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Evaluation of Tongue Impression as a Forensic Tool for Personal Identification: An Observational Study

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Abstract

Background: Unique characteristics like fingerprints, facial and iris scans contribute to forensic science by identifying an individuals' authenticity. Tongue is a fleshy muscular organ that is well protected in the oral cavity, unaffected by the external factors and difficult to be simulated. This study was an attempt to use tongue as a tool to identify a person as limited studies have been accomplished in investigating tongue's morphologic features.

Aim: To identify an individual by tongue impression.

Objectives: To clinically analyse the tongue morphology and to correlate it with that of tongue impression.

Material and methods: 30 subjects (15 males and 15 females) between the age group of 18-65 years were considered in the study. Two examiners observed the morphological features clinically and also by comparing the corresponding tongue cast.

Results: Anterior fissure pattern was observed in elder subjects while median fibrous septum was observed in younger subjects. Hammered (H) shape of the tongue was the dominant tongue pattern among male subjects; oval (O) and ellipsoid (E) were characteristic shapes noted in female subjects.

Conclusion: A detailed impression of the anterior two thirds of the tongue can aid as a promising tool to identify a person and can also serve as a permanent record through the cast.

Keywords: anterior fissure pattern; forensic science; face; human; iris; mouth; median fibrous septum; tongue

Abbreviations

Hammered (H), Ellipsoid (E), oval (O), clinical observation (CO), tongue impression cast (TIC).

Introduction

Tongue or glossa as termed in Greek, is a fleshy muscular organ present in the oral cavity which can be conveniently examined clinically. It develops within the floor of the oral cavity, [1] the muscle cells are derived from the somite mesoderm [2]. The first four pharyngeal arches contribute to the development of the tongue in its entirety [3]. It is associated with functions of taste, speech, mastication and deglutition [4]. It has an oral and pharyngeal part which is separated by V shaped sulcus named as the sulcus terminalis [5].

The dorsal tongue is covered by a stratified squamous epithelium, with numerous papillae and taste buds [6]. The features of the tongue like its color, shape, texture, various types of fissures are always personal to an individual. It is the only internal organ that can be easily exposed and carries appreciable details like its geometry and texture features that are stable. The involuntary squirm of the tongue is natural and convincing proof that a person is alive [7].

Numerous methods involving the oral hard tissues and soft tissues are practiced to identify an individual [8]. The tongue is a well encased structure within the oral cavity and protected against the external environment, unlike the palm, finger, face, individual features of the face that can be vulnerable to external factors [9, 10].

With the help of various impression materials like rubber base impression materials, alginate impression material and modelling wax, [11] the features of tongue can be analyzed, by documenting the minute details [12]. Pouring a smooth mixed type III dental stone on the obtained replica can reveal the essential details and the shape of the tongue.

In developing countries, especially in India to identify an individual by tongue is an upcoming practice that requires more quantum of research and planning to use it as a tool to identify an individual. The study aimed at analysing the tongue morphology to identify an individual by tongue impression.

Compilation of ante mortem records plays a very important role in forensic science. Casts of the tongue, recent IOPAR, OPGs expedites in precision and hastens the contingencies to particularly identify a person [13].

This study was conducted to determine the age and sex of an individual by identifying their various morphological features of tongue.

Materials and Methods

Study setting and Study design

This study was conducted in the department of Oral Pathology and Oral Microbiology, Faculty of Dental Sciences, M.S Ramaiah University of Applied Sciences, Gnanagangothri campus, New BEL Road, MSR nagar, Bangalore from February 15, 2017, to June 30, 2017.

The study group comprised of thirty subjects ie,15 Male and 15 Female who visited our institute for routine hematology investigations. The subjects were grouped according to the gender and individuals between 18-65 years. Informed consent was taken prior to the procedure. Ethical clearance was obtained from the ethical committee for the study. (Reference no: EC-25/61-PG-FDS)

Inclusion and exclusion criteria of patients

Cooperative healthy Individuals without systemic disorders, who could open their mouth wide and those who could place their four fingers vertically, between the maxillary and mandibular central incisors, those who could move their tongue freely to left and right angle of mouth, individuals who could roll their tongue were included in the study. Individuals who had limited mouth opening, restricted tongue movements, gagging sensations and neurological disorders were excluded.

