Study of Tongue Morphology in Central India Population: A Budding Tool in Forensic Odontology

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Abstract:-Forensic odontology is a branch of dentistry which deals with the identification of an individual based on his/her oral structures. The morphology of tongue is a unique structure that bears both geometric shape as well as physiological texture information that may be a potential tool which can prove useful in identity verification. The benefits of studying tongue morphology and making it a part of biometric identification is because of its genetic independence.The present research was taken over the people to study and analyse the morphological shape and texture of the tongue and to demonstrate it's importance as an aid in human identification. For the study, clinical examination, photographs and impressions were taken of the tongue. The undertaken study showed a qualitative result among different sex and age groups. It can be concluded that the human tongue promises to deliver a level of uniqueness in shape, texture and is suitable for the use in identity recognition.

Keywords:-Tongue Print; Biometric, Identification; Forensic Odontology; Forensics.

I. INTRODUCTION

The advancement in the field of Information Technology, increased rate of manmade and natural calamities makes information security an inseparable part of human authentication.

Forensic science encompasses two terms-firstly,"Biometrics" which is derived from Greek word "Bios" meaning life and "Metron" means to measure, referring to studies related with biological sciences that has been applied for several generations therefore simply viewed as biological statistics and second is "Authentication", the act by which something or someone is confirmed as authentic[1].

Since 14th century, attempts have been made in this field from Chinese fingerprinting system using ink as explored by Joao de Barros, AlphonseBertillonage'ssystem of body mechanics and measurements as developed by Alphonse Bertillon in 1890 to identify criminals to today's modern approach including physiological and behavioral classes of biometric identification.

Physiological class mainly relates to shape of body which includes fingerprints, face recognition,hand geometry, Iris recognition and tongue shape morphology. Behavioral class includes behavior of a person as reflected through his signature, voice and keystroke dynamics[2].

Variation forms the basis of biometric authentication as all objects in universe are unique; no two things happen by chance ever or in exactly the same way, neither constructed nor break in the same way. Our oral cavity provides us with diverse structure which can help in biometric authentication creating a different field known as forensic odontology, in which a dentist can contribute in investigations related to crime, mass disasters by handling, examining and evaluating dental evidences in which rugoscopy, cheiloscopy, tongue morphology, studying variations in tooth forms are some of methods of authentication[3].

Tongue is a vital and dynamic organ of oral cavity comprised entirely of muscles performing various functions like taste perception, articulation of speech, forms food bolus and helps in process of deglutition.

The ability of tongue performing such functions makes it indispensable part of oral cavity.

The vitality of tongue is best described by Traditional Chinese Medicine (TCM) practitioners by characterizing it as "tongue of life" indicative of its vitality and color and "tongue of death" having withered and dark appearance.

According to them, tongue provides a geographical map of organ systems by assessing its shape, color, thickness, distribution, and character of its root[4].

The benefits of studying tongue morphology and making it a part of biometric identification is because of its genetic independence, even the anterior and posterior part of tongue differs anatomically and physiologically, it is well encased in oral cavity getting protection from palate superiorly, lips anteriorly, pharyngeal region posteriorly, inferiorly by floor of mouth and laterally by teeth.

It has structural stability over time which cannot be forged and can be easily drawn out for examination[5].

The first tongue recognition system was described by Liu ET Al in 2007.With advancement in science and technology, various identification systems have been evolved making use of 2D Dual Tree Complex wavelet transform as proposed by Bade et al andTongue scanning systems which are under research[6].

Keeping in view these advantages of tongue printing, a prospective study was undertaken with following aims and objectives-
➢ Analysing morphological shape and texture of tongue in Central India population/Malwa region.
➢ To compare qualitative difference between different sex and age group.

II. MATERIAL AND METHODS

The study was undertaken with the sample size of 170 male and female adults dividing them in three age groups of 20 to 30 years, 31 to 40 years and 41 to 50 years old who came to government college of dentistry, Indore, Madhya Pradesh for some kind of treatment related to their dental issues.

