

Tongue prints: a novel tool for sex determination - A preliminary study using digital photography

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ABSTRACT

Introduction: Tongue print is an emerging biometric tool, which is gaining focus in recent years. The morphological features of the tongue differ from one person to another, and it can be used as a tool for personal identification. This study aimed to identify the morphological differences in the tongue between males and females and to assess the use of these features in sex determination.

Materials and Methods: A cross-sectional study was conducted in the Central Kerala population with a sample size of 260, including 130 males and females each, of 21-30 years age. Both visual examination and digital photography were made to identify the morphological features of the tongue. Statistical analysis was done and a p-value less than 0.05 was taken as statistically significant.

Results: We observed significant differences between males and females for features like 'border of the tongue' and 'fissure patterns'.

Conclusion: Border of tongue and fissure patterns of tongue exhibited considerable difference between males and females in Central Kerala population, however, a multi-center study will be more effective in developing a clear-cut idea about the tongue print patterns in this population. It will further help in the development of a database of tongue prints which is currently unavailable in India.

Keywords: Biometric tool, Forensic, Tongue print

INTRODUCTION

A biometric system identifies a person in real-time by analyzing a specific physical or behavioural characteristic and comparing it to a database of features shared by various individuals. The information on the dorsum of the tongue, such as shape and texture, is characterised as the tongue print, an emerging biometric tool. According to various studies worldwide, these morphological features differ from one person to another, so they can be utilized as a forensic tool for personal identification¹.

Identification of the morphological differences in tongue print between males and females will help in the development of a database that can be used as a biometric system along with other systems like cheiloscopy. Tongue verification protects the privacy of users better than other biometrics as it cannot be reverse-engineered. Hence new advancements and research on the potential of tongue prints as a forensic tool are warranted. In India, the use of tongue print as a forensic tool is in its early stage of development².

The tongue is a musculoskeletal organ with a mucous membrane covering it. It is the only internal organ that can be freely exposed for inspection. The shape, length, and width of the tongue, the distribution of papilla on the dorsal surface, and the characteristics of tongue fissures, such

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How to cite the article: Sabu Paul, Rasla P C, Latha Mary Cherian, Sudharani, Bhagya J. Tongue prints: a novel tool for gender determination – a preliminary study using digital photography. *Oral Maxillofac Pathol J* 2024; 15(2);173-176.

Source of Support: Nil

Conflict of Interest: None

as presence, location, width, and depth, can all be used to study the features of the tongue. Visual evaluation of the morphological characteristics of the tongue is a simple and affordable procedure³. Based on this, we conducted a cross-sectional study to distinguish the morphological differences of tongue between males and females as well as to assess the use of these morphological features of the tongue in sex determination.

MATERIALS AND METHOD

The study was conducted in tertiary health care centre to identify the morphological variations of the tongue

between males and females of the Central Kerala population and to estimate the use of morphological features of the tongue in sex determination. The study population consisted of 260 healthy individuals consisting of 130 males and 130 females of age between 21 to 30 years. All the participants were systemically and emotionally healthy. Systemic diseases, acquired or developmental tongue issues, and tobacco chewing and smoking habits were eliminated from participation. All the participants were asked to rinse their mouths with water prior to the examination. After Visual examination, digital photographs were taken with Cannon 1300D camera, and the morphological variations are studied by two observers. The distance between the patient and the camera was kept at roughly 20 cm for taking photographs. Three reference points were considered to assess the shape, including the tip of the tongue (one point) and the points where the tongue contacts the commissures of the lip (two points) on the maximum protrusion. Shape, fissure pattern, surface texture, and borders are categorized as follows, based on the study of Sreepadha et al⁴:

- Shape of the tongue - U, V, and bifid
- Fissures on the tongue- Present / Absent (If present, central, vertical, multiple vertical, horizontal, and multiple horizontal).
- Surface texture- smooth or papillated
- Borders of the tongue - scalloped, partially scalloped (based on the presence of tooth indentation along the lateral border of tongue, among dentulous and partially edentulous participants)

Table 1: Percentage distribution of morphological characteristics of the tongue between males and females

Morphologic characteristics	Males (130)	Females (130)	P Value
Shape			
U Shape	72	72	0.075
V Shape	25	23	
Bifid tongue	3	5	
Border of tongue			
Smooth	72	57	0.020*
Scalloped	28	43	
Surface texture			
Smooth	57	55	0.500
Papillated	52	45	
Geographic tongue	0.01	0	
Fissure patterns			
Without any fissure	25	37	0.003*
Single vertical	45	23	
Multiple vertical	15	20	
Multiple horizontal	15	20	

*pvalue <0.05 significant

A descriptive statistical analysis was conducted with IBM SPSS statistics version 25, and the Chi-square test was used to compare the groups. A p-value less than 0.05 was considered significant.

