TONGUE PRINTS IN FORENSIC ODONTOLOGY - A REVIEW

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ABSTRACT:

AIM: This article aims at reviewing about the tongue prints in forensic odontology

OBJECTIVE: The objective of the article is to explain about the uniqueness of tongue prints in personal identification and its superiority over other biometric identification system

BACKGROUND: Tongue is a vital internal organ well encased within the oral cavity and protected from the environment. It has unique features which differ from individual to individual and even between identical twins. The colour, shape, and surface features are characteristic of every individual, and this serves as a tool for identification. Many modes of biometric systems have come into existence such as fingerprint, iris scan, skin colour, signature verification, voice recognition, and face recognition. The search for a new personal identification method has led to the use of the tongue print as a method of biometric authentication. Tongue characteristics exhibit sexual dimorphism thus aiding in the identification of the person. Emerging as a novel biometric tool, tongue prints also hold the promise of a potential forensic tools.

REASON: This review was undertaken since tongue biometric can function as an extremely reliable means for personal identification and act as a general biometric in all applications.

Keywords: Tongue prints, biometric identification, identical twins, sexual dimorphism, forensic tool.

INTRODUCTION:

Tongue is a vital organ which performs multiple actions such as articulation of speech, perception of taste, and formation of food bolus. It is well protected from the external environment and enclosed in the oral cavity with palate on the superior aspect, floor of the mouth on the inferior aspect, mandibular teeth on the lateral aspects, pharyngeal region posteriorly, and the lips anteriorly[1,2]. It is the only internal organ which can be easily drawn out and displayed for inspection and palpation purposes. The colour, shape, and surface features are characteristic of every individual, and this serves as a tool for identification[1].By means of its shape and texture, its aspect and colour analysed in a particular moment, this organ is helpful due to its exposed portion comprising information with visible differences from one individual to another, and is called as lingual impression which is consistent and the physiological texture is invariable [4].Biometric authentication is a method of personal identification and has gained popularity in the recent years. The necessity for security in cases of bank details, transactions, etc., has propelled the research in the field of biometrics. In biometric authentication, the input sample is compared against a sample template to identify the person. Recently, there has been an increased interest in tongue prints as a biometric tool[1]. The analysis of the lingual morphological aspects preserved using the alginate moulding technique, the most reliable technique for duplicating the most minute details, represents a criterion with force of evidence up on uniqueness for each and every individual, with the help of which forensic dentistry identifi cation provides information with predictive values as far as a person's identity is concerned[4] .This review highlights the uniqueness of tongue prints and its advantages over other biometric methods. Different methods of tongue print collection, identification, classification, and its potential application in the field of forensic dentistry are also discussed.

UNIQUENESS OF TONGUE:

Its uniqueness is showcased by the fact that since it is an internal organ, it acts as a proof of life that is whether the person is alive or dead. Only when a person is alive they can protrude the tongue for examination purposes. Many a times, death occurs when the tongue falls back to obstruct the airway, especially in cases of sleep apnea[14,3.] Second, the analysis of shape, texture, and colour reveals visible differences between one individual and another thereby making it a useful tool in personal identification. The tongue like has a share of skeletal muscles, blood vessels, and nerve supply. In addition, it contains papillae and taste buds. In TCM, it has been observed and stated that the general texture of the tongue varies between individuals and since it is affected by diseases, it can be a useful tool in identifying medical conditions[5,15].

TONGUE PRINTS VERSUS OTHER BIOMETRIC SYSTEMS:

A biometric system is a real-time identification system which identifies a person by measuring a particular physical or behavioural characteristic and later comparing it to a library of characteristics belonging to many people [6]. There are different biometric systems that are employed for security purposes.They are fingerprint, retinal scan, skin colour, voice check, palm print, face scan, signature check, etc.These security systems possess both advantages and disadvantages.. The disadvantages for each system make it vulnerable for security breach and also a hassle in identification purposes. Fingerprints can be eroded, changed due to work, altered by surgery, and subjected to injuries and burns, so they are not stable. When voice is considered, it is affected by sicknesses such as cold and cough. In case of extreme emotional states, there are chances of misspoken words. Retinal scan is highly

sensitive. It is dependent on the user and can be affected by bright light and diseases such as cataract and astigmatism. Skin colour is also one type of biometric system, but it presents with stability problem as considerable differences are seen with age, burns, diseases, and use of skin creams or medications[15].

Tongue print over other biometric systems has lot of advantages The tongue is unique to every person with respect to its shape and surface textures[19]. Since it is an internal organ, it can be easily exposed for inspection and the exposed surface carries the required information. The physiological texture and shape remain constant. It is well protected from the external environment, and so it is not affected by external factors. In recent years, tongue print is gaining momentum as an important tool in biometric authentication[16].

