REVIEW

Tongue Print: A Unique Biometric and Potential Forensic Tool: A Review

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Abstract

Introduction: Forensic odontology is a branch of forensic sciences that uses the skill of a dentist in personal identification during mass calamities, sexual assault, child abuse etc. The tongue is a crucial organ very much encased inside the oral cavity and shielded from external environment. It is a unique structure that presents both geometric shape as well as physiological texture information that may be potentially useful in identity verification. The shape, colour and texture of tongue are different even in identical twins and hence it can be used as a new method for personal identification with further elaboration. The exposed portion of tongue contains information with visible differences from one individual to another therefore it is helpful in identification of suspect during forensic investigation.

Objective: This review article is aimed at describing the distinctive features of tongue, application of tongue prints in personal identification in forensic dentistry.

Conclusion: Tongue becomes the forensic evidence for establishing the cause of death. It is an evolving science in the field of forensic and there is greater scope for its further development.

Keywords: Biometric systems, Lingual impression, Tongue, Sexual dimorphism.

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Introduction

Tongue is a vital organ which performs multiple actions such as articulation of speech, perception of taste, and formation of food bolus. The human tongue is encased within the oral cavity, where it lies isolated from and protected against the external environment. Personal identity by biometric authentication has grown in popularity in recent years. Fingerprint, palm print, iris scan, signature scan etc., are the different biometric methods in use for biometric authentication.[1] Bite mark analysis, cheiloscopy, tongue print, rugoscopy, odontometry, tooth print, radiographs, DNA analysis, comparison with previous dental records, and other techniques are some of the contemporary technologies utilised in forensic odontology. The use of tongue prints as a biometric instrument has gained popularity recently. This review emphasizes the distinction of tongue prints and their benefits over other biometric techniques. Different techniques for collecting tongue prints, classifying them, and discussing how they might be used in forensic dentistry are also covered.

Discussion

Uniqueness of tongue

The tongue is a critical organ, and Traditional Chinese Medicine (TCM) refers to it as the "Tongue of life" because it has a vital colour. The "Tongue of death," in contrast, is thus named in TCM due to its gloomy and withered appearance.

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The main internal organ that can typically and readily be exposed for forensic odontology examination purposes is the tongue. Tongue is proof of life that is whether the person is alive or dead. Only when a person is alive can they protrude the tongue for examination purposes. It has unique shape and surface textures in each individual.[2] With more explanation, the tongue's shape, colour, and texture can be utilized as a novel approach for identifying individuals because they differ among identical twins.[3]

Difference between tongue print and other biometrics systems

A person's identity can be verified using a variety of

biometric technologies, such as fingerprint, face, palm print, iris, hand shape, gait, voice, and signature. However, due to its ease of forging, this old biometric system has several limitations.[4] Every biometric technology has some advantages and disadvantages. These systems' drawbacks make them unsafe for application in forensic sciences. The major drawback of fingerprints is that they are susceptible to erosion, surgery, and injury, all of which can modify a fingerprint and render it unreliable. The voice's drawback is that illnesses like a cold or a cough can influence it. The retinal scan is the most sensitive, but cataract and astigmatism can be a down fall in case of retinal scans. Skin colour is yet another sort of biometric system; however it has stability issues because of the variations brought on by ageing, burns, illnesses, and the use of skin creams or pharmaceuticals.

Using a tongue print has many advantages over other biometric methods. Everybody has a different tongue, both in terms of form and surface roughness. It can be easily exposed for investigation because it is an internal organ, and the information needed is on the exposed surface. The physiological shape and texture don't change. Since it is adequately insulated from the outside environment, external variables do not impact it. It is also a trustworthy indicator of life.

Recording of tongue print

There are numerous methods for obtaining tongue prints.

The colour of the tongue, differences in surface texture, movement, and any other particular characteristics that may be present can all be examined by simple visual inspection.

Three reference focuses are used to determine the shape of the tongue. The tip of the tongue and the region of the tongue in touch with the commissure of the lips when they are stretched outside of the mouth are reference points (Figure 1).

Alginate impressions followed by cast preparation can be used for analysis. For research purposes, it is possible to record and replicate the distinctive characteristics of the tongue on a cast.

Analyzing digital photos is another option. Digital software automatically corrects the colour, hue, and positioning changes before analyzing the tongue to compare it to a data base for accurate identification. However, numerous studies are being conducted to create a precise algorithm for analyzing tongue image data.[5]

Table 1: Classification of tongue features by Stefanescuet al.