Ethical Clearance for the study was obtained from the Institutional Ethical Committee (IEC/M/24/2022/06/DCK.)

RESULTS

The study cohort of 130 males and 130 females was examined clinically. Percentage distribution of each morphological feature is given in Table 1.

'U' shape of the tongue was common among males and females (72% each for males and females), followed by the 'V' shape (25% in males and 23% in females). The bifid tongue was noted in a very small percentage of individuals (4% in males and 7% in females). Chi-square test revealed a non significant association between sex and shape with a p-value of 0.075 (Figure 1). While considering the borders of the tongue, 72% of males and 57% of females were presented with smooth borders whereas 37% of males and 43% of females were presented with scalloped borders. It was statistically significant with a p-value of 0.020 (Figure 2).

Different surface textures considered were papillated, smooth, and geographic tongue. Smooth surfaces were the most common feature among both males and females (57% in males and 55% in females), followed by papillated surfaces (42% males and 45% females). Only one individual in our study population presented with a geographic tongue. Association between surface texture and sex was found to be non significant (Figure 3)

Based on the patterns, fissures on the dorsum of the tongue were divided into single vertical, multiple vertical, multiple horizontal, and those without any fissures. Among males, 25% were without any fissures, 43% had single vertical fissure, 15% had multiple vertical fissures and multiple horizontal fissures each. Similarly, among females, 37% were without any fissures, 23% with single vertical and 20% each with multiple vertical and multiple horizontal fissures. We observed a statistically significant relationship between fissure patterns and sex (p value 0.003) (Figure 4).

DISCUSSION

Biometric technologies are automated processes to validate or identify a living individual based on a physiological or behavioral characteristic. Amelography, Rugoscopy, Dental radiographs, and Cheiloscropy are different biometric tools used in forensic odontology. Tongue print is a novel forensic tool in which the surface characteristics of the tongue are used to identify a person². The analysis of the tongue's shape, texture, and color reveals visible differences between individuals, thereby making it a useful tool in personal identification. It conveys a lot of information regarding the health status of an individual. The change in size, shape or presence of tongue injuries that occur during suicidal or homicidal cases can aid forensic investigators to determine the cause or manner of death⁵.

Tongue prints can be collected using various techniques, including visual inspection, digital photography, alginate



impression, and three-dimensional analysis. The first imaging system for obtaining tongue prints was proposed by Liu et al. ten years ago⁶. Since then, various researchers have developed alternative imaging methods. The most reliable study to date is one by Diwakar who developed a system for obtaining tongue prints with a shape recognition feature and recognition of papillary distribution⁷. Johnson et al used alginate impression to record the tongue prints⁸. Similarly, Jeddy et al conducted a study to evaluate the common morphological features of the tongue and its variations in males and females using digital photography and alginate impression⁹. We used digital photography to identify the morphological features of individuals as it is a simple and economic method.

The tongue has a consistent geometric contour. Despite the tongue's coating changing, the physiological surface texture does not alter much². Although the 'U' shape appeared to be the most prevalent among both males and females, this finding was statistically insignificant. Similar outcomes were seen in a number of additional studies^{9,10}. Jayan et al conducted a study on the morphological variations of the tongue among

the Tamil population and found that the 'U' shape was a common characteristic in both males and females¹⁰. In contrast to this, Madhusudan et al found 'V' shape tongue as the most predominant, but it was statistically non-significant¹¹. No comparison was possible with the study of Stefanescu et al., who classified the tongue shapes as ovoid, ellipsoid, rectangular, pentagonal, trapezoidal to asymmetrical¹².