COLLECTION AND IDENTIFICATION OF TONGUE PRINTS:
A study carried out in Hong Kong Polytechnic University in 2007, was designed to develop tongue image database, which included both tongue geometric shape and surface textures of individuals, and this database was assumed to be a valuable resource for assessment, comparison, and evaluation[8].Tongue prints can be obtained in different ways. The colour of the tongue, mobility, surface textural variations can be revealed by a simple visual inspection. To identify the shape of the tongue , digital photographs of the tongue can be captured and matched with a database for verification [18].Three-dimensional analysis of the tongue is a viable option for assessment and the shape of the tongue is assessed by joining three reference points.Analysis of the tongue can be performed by taking an alginate impression followed by cast preparation [9] .This helps in capturing the unique features and reproducing them onto a cast which can be used for study purposes. Many studies have been researched into preparing a proper algorithm for tongue image analysis[10] .Other methods are :
1. Capturing the video of a tongue and extracting images from the same as the tongue is a nonrigid organ.
2. Sublingual vein analysis, which is one of the common methods employed in tongue diagnosis[11]
3. An ultrasound technique has been employed using an ultrasound transducer placed in the sublingual area to analyze the tongue function[12].
4. Histological examination of the tongue can also be undertaken.

TONGUE PRINTS IN FORENSIC ODONTOLOGY:

Uniqueness is very important for personal identification. The dorsal surface of the tongue is unique for each person. The characteristic features of the tongue exhibit remarkable difference even between identical twins [1,13] .In forensic dentistry identification lingual impressions have been proved to be useful when used in conjunction with methods such as cheiloscopy and rugoscopy [1,14] .Its use in natural and human made disasters is yet to be documented although the tongue is one of the main components for diagnosis in TCM[17].

CLASSIFICATION:
Vitality, colour, shape, moisture, and movement are the different aspects of the tongue that are considered for assessment in case of living cases. The surface coatings of the tongue are also further classified based on the colour which is normally clear-white and of thin uniform layer. Alterations in these characteristics depict illness and can be used for diagnostic purposes.
The characteristic features observed on the dorsal surface of the tongue have been classified by various authors in different studies [table 1][4]

Table 1: Classification of features on dorsal surface of tongue.

Textural variations in tongue	Shapes of tongue	Tongue geometry features
Tongue fissure or tongue crack smooth tongue	Elliptical Hammer Rectangular Acute triangular Obtuse triangular Square Round	Length Width Thickness

On the dorsal surface of the tongue there are many grooves or furrows present which are known as tongue fissures. They can occur as single groove or multiple grooves. The grooves can either be shallow or deep. A tongue without any fissures or cracks is known as smooth tongue.The shape of the tongue is analysed by taking reference points on the lingual tip and the V-shaped lingual sulcus. Other variations which have been observed on the tongue is the presence of a fibrous band in the tip of the tongue, mild or a partial cleft in the tip of the tongue appearing as bifid tongue, etc., can also be seen. Another classification was put forth by Stefanescu *et al*. in 2014 [Table 2][9]

Table 2: Classification of tongue features by Stefanescu *et al*.

Tongue texture	Shapes of tongue	Longitudinal grooves
Physiological	Ovoid	Perceptible/ Imperceptible
Scrotal	Ellipsoid	Rectilinear / twisty
Geographic	Rectangular	Superficial/ deep
	Pentagonal	
	Trapezoidal to asymmetrical	

SEXUAL DIMORPHISM IN TONGUE CHARACTERISTICS: Sexual dimorphism in tongue characteristics plays an important role in personal identification. It has been identified that, there are specific differences or variations in the tongue characteristics between men and women. It has been observed that scrotal tongue and geographic tongue were characteristic of female patients. According to a study, patients with sharp tip at the lingual apex were females and patients with septate tips were males [4].When comparing the length and width of the tongue between men and women, it has been observed that male patients were having an increased length and width when compared to female patients. When histologically examined there was a significant difference in the orientation of the muscle fibers of the tongue among men and women. These differences were seen in the middle region of the tongue [1].

CONCLUSION:

The tongue is a unique organ exhibiting many static and dynamic characteristics which differ considerably between individuals. Use of tongue prints as a biometric authentication tool has been under research, and studies have found it to be beneficial and comparable to other biometric tools[5]. Although so many biometrics have been used and developed, to our best knowledge, there is not so work has been done in tongue print recognition system and its use in any application yet. With increasing identity fraud and emphasis on security, there is a growing and urgent need to efficiently identify humans both locally and remotely on a routine basis. The human tongue promises to deliver a level of uniqueness to identification applications that other biometrics cannot match in context of that it is well protected in mouth and is difficult to forge. As the only internal organ that can be protruded from the body, the human tongue is well protected and is immune to forgery. The explicit features of the tongue cannot be reverse engineered, meaning that tongue verification protects the privacy of users better than other biometrics [6]. Hence new advancements and research on the potential of tongue prints as a forensic tool is warranted.

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