Methodology

The subjects were instructed to rinse their mouth with water to get maximum details. Reference points at the tip of the tongue (lingual tip), a point along the lateral border on either side of the tongue were taken. (figure 1)

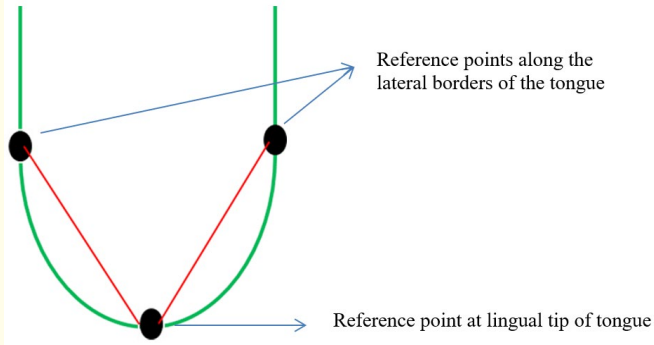

Figure 1

With the help of mouth mirror and gauze, the subjects tongue were examined clinically for morphological features mainly; the tongue shape, anterior fissure pattern and median fibrous septum. These features were compared by clinical observation (CO) that was recorded by taking photograph of the tongue and correlated with the tongue impression cast (TIC) taken with the alginate material without much delay, using type III dental stone.

The subjects were instructed to open their mouth and stretch their tongue till they said "Ah"; Alginate impression material was manipulated to a smooth mouldable consistency (2scoops powder:1ratio), and placed on the dorsal two thirds of the tongue uniformly and removed once it got set. For better lucidity of the fissures and median fibrous septum, the positive replica was painted uniformly with magenta color acrylic paint.

Data Analysis

The morphological features of the tongue were analysed with both CO recorded as photographs and corresponding TIC by two observers separately. Against the assigned number for each subject, '+' or '-' was mentioned for Anterior fissure pattern (Table: 1) and Median fibrous Septum (Table: 2) indicating if it was present or absent respectively. Tongue shape was identified as (H) hammered, (E) Ellipsoid and (O) Oval against the assigned number (Table: 3). Demographic details of the subjects were blinded to overcome bias.

S. No	Parameter considered	Age/Gender	Observer 1		Observer 2	
			CO	TIC	CO	TIC
1.	Anterior fissure pattern	56/F	+	+	+	+
2.		59/F	+	+	+	+
3.		65/M	+	+	+	+
4.		29/F	-	-	-	-
5.		25/F	-	-	-	-
6.		28/M	-	-	-	-
7.		25/F	-	-	-	-
8.		20/F	-	-	-	-
9.		23/M	-	-	-	-
10.		20/F	-	-	-	-
11.		22/F	-	-	-	-
12.		20/F	-	-	-	-
13.		22/F	-	-	-	-
14.		22/F	-	-	-	-
15.		23/F	-	-	-	-
16.		21/M	-	-	-	-
17.		21/M	-	-	-	-
18.		20/M	-	-	-	-
19.		20/M	-	-	-	-
20.		19/M	-	-	-	-
21.		20/M	-	-	-	-
22.		21/M	-	-	-	-
23.		20/M	-	-	-	-
24.		20/M	-	-	-	-
25.		20/M	-	-	-	-
26.		20/M	-	-	-	-
27.		22/F	-	-	-	-
28.		23/F	-	-	-	-
29.		21/M	-	-	-	-
30.		21/F	-	-	-	-

