

Tongue Prints: A Forensic Review

Gargi Nimbalkar¹, Ruchita Patil², Simran Nathani², Sakshi Salve²,
Kumar Gaurav Chhabra³, Shravani Deolia⁴ Amit Reche¹

¹Assistant Professor, Department of Public Health Dentistry, Sharad Pawar Dental College and Hospital, Datta Meghe Institute of Medical Sciences (Deemed to be University), Sawangi (Meghe), Wardha, Maharashtra, India- 442001, ²Intern, Sharad Pawar Dental College and Hospital, Datta Meghe Institute of Medical Sciences (Deemed to be University), Sawangi (Meghe), Wardha, 442001, ³Associate Professor and Head, Department of Public Health Dentistry, Sharad Pawar Dental College and Hospital, Datta Meghe Institute of Medical Sciences (Deemed to be University), Sawangi (Meghe), Wardha, Maharashtra, India- 442001, ⁴Research in-charge, Vidya Cancer Hospital, Gwalior

Abstract

Forensic odontology is a branch of forensic sciences which prove to be very helpful during investigation of criminal cases and during person identification by providing the dental expertise in the court and to the legal system so that proper justice can be done based on evidence. The tongue is a crucial organ very much encased inside the oral cavity and shielded from nature. Tongue print is the subtleties present on uncovered section of tongue when the surface and shape are assembled. The morphology and surface highlights are attributes of each person, and these characteristics can be utilized for criminological distinguishing proof. It has unique shape and surface textures in each individual. The shape, colour and texture of tongue are different in identical twins. And hence it can be used as a new method for personal identification with further elaboration. The unique features make it a valuable tool in forensic odontology. 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. 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. The use of tongue print as forensic identification is at budding stage but now its use as a biometric authentication system is gaining a lot of popularity. This review is aimed at describing the distinctive features of tongue, application of tongue prints in personal identification and as biometric system and the challenges faced in its use.

Keywords: Tongue print; Forensics; Biometric; Identification; Forensic odontology.

Introduction

Forensic science or forensics is a multidisciplinary

branch of a science which uses the scientific concepts in issues of law¹. Forensic odontology can be characterized as a part of dentistry which manages the suitable taking care of and assessment of dental proof and with the correct assessment and introduction of dental discoveries in light of a legitimate concern for equity². Forensic odontology is a branch of forensic sciences which prove to be very helpful during investigation of criminal cases and during person identification by providing the dental expertise in the court and to the legal system³ so that proper justice can be done based on evidence. Forensic dentistry or forensic odontology includes various zones; the general definition might be the mix of the science and craft of dentistry and lawful

Corresponding Author:

Dr. Kumar Gaurav Chhabra

Associate Professor and Head, Department of Public Health Dentistry, Sharad Pawar Dental College and Hospital, Datta Meghe Institute of Medical Sciences (Deemed to be University), Sawangi (Meghe), Wardha, Maharashtra, India- 442001

Mobile No.: 7976840339

e-mail: rajsushil.chhabra@gmail.com

framework, a junction of dental science and law⁴. It is an evolving science in the field of forensic and there is greater scope for its further development. As the dental tissues are often preserved even after death of person, whether the person's body is decomposed, skeletonized, burnt, or dismembered⁵. Therefore, it has established a great popularity in medico-legal matters and in the identification of the dead person.

With advancement in technology, the tools have evolved as well. The various tools currently used in forensic odontology include bite mark analysis⁶, Cheiloscopy^{7,27}, Tongue print⁸, Rugoscopy⁹, Odontometric¹⁰, Tooth print¹¹, Radiographs¹², DNA analysis⁶, comparison with past dental records⁶ etc.

Therefore this review aims to throw light on new tool- tongue prints which has evolved in recent times owing to its uniqueness. It is an effort to summarise the distinctive features of tongue, its usefulness in personal identification, use as a biometric tool, its limitations and future scope so as to understand its implication in forensic odontology.

Tongue Print: Tongue print is the subtleties present on uncovered section of tongue when the surface and shape are assembled¹³. Tongue can be effortlessly exposed for inspection but at the same time it is well protected from any kind of environmental influences and therefore it is quite difficult to manipulate or forge the tongue print¹⁴. However, the use of tongue print as forensic identification is at budding stage⁵ but now its use as a biometric authentication system is gaining a lot of popularity¹³.