Study was conducted after getting approval from institutional ethical committee. Subjects were informed verbally about the details of the study in their vernacular language and consent was obtained duly signed by them.

➢ Inclusion criteria
   Individuals should be clinically healthy.

➢ Exclusion criteria
   Individuals suffering from any contagious disease, systemic disease like hyperthyroidism, gigantism, dwarfism, syphilis,down syndrome.

   Individuals undergoing orthodontic treatment or with ulcer, abnormality of soft tissue, deformity and active lesions of tongue.

➢ *Procedure*
   Prior to the examination of tongue, it was cleaned using the sterile gauge pieces together with rinsing of mouth.

   Subjects were asked to protract the tongue in a relaxed position so as to prevent contraction of striated muscles of tongue which could either alter its original shape or can lead to deflection of lingual Apex.

Tongue prints were then obtained by three different ways:-
   First, all subjects were directly examined visually for morphological features such as shape, texture, longitudinal median septum and related groovesand apex.

➢ *Tongue shape*
   Shape of the tongue was determined according to the classification given in TCM dividing it into five categories[7],

- Rectangle- vertical length is longer but its horizontal width along thetip, body and root remains relatively constant.
- Acute triangle- vertical length is longer than its horizontal width atroot but gradually decreases from body down to its tip.
- Obtuse triangle-horizontal width is greater than its vertical length, width steadily decreases as it approaches tip of tongue.
- Square- both horizontal width and vertical length are similar.
- Circle- both horizontal width and vertical length are alike.
- Hammer- apexis broader than its base or root
- Elliptical-vertical length is greater than horizontal width where horizontal width is greatest at centre.

The shape was determined by taking three consecutive measurements of vertical length and horizontal width (at tip, body and behind sulcus terminalis) of tongue using Digital Vernier caliper and mean was then calculated of each dimension.

The other features like tongue texture, longitudinal grooves, and lingual apex were recorded on basis of classification given by Stefanescu et al (gave in 2014), according to which the various features are segregated as[8]-

➢ *Tongue Texture*
- Physiological or smooth
- Scrotal tongue having fissures or cracks
- Geographic

➢ *Longitudinal Grooves*
- Perceptible or imperceptible
- Rectilinear or Twisty
- Superficial or deep

➢ *Lingual Apex*
- Sharp
- Rounded
- Septate

Second, photographs of tongue were taken under same environmental and lighting condition from a predetermined distance using professional DSLR camera. Two views of tongue were taken as to make tongue recognition more secure, as tongue is a non rigid organ and it is very difficult fir an individual to keep it straight.-
a) Frontal view
b) Profile view

Third, lingual Impressions were made by using alginate molding technique as it is more reliable technique to duplicate most minute surface details by first making a custom tray of impression compound and then registering dorsal surface and lateral lingual edges with alginate applied to custom tray having holes in it created by warm sharp end of wax spatula for mechanical interlocking of alginate. Care was taken to avoid regurgitation reflex (fig.1).

Photographs and lingual Impressions were made for record-keeping purposes and to have a relevant positive image for identification.

➢ *Statistical Analysis*

Microsoft Excel sheet was composed using the recorded data and statistical analysis was done using standard deviation and chi square test utilizing SPSS statistical software.

III. RESULT AND OBSERVATION

When the tongue shape was analysed, 9 individuals showed elliptical tongue, 30 individuals showed hammer tongue, 78 individuals showed rectangular tongue, 48 individuals showed acute triangle tongue, none showed obtuse triangle and circle tongue and 5 individuals showed square tongue. Statistical analysis of tongue shape distribution between different age and gender group showed that elliptical shaped tongue was significantly seen in males than that of females in age group 20-30 yrs (pvalue-0.04), 31-40 yrs (p value- 0.048) and 41-50 yrs (p value- 0.049) (fig.2, table 1, graph 1).