Table 1

S. No	Parameter considered	Subject Gender	Observer 1		Observer 2	
			CO	TIC	CO	TIC
1.	Median Fibrous Septum	56/F	-	-	-	-
2.		59/F	-	-	-	-
3.		65/M	-	-	-	-
4.		29/F	+	+	+	+
5.		25/F	+	+	+	+
6.		28/M	+	+	+	+
7.		25/F	-	-	-	-
8.		20/F	+	+	+	+
9.		23/M	-	-	-	-
10.		20/F	+	+	+	+
11.		22/F	+	+	+	+
12.		20/F	+	+	+	+
13.		22/F	+	+	+	+
14.		22/F	+	+	+	+
15.		23/F	+	+	+	+
16.		21/M	+	+	+	+
17.		21/M	+	+	+	+
18.		20/M	+	+	+	+
19.		20/M	+	+	+	+
20.		19/M	+	+	+	+
21.		20/M	+	+	+	+
22.		21/M	+	+	+	+
23.		20/M	+	+	+	+
24.		20/M	+	+	+	+
25.		20/M	+	+	+	+
26.		20/M	+	+	+	+
27.		22/F	+	+	+	+
28.		23/F	+	+	+	+
29.		21/M	+	+	+	+
30.		21/F	+	+	+	+

Table 2

S. No	Parameter considered	Subject Gender	Observer 1		Observer 2	
			CO	TIC	CO	TIC
1.	Shape of tongue Hammered(H) Ellipsoid(E) Oval(O)	56/F	E	E	E	E
2.		59/F	E	E	E	E
3.		65/M	H	H	H	H
4.		29/F	E	E	E	E
5.		25/F	E	E	E	E
6.		28/M	H	H	H	H
7.		25/F	E	E	E	E
8.		20/F	O	O	O	O
9.		23/M	H	H	H	H
10.		20/F	O	O	O	O
11.		22/F	O	O	O	O
12.		20/F	O	O	O	O
13.		22/F	O	O	O	O
14.		22/F	O	O	O	O
15.		23/F	O	O	O	O
16.		21/M	H	H	H	H
17.		21/M	H	H	H	H
18.		20/M	H	H	H	H
19.		20/M	H	H	H	H
20.		19/M	H	H	H	H
21.		20/M	H	H	H	H
22.		21/M	H	H	H	H
23.		20/M	E	E	E	E
24.		20/M	E	E	E	E
25.		20/M	E	E	E	E
26.		20/M	E	E	E	E
27.		22/F	O	O	O	O
28.		23/F	O	O	O	O
29.		21/M	O	O	O	O
30.		21/F	O	O	O	O

Table 3

Results and Discussion

Clinically observed features of the tongue and its morphological pattern were correlated with the tongue cast and results were subjected to chi square analysis using SPSS version 23.

In the present study three parameters were considered namely the anterior fissure pattern, median fibrous septum and shape of the tongue. The anterior fissure pattern was observed in 3 of 30 subjects, i.e, 10% of the subjects in the study. (Figure: 2A & B)

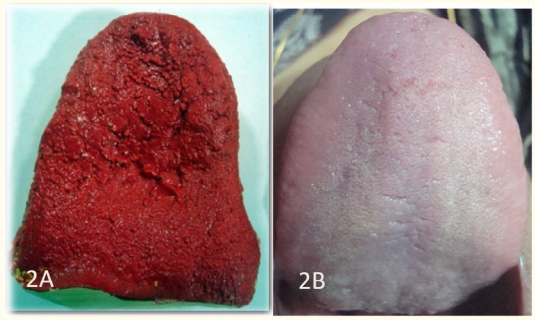

Figure 2: 2A-TIC,2B-CO of Anterior Fissure Pattern.

Median Fibrous septum was observed in 25 of the 30 subjects, of which 13 were males and 12 were females. (Figure: 3A & B) A statistically insignificant difference with a p value 0.624 was attained. (Table: 4) This feature was absent in 5/30 persons of which three of them were elderly individuals while 2 of them belonged to the younger group (Figure: 4) For the latter comparison, a statistical analysis could not be performed as it was a smaller group of males and females. The investigation being a pilot study, only the numerical values were compared.

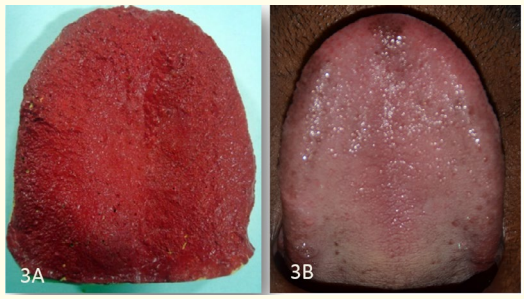

Figure 3: 3A-TIC,2B-CO of Median Fibrous Septum.

