Original Research Article

Role of tongue in Biometric Authentication: A Digital Pictorial Study

ABSTRACT-

Background: *Biometric Authentication by the application of dental findings has gained a lot of popularity in the last few years and has set out as an important adjunct in identification of an individual. Forensic odontology uses various tools such as bite marks, cheiloscopy, rugoscopy, DNA analysis, and many other tools for identification of an individual. In forensic odontology one of the most recently developed methods for biometric authentication is tongue print which has been used in our study for human identification.*

Aim: *To establish human tongue print as a tool for Biometric Authentication*

Study design: *A study was conducted in the Department of Oral Medicine and Radiology in Manav Rachna Dental College from May-August in the year 2022.*

Methodology: *In the study 200 participants of an age group of 10 to 65 years were made to participate. Examination of the tongue was done prior to sample collection followed by protraction of the tongue for digital photography.*

Result: *The Study was designed to use tongue prints as a tool for biometric authentication. The human tongue was studied for its shape, color and texture according to different sex and age group. Statistically significant results were obtained in relation of age with color (p value=0.00) and relation of gender with texture (p value=0.026) and statistically non-significant result was obtained in other scenarios.*

Conclusion: *The dorsal surface of the tongue is unique in each individual when it comes to its shape, texture, color and hence it can be used as a stable and difficult to forge source of evidence that can be used for biometric authentication.*

KEY WORDS-

Biometric authentication, tongue print, morphological characteristic of tongue, tongue print analysis

INTRODUCTION-

Biometrics is a term that is procured from the Greek word bio and matric which means life and measure respectively [1]. It is the measurement and analysis of people's unique physical and behavioral characteristics which helps to differentiate one individual from the other.

In biometric authentication numerous methods such as face scan, iris scan, fingerprint scan, voice scan were used traditionally but each of these methods had its own curbs [2]. Hence, to overcome these restrictions new methods of biometric authentications are being found out and one of those include the use of tongue print for identification of the individual.

In traditional Chinese medicine the human tongue was considered mirror of not only the oral health but also the general health of an individual [3]. Liu et al. in the year 2007 conducted a research on tongue print recognition system after which new researches were conducted to use tongue for biometric authentication [4].

Tongue is a vital organ well encased in the oral cavity protected from the external environment [5]. Also, the use of tongue for biometric authentication is economical, a stable source of evidence (difficult to alter or destroy), and the process of sample collection is easy (as tongue can be easily protruded for sample collection) which makes the method one of the most recommended methods of biometric authentication.

With this introduction a study was outlined and conducted to investigate the desired aim and objective of the study.

METHODOLOGY-

Aim: *To establish human tongue print as a tool for Biometric Authentication*

Objective:

a) *To study the shape, color, texture of the tongue in different age groups.*

b) *To study the shape, color, texture of the tongue in males and females.*

Setting of the study: *The study was conducted in The Department of Oral Medicine and Radiology, Manav Rachna Dental College, Faridabad, Haryana.*

Sample Size: *A total of 200 participants were engaged in the study.*

Inclusion Criteria: *A total of 200 healthy male and female subjects from the age group of 10 to 65 years of age were enrolled in the study.*

Exclusion Criteria: *Any subject with pre-existing systemic illness or any form of tongue disorder.*

Method of Sample collection: *The participant was asked to rinse the mouth properly before the examination. The tongue was then examined for any abnormality after which the participant was asked to protract the tongue to its maximum protraction but in a position where the lingual muscles are in a relaxed position as excessive amount of protraction can cause error in recording the shape of the tongue.*

This process was then followed by digital photography of the tongue in natural light using a One Plus mobile camera of 8 megapixels to evaluate the tongue for its shape (shown in figure 1), texture, color.

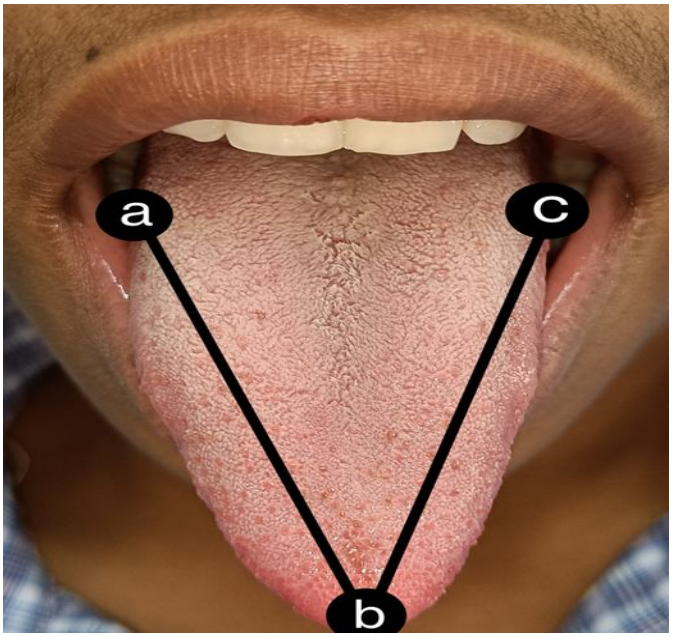

Figure 1: Reference point to determine shape of tongue.