When the tongue texture was analysed, 112 individuals showed physiological tongue, 28 individuals showed scrotal tongue, 14 individuals showed geographic tongue and 16 individuals showed hairy tongue. Statistical analysis of tongue texture distribution between different age and gender group showed no significant association p value more than 0.05 (fig. 3, table 2, graph 2).

When the groove pattern was analysed, 19 individuals showed perceptible grooves, 61 individuals showed imperceptible, 70 individuals showed rectilinear grooves, 99 individuals showed twisty grooves, 61 individuals showed superficial grooves and 109 individuals showed deep grooves. Statistical analysis of tongue shape distribution between different age and gender group showed that perceptible longitudinal grooves was significantly seen in females than that of males in age group 20-30 yrs (pvalue-0.043) and no significant association was seen in the age group 31-40 yrs (p value- 0.41) and 41-50 yrs (p value-0.23) (table 3, graph 3).

When the lingual apex was analysed, 48 individuals showed sharp apex, 83 individuals showed rounded apex and 40 individuals showed septate apex. Statistical analysis of tongue shape distribution between different age and gender group showed no significant association (p value more than 0.05) (fig. 4, table 4, graph 4).

IV. DISCUSSION

The tongue is a muscular organ which manipulates food, has importance in digestive system, is primarily organ of taste in gustatory system and enables speech in humans. It also serves in natural way of cleaning of the teeth. The human tongue is divided into two parts- an oral and a pharyngeal part. Right and left halves are divided by a vertical section of fibrous tissue that is the medium sulcus. It is composed of two groups of muscles that is intrinsic and extrinsic whose contraction and relaxation helps in carrying out various important functions.

The various morphological characteristics of tongue can change under various pathological conditions like red and smooth tongue is seen in iron deficiency and pernicious anaemia, scrotal tongue or tongue present with multiple groups can be associated with down syndrome and melkersson-rosenthal syndrome or it can be useful to identify an individual[9].

In the present study, rectangular shaped tongue was predominantly seen with elliptical shaped tongue was significantly seen in males than that of females in age group 20-30 yrs (pvalue-0.04), 31-40 yrs (p value- 0.048) and 41-50 yrs (p value- 0.049). Contrastingly comparison was not possible with Stefanescu et al as shapes were classified as ovoid, ellipsoid, rectangular, Pentagonal, trapezoidal and asymmetric.

Perceptible deep grooves were predominant with perceptible longitudinal grooves was significantly seen in females than that of males in age group 20-30 yrs (pvalue-0.043) and no significant association was seen in the age group 31-40 yrs (p value- 0.41) and 41-50 yrs (p value-0.23).

While comparing tongue texture, physiological texture was predominant with no significant association p value more than 0.05 while analyzing different age and gender group.

Rounded lingual apex was predominantly seen with no significant association (p value more than 0.05) while analyzing different age and gender group

In contrast, studies done by Nadeem J et al, MadhusudanAstekar et al found acute triangle or V shaped tongue to be predominantly seen in Uttar Pradesh population[10]. Studies done by Abralingam et al in Karnataka, Kerala and Tamil Nadu population, found U shaped tongue was commonly seen in males and V shaped was commonly seen females with no significant difference in grooves while analyzing different age and gender group groups which was consistent with results found by Jeddy et al[11,12].

The tongue some presents us with both geometrical shape information and physiological texture related information which can be used as potential tools for human identification and verification process. . Ever individual has a unique combination of all these features.The present study primarily focus on the importance of tongue as an organ of biometric authentication of an individual in field of forensics[13].

Further studies need to be carried out with larger sample sizes and different geographical distribution to create a database which will prove the saying "Lips speak the untold, rugea see the unseen and tongue unleash the truth"

with even more sophisticated techniques like 3D stereo reconstruction for shape feature extraction of tongue and texture of tongues and be analysed with Scale Invariant Feature Transform (SIFT) software with which verification matching can be done.