	Male (15)	***Female (15)***	***P value***
Present 25	13	12	0.624
Absent 5	2	3	

Table 4

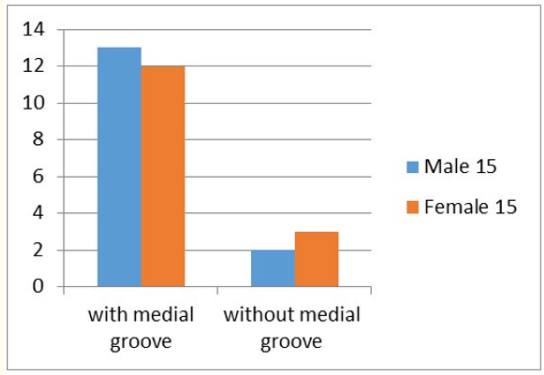

Figure 4: Comparative bar graph showing Subjects with and without medial groove/Median Fibrous Septum.

Numerous types of tongue shapes are present in different communities. The various shapes of the tongue were analyzed with the help of reference points on the lingual tip as mentioned by Stefanescu et al in 2014, who also classified tongue shapes as hammered, ellipsoid, rectangular, acute triangular, oval, obtuse triangular, square and round [8]. In the current study the commonly observed tongue shapes were the hammered, ellipsoid and oval. (Figure: 5A-F) The Hammered shape of the tongue was the most common pattern observed in males 10/15, 66% (Figure: 5A & D) while oval 10/15,66% (Figure: 5B & E) and ellipsoid 5/15 33% (Figure: 5C & F) were the commonly observed shape in females with a statistical significant p value of 0.0001. (Figure: 6) (Table: 5)

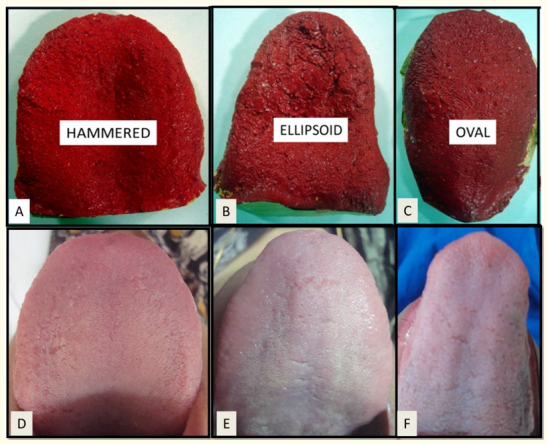

Figure 5: Casts of three predominantly noted tongue shapes with the corresponding clinical images.

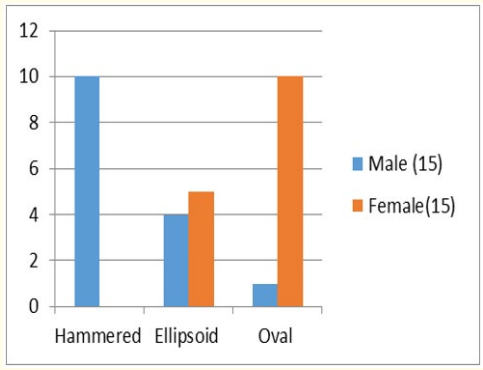

Figure 6: Bar graph comparing the H, E, O tongue shapes with dominance of hammered shape in Males.

	Male	***Female***	***P value***
Hammered	10	0	0.0001
Ellipsoid	4	5	
Oval	1	10	

Table 5: Hammered shape is predominant in males, Ellipsoid and Oval shapes are more often seen in Females, Chi square analysis shows statistical significance.

Discussion

Tongue is a well encased structure that rests in the floor of the oral cavity abutting the lingual surfaces of the teeth, beneath the surface of the hard and soft palate. The tip of the tongue is usually in contact with the hard palate behind the upper incisor teeth. The root of the tongue is attached to the hyoid bone and the mandible and in between them it is in contact inferiorly with the geniohyoid and the mylohyoid muscles. The tongue is divided into right and left halves by a median fibrous septum. Each half contains two sets of muscles, which are intrinsic and extrinsic [3-6].