RESULT-

The study was designed to demonstrate the use of tongue print as a tool for personal identification in which both male and female individuals from the age group of 10 years to 85 years participated.

In this study different morphological characteristics such as shape, color, and texture of the tongue were used for identification of the individual.

The tables given below showcases the results obtained from the study-

1) Relation of age with shape

Variable	*10-20 years*	*21-30 years*	*31-40 years*	*41-50 years*	*51-60 years*	*>61years*	*p-value*
Square	*6 (6.6%)*	*5(11.6%)*	*5 (16.7%)*	*5(25%)*	*0(0%)*	*0(0%)*	

Rectangle	*17(18.7%)*	*7(16.3%)*	*4(13.3%)*	*3(15%)*	*4(36.4%)*	*2(50%)*	
Acute Triangle	*21(23.1%)*	*12(27.3%)*	*8(26.7%)*	*7(35%)*	*3(27.3%)*	*1(25%)*	
Obtuse Triangle	*5(5.5%)*	*8(18.6%)*	*2(6.7%)*	*2(10%)*	*1(9.1%)*	*0(0%)*	
Circle	*39(42.9%)*	*12(27.9%)*	*10(33.3%)*	*3(15%)*	*2(18.2%)*	*1(25%)*	*0.249, NS*
Any other shape	*3(3.3%)*	*0(0%)*	*1(3.3%)*	*0(0%)*	*1(9.1%)*	*0(0%)*	

Table1: Relation of age with shape

The above mentioned table no 1 depicts the relationship between different age groups with tongue shapes. On comparison statistically a non -significant result was obtained (p value- 0.249).

2) Relation of gender with shape

Variable	*Male*	*Female*	*p-value*
Square	*8 (4%)*	*13(6.5%)*	
Rectangle	*15(7.5%)*	*22(11%)*	
Acute Triangle	*22(11%)*	*30(15%)*	
Obtuse Triangle	*3(1.5%)*	*15(7.5%)*	*0.244,NS*
Circle	*32(16%)*	*35(17.5%)*	
Any other shape	*1(0.5%)*	*4(2%)*	

Table 2: Relation of gender with shape

The above mentioned table no 2 depicts the relationship between males and females with different shapes of the tongue. On comparison of different shapes of tongue to male and females a statistically non- significant result was obtained (p value – 0.244).

3) Relation of age with color

Variable	*10-20 years*	*21-30 years*	*31-40 years*	*41-50 years*	*51-60 years*	*>61years*	*p-value*
Crimson	*1 (1.1%)*	*0(0%)*	*0(0%)*	*0(0%)*	*0(0%)*	*0(0%)*	*0.000,S*
Pale	*29(31.9%)*	*26(59.1%)*	*14(46.7%)*	*14(70%)*	*7(63.6%)*	*1(25%)*	
Red	*2(2.2%)*	*0(0%)*	*5(16.7%)*	*1(5%)*	*0(0%)*	*2(50%)*	
Light Red	*59(64.8%)*	*18(40.9%)*	*11(36.7%)*	*5(25%)*	*2(18.2%)*	*1(25%)*	
Purplish	*0(0%)*	*0(0%)*	*0(0%)*	*0(0%)*	*2(18.2%)*	*0(0%)*	

Table 3: Relation of age with color

The above mentioned table no 3 depicts the relationship between different age groups with the color of the tongue. On comparison of different colors to different age groups a statistically significant result was obtained (p value -0.000).

4) Relation of gender with color

Variable	*Male*	*Female*	*p-value*
Crimson	*0 (0%)*	*1(0.5%)*	*0.164,NS*
Pale	*39(19.5%)*	*52(26%)*	
Red	*7(3.5%)*	*3(1.5%)*	
Light Red	*35(17.5%)*	*61(30.5%)*	

Purplish	*0(0%)*	*2(1%)*	

Table 4: Relation of gender with color

The above mentioned table no 4 depicts the relationship between males and females with the color of the tongue. On comparison of different colors to male and females a statistically non -significant result was obtained (p value- 0.164).