V.   CONCLUSION

As law and advancements gave us crime science gave us forensics. Biometric authentication of living or deceased is a multispeciality task. Increasing identity fraud demands for new technique for person identification which are more reliable and legally valuable giving emphasis on person's security. Tongue which is internal organ and immune to forgery makes it more secure method together with its impression and photographic image.

In this study we have tried to put forth the the importance of tongue as its role in biometric authentication, though more research is necessary in this field which will help us in not only seeing but also keenly observing to reveal all secrets of person's identity.
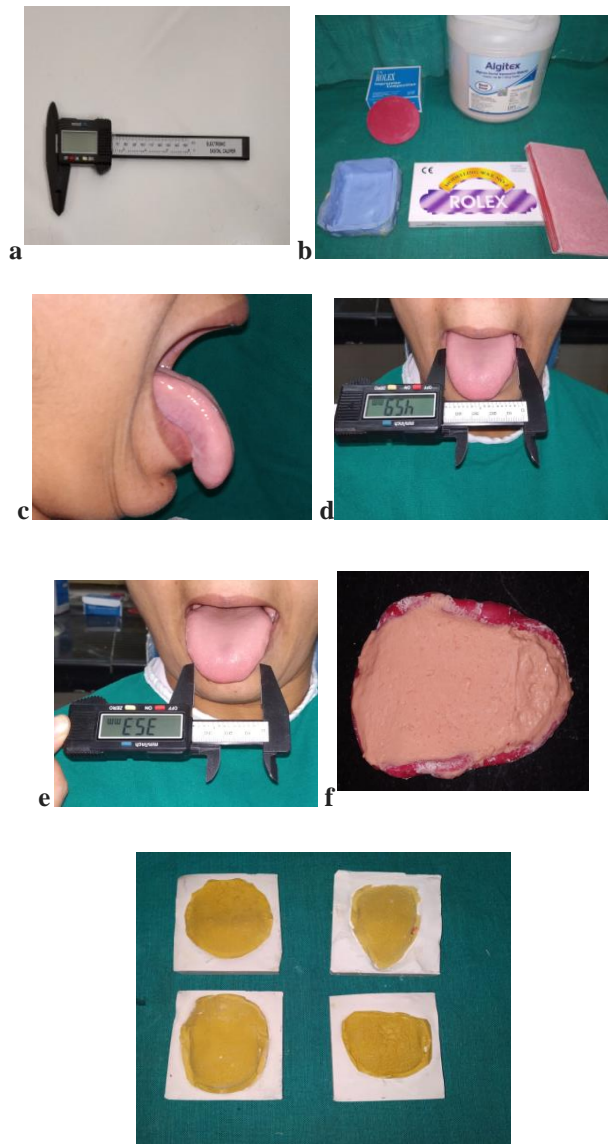