In the present study, the clinically and morphologically identified tongue features positively coincided with that of the recorded tongue impressions, however the features were more appreciable in the latter method and can also serve as a tool in forensics to identify the deceased. These findings were in accordance to the studies conducted by Stefanescu et al in 2014 [8] and Jeddy et al in 2016 [10] who have also observed the features of tongue clinically and by tongue impression.

The three parameters that were prioritized in the current study were anterior fissure pattern, median fibrous septum and shape of the tongue. In the current study, the anterior fissure pattern was observed only in the elder population group, however due to limited sample size and the greater number of subjects that were considered in the study belonged to the younger age group, it could not be definitely concluded if anterior fissure pattern is a characteristic feature of the elder population. The findings obtained from present study were in accordance with that observed by Stefanescu et al in 2014 [8] and Jeddy et al in 2017 [10]. Mathew et al in 2017 [14] identified that fissures were found to be least in the younger age group and it was most prevalent as the age progressed, precisely between 40-80 years. The prevalence of fissured tongue was higher among males as compared to females. Most common site of occurrence was anterior and middle portions of the tongue. In the present study, this feature was identified in the elder group of individuals, in age group of 56-65years. However more sample size is essential to ascertain the same.

Median fibrous septum was another characteristic feature observed in the subjects. It was more distinctly observed in the younger subjects, between the age group of 20-25years compared to that of the elder group of individuals. Russ et al in 2012 recognized that in skeletal muscles, changes are observed with neurological functions and the intrinsic force generating properties which contribute to dynapenia; an age associated loss of muscle strength. Evaluation by numerous studies has assessed depreciation in skeletal muscles with age progression [15]. The human muscle fiber volume decreases continuously throughout the life-span by 23%, from birth to third decade of life and a subsequent decrease of 24% by about seventh decade of life [16]. Tongue being a skeletal muscular organ, can undergo changes with ageing; could be the reason as to why median fibrous septum was less prominent in the elder age group subjects when compared to the younger subjects. To our knowledge, presence of median fibrous septum hasn't been considered as a characteristic feature in younger age group in any of the previous studies, therefore it is the first of its kind. In the current study, it was observed that this feature was evident in younger age group when compared to the elder subjects. However, a statistical significance could not be achieved between the elder and younger subjects within the study group due to the uneven distribution.

Another important feature considered in the study was the tongue shape. The various tongue patterns are hammered, ellipsoid, rectangular, acute triangular, oval, obtuse triangular, square and round. In the present study, the predominantly encountered tongue shapes were hammered, ellipsoid and oval. The hammered shape was predominant among the males, whereas the ovoid and ellipsoid were more prevalent in female subjects. This could be due to larger craniofacial complex in men by 5% to 9% than in women as established by Forsberg in 1979 [17, 18]. Studies conducted by Stefanescu et al in 2014 [8] commented that the male subjects have a rounded apex. Bo Hong et al in 2014 [19] have illustrated hammered shape of the tongue was not a common shape while elliptical and oval were more common shapes irrespective of the gender.

Limited studies have been conducted on the characteristic features of tongue for it to be authorized as a tool for person identification. In our country, though numerous other modes of person identification are established, with that of the tongue is a nascent approach. The study summarizes that anterior fissure pattern was more observed in the elder group of individuals who are in their fifth and sixth decades while the median fibrous septum was more pronounced in the younger subjects, within the second decade compared to that of the elder group of individuals. The hammered shape of the tongue was more observed among the male subjects while other shapes like ellipsoid and oval pattern of tongue were predominant among females. However an investigation with larger sample size is essential to arrive with appropriate distinguishable features between gender and age.

Conclusion

Features of the tongue are personalized and constant; therefore it can be used in forensics along with lingual impressions and photographic image. A detailed tongue impression of the anterior two thirds of the tongue could be helpful in determining the shape and features of the tongue, which can serve as a permanent record through the cast. Tongue can also be promising biometric tool, its characteristic morphological features can definitely identify a person.

Conflict of interest

Nil.

Acknowledgements

NA.

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