Geographic tongue is a benign condition characterized by its changing pattern. Familial and hereditary factors play a role in the pathogenesis. Redman et al. showed a significantly increased prevalence of geographic tongue in parents and siblings. They proposed a polygenetic inheritance model¹³. In a study with 270 subjects, Stefanescu et al observed geographical tongue in 0.3% of individuals with a female predilection¹². In our study only one male patient presented with a geographic tongue whereas no geographic tongue were observed by Jeddy et al⁹.

The main morphological feature present in the dorsum of the tongue was the presence of fissures. Various studies reported that central fissures in the central region of the tongue

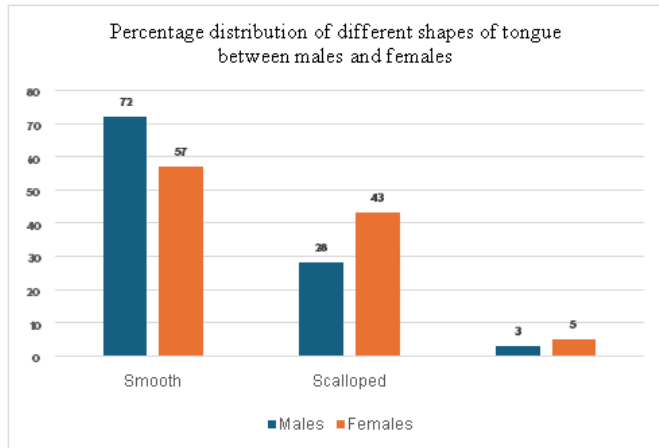


Fig. 1: Graphical presentation of 'Shape of the tongue' between males and females