Fig 1:- a) and b)Armamentarium required, c)profile view, d) and e) measurements to analyse tongue shape using vernier caliper in frontal view and f) lingual impression and g) cast obtained
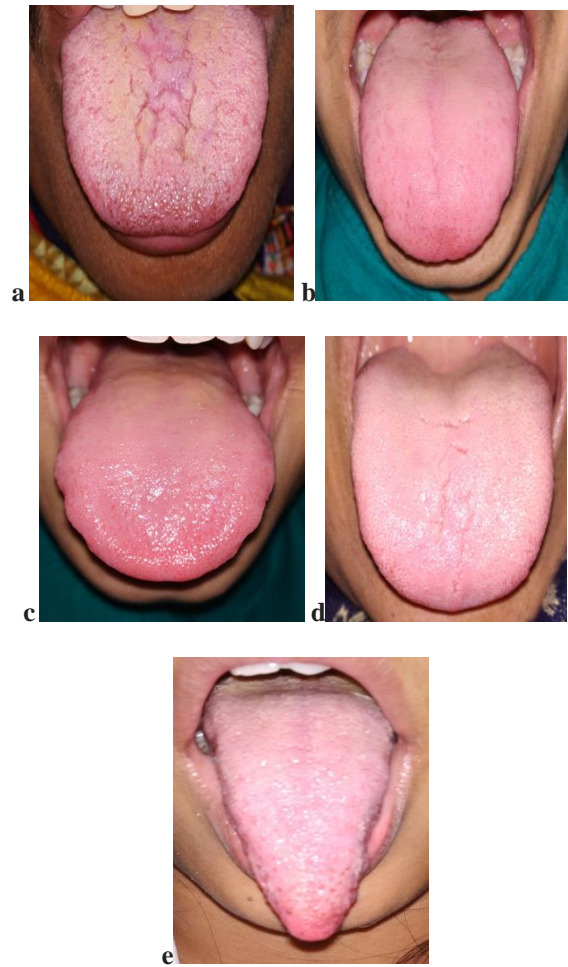
Fig 2:- Clinical photographs of the tongue showing a) Square b) Elliptical c) Hammer d) Rectangular and e) Acute triangle shape

Fig 3:- Clinical photographs of the tongue showing a) Physiological b) Geographic c) Hairy and d) Scrotal texture
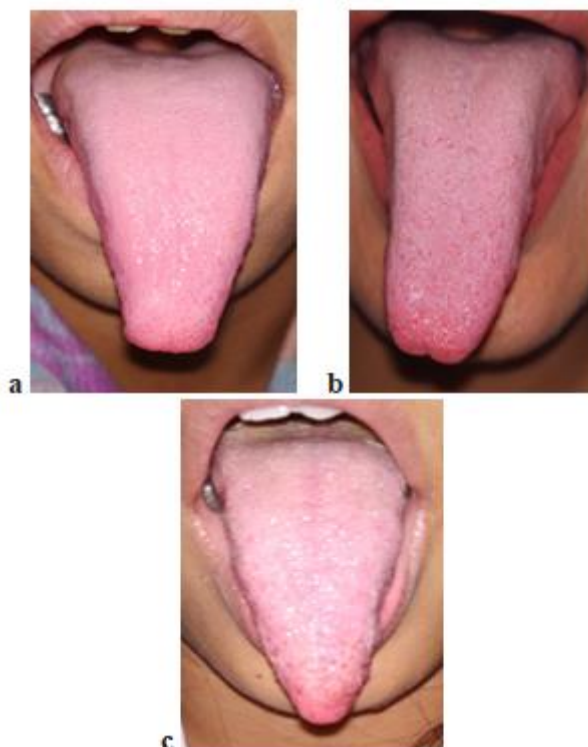
Fig 4:- Clinical photographs of the tongue showing a) Round b) Septate and c) Sharp lingual apex

SUB CATEGORY	20-30 years		31-40 years		41- 50 years	
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE
ELLIPTICAL	3	0	4	0	2	0
HAMMER	5	6	7	2	6	4
RECTANGLE	11	19	12	11	13	12
ACUTE TRIANGLE	7	13	7	7	8	6
OBTUSE TRIANGLE	0	0	0	0	0	0
CIRCLE	0	0	0	0	0	0
SQUARE	0	0	2	3	0	0
p value	0.04		0.048		0.049	

