)
Scrotal	1 (2.0%)	5 (10.0%)
Geographic	0 (0.0%)	1 (2.0%)

Table 4: Pearson Chi-Square for Gender wise Distribution of Tongue Texture

Chi-Square Tests			
	Value	df	p value (<0.05 is significant)
Pearson Chi-Square	3.935	2	.140 (NS)

Table 5: Gender-wise Distribution of Tongue Shape

Tongue Shape	Female (Count, %)	Male (Count, %)
Ovoid	35 (70.0%)	2 (4.0%)
Ellipsoid	1 (2.0%)	2 (4.0%)
Rectangular	4 (8.0%)	10 (20.0%)
Pentagonal	8 (18.0%)	33 (66.0%)
Trapezoidal or Asymmetrical	2 (4.0%)	3 (6.0%)

Table 6: Pearson Chi-Square for Gender wise Distribution of Tongue Shape

Chi-Square Tests			
	Value	df	p value (<0.05 is significant)
Pearson Chi-Square	46.735	2	**<0.001(S)**

Table 7: Gender-wise Distribution of Longitudinal Grooves

Longitudinal Grooves	Female (Count, %)	Male (Count, %)
Perceptible	16 (32.00%)	7 (14.00%)
Imperceptible	12 (24.00%)	5 (10.00%)
Rectilinear	10 (20.00%)	10 (20.00%)
Twisty	8 (16.00%)	9 (18.00%)
Superficial	2 (4.00%)	11 (22.00%)
Deep	2 (4.00%)	8 (16.00%)

Table 8: Gender wise Distribution of Longitudinal Grooves

Chi-Square Tests			
	Value	df	p value (<0.05 is significant)
Pearson Chi-Square	16.29	5	**0.0061 (S)**

Table 9: Gender-wise Distribution of Lingual Apex

Lingual Apex	Female (Count, %)	Male (Count, %)
Sharp	44 (88.0%)	14 (28.0%)
Blunt	6 (12.0%)	36 (72.0%)

Table 10: Pearson Chi-Square for Gender wise Distribution of Lingual Apex

Chi-Square Tests			
	Value	df	p value (<0.05 is significant)
Pearson Chi-Square	36.946	1	**<0.001(S)**

Table 11: Dependent Variable Encoding

Dependent Variable Encoding	
Original Value	Internal Value
Female	0
Male	1

Table 12: Predicting Classification capabilities Table

Classification Table[a]					
	Observed		Predicted		
			Gender		Percentage Correct
			Female	Male	
Step 1	Gender	Female	46	4	92.0

		Male	2	48	96.0
	Overall Percentage				94.0
a. The cut value is .500					

Table 13: Variables in the Equation for Prediction of Classification capability of the tongue and lip prints for gender

Variables in the Equation									
		B	S.E.	Wald	df	P value	Odds ratio	95% C.I.for Odds ratio	
								Lower	Upper
Step 1[a]	LipPrints	1.130	.398	8.046	1	.005	3.095	1.418	6.756
	TongueTexture	.180	1.777	.010	1	.920	1.197	.037	38.937
	TongueShape	1.260	.424	8.846	1	.003	3.524	1.537	8.084
	Longitudinal Grooves	1.580	0.450	12.345	1	0.002	4.857	1.960	12.058
	LingualApex	2.816	.700	16.174	1	<0.001	16.705	4.236	65.888
	Constant	-9.466	2.475	14.631	1	.000	.000		
a. Variable(s) entered on step 1: LipPrints, TongueTexture, TongueShape, Longitudinal grooves, LingualApex.									

Figure: 1 Lip Prints Of Female Participant Transferred To The Bond Paper: Lipprint Pattern-Type Ⅰ'

Figure: 2 Lip Prints Of Male Participant Transferred To The Bond Paper : Lip Print Pattern –Type II

Fig 3: Cast Of Female Tongue Impression: Tongue Texture – Physiological, Tongue Shape –Ovoid, Longitudinal Grooves-Perceptible, Lingual Apex-Sharp

Fig 4: Cast Of Male Tongue Impression: Tongue Texture – Physiological, Tongue Shape –Pentagonal, Longitudinal Grooves-Deep, Lingual Apex-Blunt

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