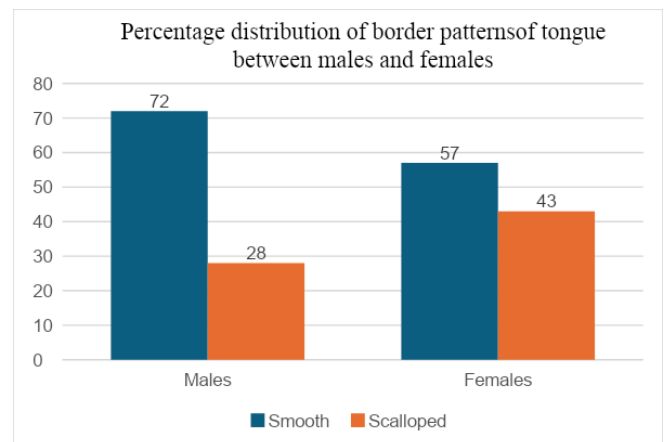


Fig. 2: Graphical presentation of Border patterns between males and females

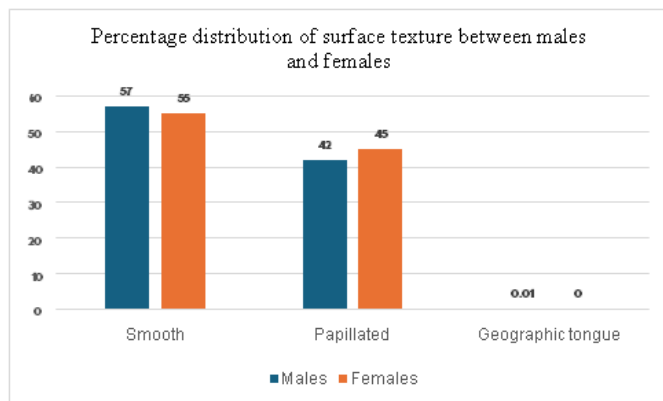


Fig. 3: Graphical presentation of 'Surface texture' between males and females

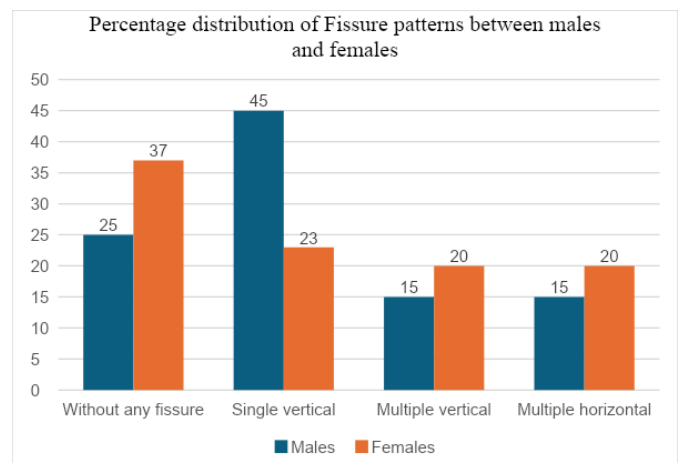


Fig. 4: Graphical presentation of 'Fissure patterns' between males and females

were predominant^{9,10,12}. The present study revealed a single vertical fissure as the most significant fissure pattern among males and the absence of any fissure is significant among females. Indentations of lateral border of the tongue were absent in the study populations of Jeddy et al⁹, whereas it was observed in 5 subjects by Madhusudan et al¹¹. We observed a larger population with a scalloped lateral border. Contrary to our findings, Madhusudan et al. recognized the rough surface texture as being more prevalent than the smooth surface¹¹.

Different studies revealed variable differences in the morphological features of the tongue between different populations^{8,9,10}. We observed a significant association of fissure patterns and the border patterns of the tongue with sex. A multicentre study with a large population will give a clear idea about the tongue print patterns of this population.

CONCLUSION

In India, tongue print as a biometric tool is in its early stages of development. It points towards the necessity of newer research and advancements in the field of tongue print. The development of artificial intelligence-based systems and building a nationwide database based on tongue prints, both currently unavailable in India, are promising.

REFERENCES

1. Nimbalkar G, Patil R, Nathani S, Salve S, Chhabra KG, Reche SD. Tongue prints: A forensic review. *Indian Journal of Forensic Medicine & Toxicology*. 2020 Oct 29;14(4):6802-6.
2. Kaul B, Vaid V, Gupta S, Kaul S. Forensic odontological parameters as biometric tool: A review. *International Journal of Clinical Pediatric Dentistry*. 2021 May;14(3):416.
3. Radhika T, Jeddy N, Nithya S. Tongue prints: A novel biometric and potential forensic tool. *Journal of forensic dental sciences*. 2016 Sep;8(3):117.
4. Sreepradha C, Vaishali MR, David MP. Tongue replica for personal identification: A digital photographic study. *Journal of Indian Academy of Oral Medicine and Radiology*. 2019 Jan 1;31(1):57-61.
5. Anastasi JK, Currie LM, Kim GH. Understanding diagnostic reasoning in TCM practice: Tongue diagnosis. *Altern Ther Health Med* 2009;15:18-28
6. Liu ZH, Yan J, Zhang D, Tang Q. A Tongue-print Image Database for Recognition. 2007. p. 19-22.
7. Diwakar M. An extraction and recognition of tongueprint images for biometrics authentication system. *International Journal of Computer Applications* 2013;61:36-42
8. Johnson A, Gandhi B, Joseph SE. A morphological study of tongue and its role in forensics odontology. *J Forensic Sci & Criminal Inves*. 2018;7(5):1-5.
9. Jeddy N, Radhika T, Nithya S. Tongue prints in biometric authentication: A pilot study. *Journal of oral and maxillofacial pathology: JOMFP*. 2017 Jan;21(1):176.
10. Jayan L, Bharanidharan R, Ramya R, Priyadharsini N, Kumar AR. Tongue morphometry: Evaluation of morphological variations in ethnic Tamil population. *SRM Journal of Research in Dental Sciences*. 2019 Jul 1;10(3):139.
11. Madhusudan A, Shipra S, Gaurav S, Ashutosh A, Aditi M. Lingual morphology: A secure method for forensic identification. *J Forensic Sci & Criminal Inves*. 2018;9(2):555758.
12. Stefanescu CL, Popa MF, Candea LS. Preliminary study on the tongue-based forensic identification. *Rom J Leg Med*. 2014 Dec 1;22(2):263-6.
13. Redman RS, Shapiro BL, Gorlin RJ. Hereditary component in the etiology of benign migratory glossitis. *Am J Hum Genet*. 1972 Mar;24(2):124-33