Table 1:- Distribution of tongue shape in individuals according to different age and gender groups.
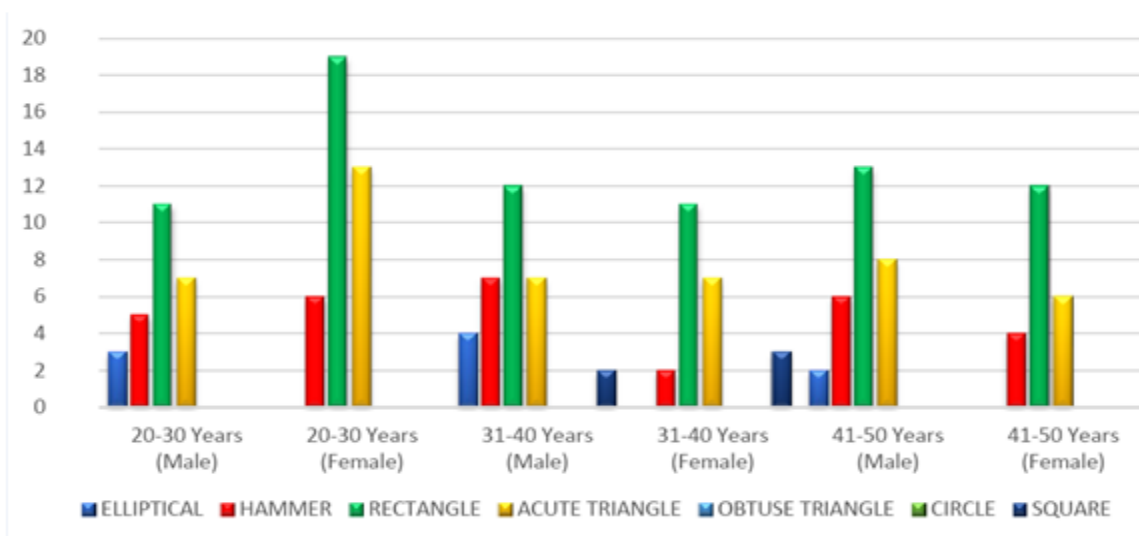
Graph 1:- Graphical representation of distribution of tongue shape in individuals according to different age and gender groups.
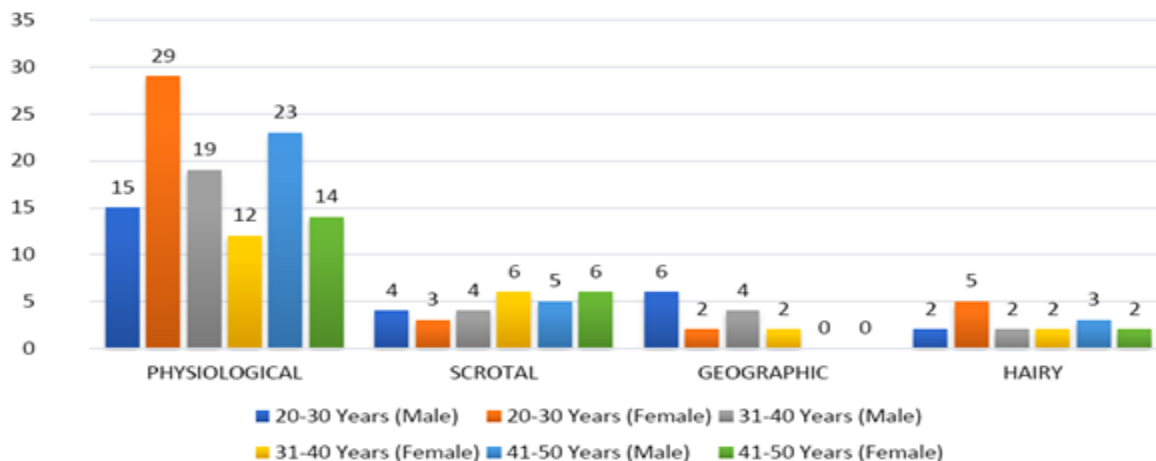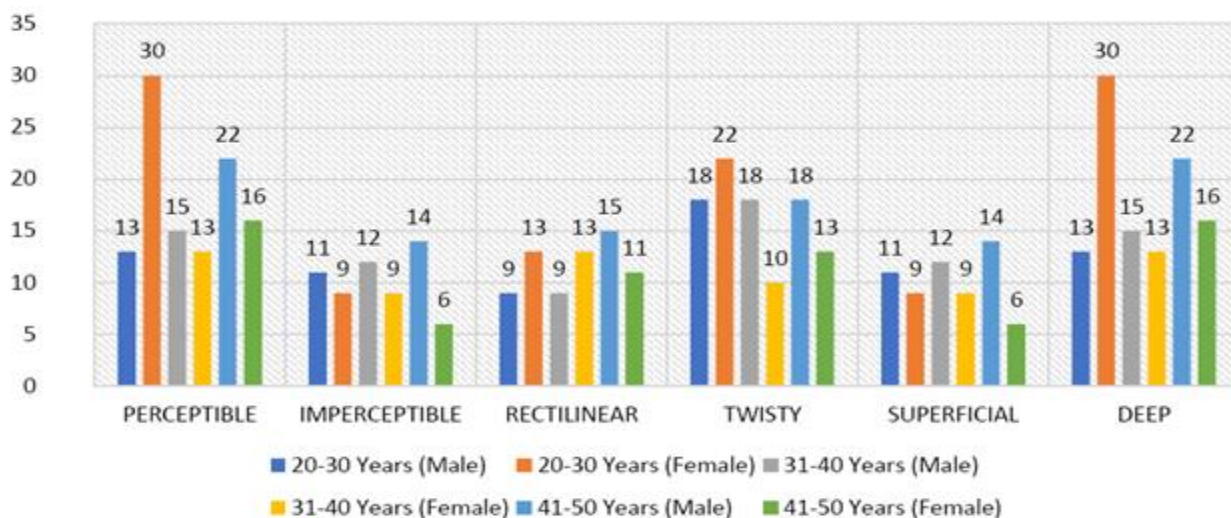
Graph 2:- Graphical representation of distribution of tongue texture in individuals according to different age and gender groups.