5) Relation of age with Texture

Variable	*10-20 years*	*21-30 years*	*31-40 years*	*41-50 years*	*51-60 years*	*>61years*	*p-value*
Physiological Tongue	*33 (16.5%)*	*21(10.5%)*	*11(5.5%)*	*8(4%)*	*1(0.5%)*	*1(0.5%)*	
Scrotal Tongue	*21(10.5%)*	*6(3%)*	*8(4%)*	*7(3.5%)*	*4(2%)*	*2(1%)*	*0.376,NS*
Geographic Tongue	*0(0%)*	*0(0%)*	*0(0%)*	*0(0%)*	*0(0%)*	*0(0%)*	
Any other	*37(18.5%)*	*17(8.5%)*	*11(5.5%)*	*5(2.5%)*	*6(3%)*	*1(0.5%)*	

Table 5: Relation of age with Texture

The above mentioned table no 5 depicts the relationship between different age groups with the texture of the tongue. On comparison of different texture of the tongue to different age groups a statistically non-significant result was obtained (p value – 0.376).

6) Relation of gender with Texture

Variable	*Male*	*Female*	*p-value*
Physiological Tongue	*24 (12%)*	*51(25.5%)*	
Scrotal Tongue	*27(13.5%)*	*21(10.5%)*	*0.026,S*
Geographic Tongue	*0(0%)*	*0(0%)*	
Any other	*30(15%)*	*47(23.5%)*	

Table 6: Relation of gender with Texture

The above mentioned table no 6 depicts the relationship between males and females with the texture of the tongue. On comparison of different texture of the tongue to males and females a statistically significant result was obtained (p value -0.026).

DISCUSSION-

Human tongue of each individual is different from one another which serve as a good source of evidence for biometric authentication. In this study we are trying to study about different attributes of the tongue that help us in determining the uniqueness of tongue in each individual. In this study we have used different classifications to classify the human tongue which includes the use of Traditional Chinese Medicine classification for classifying the shape of tongue (rectangular, acute triangle, obtuse triangle, square, and circle) [6], use of Traditional Chinese Medicine for classifying the color of tongue (pale, light red, red, crimson and purplish) [7] and also used classification by Stefanescu.et.al for the classification of texture of the tongue (physiological tongue, scrotal tongue and geographic tongue) [8].

The main aim and objective of this study was to establish human tongue print as a tool for biometric authentication and to study the variations in the shape, color and texture of human tongue of both the sexes and at different age groups.

In this study a statistically significant p value (0.00) was obtained when relation of age with color of the tongue was studied due to local infection, systemic condition and nutritional deficiency which serves as a reason which causes color variation in human tongue at different age groups which was seen in accordance to a study conducted by Takeshi Oji, Takao Namiki, Toshiya Nakaguchi, Keigo Ueda, Kanako Takeda, Michimi Nakamura, Hideki Okamoto, and Yoshiro Hirasaki entitled as Study of Factors Involved in Tongue Color Diagnosis by Kampo Medical Practitioners Using the Farnsworth-Munsell 100 Hue Test and Tongue Color Images which confirms the result of our study [9].

Also, another statistically significant p value (0.026) was obtained when relation of gender with texture of the tongue was studied due to anatomical and histological difference in tongue of male and female as there is difference in the distribution of papillae in males and females which serves as reason which causes texture variations in males and females.

CONCLUSION-

Even though different methods of biometric authentication are used in forensics for the identification of an individual, each of those methods have their own imperfections due to which proofs for biometrics are not obtained. To overcome the shortcomings of the previously used methods new researches and studies are

being conducted where different body parts other than the fingers and iris are being used for biometric authentication one of which is tongue print. The dorsal surface of the tongue is mainly used for the process of tongue print from where various morphological features such as shape, color, texture of the tongue can be studied.

Use of tongue prints in forensic odontology for biometric authentication has various advantages which include –

- *Easy sample collection – For sample collection photographs and alginate impressions of the dorsal surface of a well protruded tongue is taken.*
- *Hereditary independence – the dorsal surface of each tongue is different, even two identical twins have different tongues which makes the tongue print of each individual unique.*
- *Stable source of evidence – Human tongue is well protected in our oral cavity so it has very less chances to get destroyed during any natural or man-made disaster.*
- *Difficult to Forge- As our tongue is encased in our oral cavity its duplication is not very difficult which makes it a strong evidence for biometric authentication.*

Hence, tongue print can also be used as a method of biometric authentication along with the other available methods.

Consent

As per international standard or university standard, patient(s) written consent has been collected and preserved by the author(s).

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