Tongue texture	Shapes of tongue	Longitudinal grooves	Lingual apex
Physiological	Ovoid	Perceptible/ imperceptible	Sharp
Scrotal	Ellipsoid	Rectilinear/ twisty	Septate
Geographical	Rectangular	Superficial/ deep	
	Pentagonal		
	Trapezoidal or asymmetrical		

Since the tongue is a movable organ, many alternative techniques have been employed to record video of it and extract images from it. Sublingual valve analysis is the method of tongue diagnostics that is most frequently employed. For the examination of tongue function, an ultrasonic transducer is introduced and positioned in the sublingual region.[6]

The histological examination is another technique that is useful for tongue testing. Everybody has a unique dorsal surface to their tongue.

The distinctive features of the tongue differ even between identical twins. When combined with cheiloscopy and rugoscopy, taking an impression of the dorsal surface of the tongue, including the lateral borders, is the most effective forensic odontology evidence.

Application of tongue print in forensic odontology

It has distinctive qualities like colour, shape, and surface characteristics that vary from person to person. It serves as a tool for personal identification because they differ amongst identical twins. The tongue's texture and shape are both used for identification. The exposed part of the tongue includes information that differs visibly from person to person; as a result, it aids in the identification of suspects during forensic investigations.

The forensic evidence used to determine the cause of

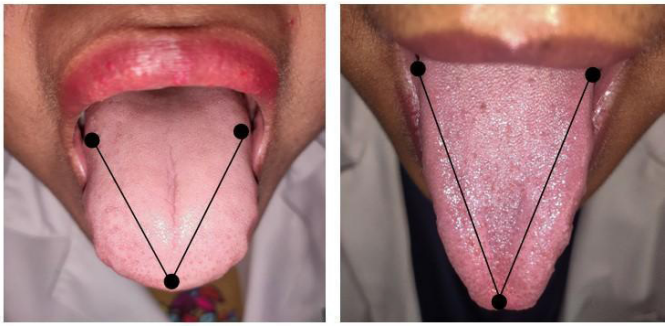

Fig. 1: Reference points on tongue for shape determination

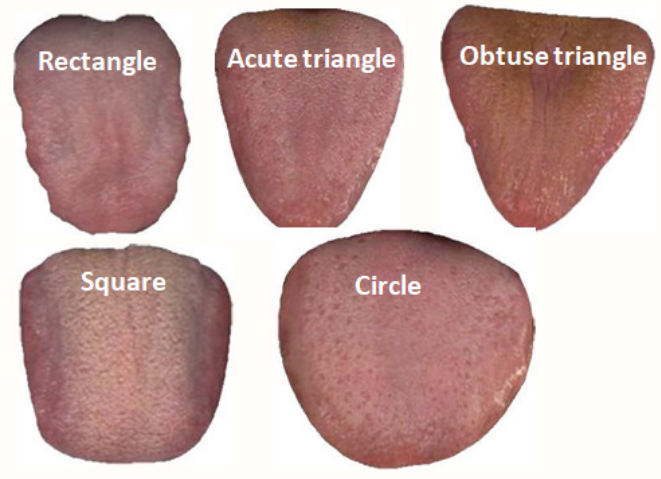

Fig. 2: Different shapes of tongue

death is the tongue. Important drowning evidence includes a biting tongue in addition to bulging eyes, anus, and enlarged abdomen. Protrusion of tongue is evidence in detecting the death by hanging whereas dark tongue becomes the evidence in case of poisoning.

Classification

The different aspects of the tongue that are considered for assessment are vitality, color, shape, surface texture, moisture, and movement in case of living cases.

According to Traditional Chinese Medicine (TCM), the shape can be classified as: - rectangular, acute triangular, obtuse triangular, square, circular (Figure 2).[7]

Texture Feature is calculated by SIFT (Scale Invariant Feature Transform) Algorithm which is Pre-processed by Histogram Equalization. According to texture tongue can be classified as-physiological and pathological (geographical, scrotal, smooth, hairy, furrowing, and ulcerated).[8] The term "tongue fissure" describes the furrows or grooves found on the tongue's dorsal surface. A single groove or several grooves may be present. The two options are shallow and deep. The term "smooth tongue" describes a tongue free of fissures or cracks. The existence of a fibrous band in the tongue's tip, a moderate or partial cleft in the tongue's tip that seems to be a bifid tongue, etc., are other variations that have been noticed. Stefanescu et al. proposed a new categorization in 2014 (Table 1). [9]

Sexual Dimorphism in Tongue

Scrotal tongue and geographic tongue have been noted to be characteristics of female patients when examining sexual dimorphism. According to a study, male patients had septate tips while patients with sharp ends at the lingual apex were usually female. Men and females had different tongue lengths and widths, with males having longer and wider tongues than females. Men and women's tongue muscle fiber orientation has been found to differ significantly between the sexes by histological analysis.

Conclusion

The uniqueness of tongue prints makes them a useful tool for biometric systems and personal identification. Dentists can regularly use the procedure for tongue prints. A clue for personal identification can be found in the lingual photograph that the dentist took. In this digital age, tongue prints have a bright future as a forensic odontology instrument.

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