SUB CATEGORY	20-30yrs		31-40 years		41- 50 years	
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE
PHYSIOLOGICAL	15	29	19	12	23	14
SCROTAL	4	3	4	6	5	6
GEOGRAPHIC	6	2	4	2	0	0
HAIRY	2	5	2	2	3	2
p value	0.31		0.12		0.25	

Table 2:- Distribution of tongue texture in individuals according to different age and gender groups.

| SUB CATEGORY	20-30 years		31-40 years		41- 50 years	
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE
PERCEPTIBLE	13	30	15	13	22	16
IMPERCEPTIBLE	11	9	12	9	14	6
RECTILINEAR	9	13	9	13	15	11
TWISTY	18	22	18	10	18	13
SUPERFICIAL	11	9	12	9	14	6
DEEP	13	30	15	13	22	16
p value	0.043		0.41		0.23	

Table 3:- Distribution of longitudinal groove pattern on tongue in individuals according to different age and gender groups.

Graph 3:- Graphical representation of distribution of longitudinal groove pattern on tongue in individuals according to different age and gender groups.

SUB CATEGORY	20-30 years		31-40 years		41- 50 years	
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE
SHARP	7	13	7	7	8	6
ROUNDED	12	19	12	11	14	14
SEPTATE	7	6	10	4	10	3
p value	0.63		0.85		0.75	

Table 4:- Distribution of lingual apex in individuals according to different age and gender groups.
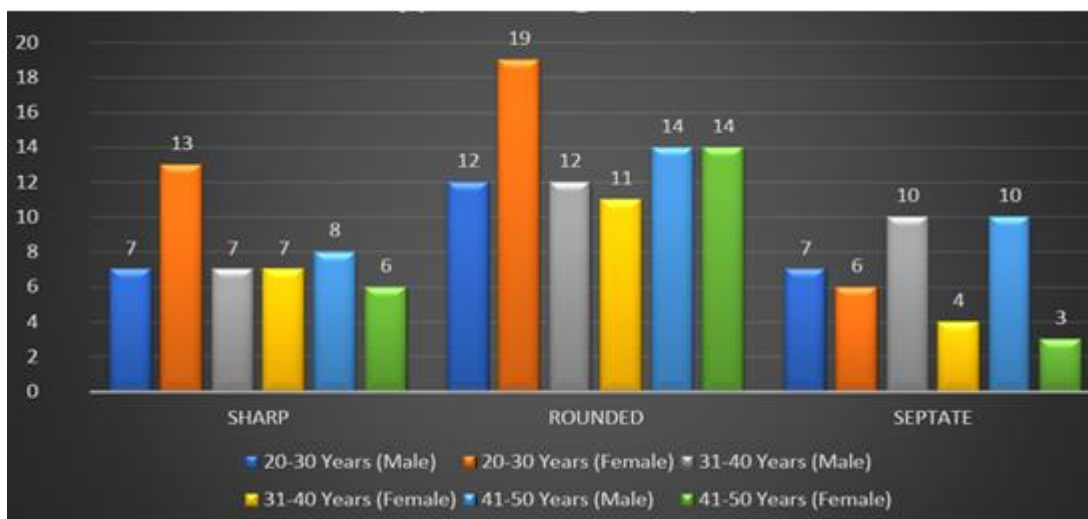
Graph 4:- Graphical representation of distribution of lingual apex tongue in individuals according to different age and gender groups.

REFERENCES

[1]. Jain, A. K.; Ross, A. &Pankanti, S., "Biometrics: A Tool for Information Security", IEEE Transactions on Information Forensics And Security, Volume 1, issue 2, Jun. 2006, pp 125 – 144.

[2]. Bhattacharyya, Debnath&Ranjan, Rahul &Alisherov, Farkhod&Minkyu, Choi. Biometric Authentication: A Review. International Journal of u- and e- Service, Science and Technology. 2009;volume 2:pp13-27.

[3]. Caldas IM, Magalha T, Afonso A. Establishing identity using cheiloscopy and palatoscopy. Forensic Sci Int 2007;165:1-9.

[4]. Anastasi JK, Currie LM, Kim GH. Understanding diagnostic reasoning in TCM practice: tongue diagnosis. AlternTher Health Med. 2009 May-Jun;15(3):18-28. Erratum in: AlternTher Health Med. 2009 Jul-Aug;15(4):10.

[5]. Abd-El-Malek S (1939) Observations on the morphology of the human tongue. J Anat73:(pt2) 201-205.

[6]. SanjanaArora, GagandeepKaur, Neha. Tongue printing: A unique identification system. Journal of advanced medical and dental sciences research. 2019;vol. 7:115-117.

[7]. Zhang B, Zhang H. Significant geometry features in tongue image analysis. Evid Based Complement Alternat Med 2015;2015:897580.

[8]. Stefanescu CL, Popa MF, Candea LS. Preliminary study on the tongue-based forensic identification. Rom J Leg Med 2014;22:263-6.

[9]. Byrd JA, Bruce AJ, Rogers III RS (2003) Glossitis and other tongue disorders. DermatolClin 21(1): 123-34.

[10]. Park JW, Kang SK, Jung ST (2011) Tongue Diagnosis System Based on PCA and SVM. World Academy of Science, Engineering and Technology 5(12): 1729-1732.3.

[11]. Abranalingam, Shubhalakshmi, Dinkar Desai, Gem Singh Christopher.Comparison of Lip Prints, Rugae Pattern and Tongue Prints among Karnataka, Kerala and Tamil Nadu Population – A Short Study. International Journal of Innovative Science and Research Technology. Volume 4, Issue 7;pp1182-1187.

[12]. Radhika T, Jeddy N, Nithya S (2016) Tongue prints: A novel biometric and potential forensic tool. J Forensic Dent Sci 8(3): 117-201.

[13]. Diwakar, Manoj&Maharshi, Manish. An Extraction and Recognition of Tongue-Print Images for Biometrics Authentication System. International Journal of Computer Applications. 2013; 61. 36-42.