Overview of Tongue: The tongue is an exceptionally movable set of muscles, which is richly supplied with blood and nerves¹⁵. Tongue is joined to the mandible, hyoid bone, pharynx, sense of taste and styloid process by means of muscles. It comprises two sections; a foremost 66% and a back 33% which is partitioned by V-formed sulcus terminalis¹⁶. The root of the tongue is securely anchored to the floor of the mouth¹⁵. The mucous layer of tongue has three kinds of papillae. The dorsum of

the tongue show filiform papillae. Fungiform papillae are seen close to the surface of tongue, are marginally redder and increasingly at tip and edges of the tongue. Circumvallate papillae are approximately 8 to 12 in number¹⁷. They are bigger in size and are positioned at the intersection of oral and pharyngeal tongue¹⁷. It is pink in colour and moist with neither localized nor diffuse discoloration nor ulceration¹⁷. The human tongue is known as the mirror of the oral and general health¹⁸.

Unique Features of Tongue: Tongue is the main organ that is available inside which can be ordinarily and easily be uncovered for investigation purposes in forensic odontology¹⁹. The process of tongue inspection gives a reliable confirmation of life²⁰. It has unique shape and surface textures in each individual¹⁹. The shape, colour and texture of tongue are different in identical twins²¹. And hence it can be used as a new method for personal identification with further elaboration²¹. It performs various functions such as articulation of speech, perception of taste, and formation of bolus²².

When the morphology of the tongue is examined it displays a "U-shape", with slightly round off tip. The other commonly seen shape of the tongue was trapezoidal, which have the large base at the oral commissures level and a smaller base at anterior side⁸. In the dorsum surface of the tongue there is presence of fissures which is the most common morphological feature¹³. A preliminary study stated that geographic tongue and sharp tips are commonly found in female subjects, whereas a septate tip is a common feature in males¹⁸. Gender wise differences are observed in width and length of the tongue with Males depicting an increased width and length of tongue as compared to females²³.

Recording Tongue Print: There are different ways that can be used to obtain tongue prints. Some of the basic features of tongue like the colour of the tongue, variations in surface texture, mobility and any other special characteristics if present they can be inspected by simple visualisation.



Figure 1: Reference points on tongue for shape determination 24

Determination of the shape of tongue is done by utilizing three reference focuses. The reference focuses incorporate the area of the tongue in contact with the commissure of the lips when distended outside the mouth and the tip of the tongue, as depicted in Figure 1²⁴. The most viable option for tongue assessment is a three dimensional analysis.

Alginate impressions followed by cast preparation can be used for analysis. The unique features of tongue can be captured and those can be reproduced on cast for study purpose¹⁸. Digital images can also be used for analysis. Digital software autocorrects the colour and hue along with positional alterations and later analyses the tongue for it to match with data base for positive identification. However, there are a number of researches going on to prepare an exact algorithm for analysis of tongue images²⁵.

There are various other method that are been used to capture the video of tongue and to pull out the images from it as this organ is non-rigid. The most common technique used in tongue diagnosis is sublingual valve analysis. An ultrasound transducer is introduced that is positioned in sublingual area for the analysis of the tongue function²⁶. Another method that is helpful for the examination of tongue is the Histological examination. Tongue dorsal surface is different in each person. Even between identical twins the characteristic features of tongue are different²¹. The most useful proof in forensic odontology is taking impression of the dorsal surface of tongue including lateral borders when it is used in combination with Cheiloscopy and Rugoscopy^{10,27}.

Application of Tongue Print in Forensic Odontology: It has unique features like colour, shape,

and surface features which are different from person to person. They are different between identical twins also making it a tool for personal identification. Both texture and shape of the tongue is used for identification purpose. 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.

Tongue becomes the forensic evidence for establishing the cause of death. Bitten tongue in addition to protruding eyes or anus and swollen abdomen is important evidence in drowning. Protrusion of tongue is evidence in detecting the death by hanging whereas dark tongue becomes the evidence in case of poisoning.

Tongue Print as Biometric System: There are various biometric systems that are used for recognition of person's identity which includes fingerprint, face, palm print, iris, hand shape, gait, voice, and signature. However, this traditional biometric system has some restriction as they can be easily forged¹⁹. Each biometric system has some advantages and some disadvantages. The disadvantages of these systems make it vulnerable to use in forensic sciences. Fingerprints cannot be trusted because of their biggest disadvantage that they can be eroded, altered by surgery, and are subjected to injuries due to which finger print can be altered. The disadvantage with the voice is that it can get affected by sickness such as cold and cough. The most sensitive being the retinal scan. But cataract and astigmatism can be a down fall in case of retinal scans. Yet another type of biometric system is skin colour, but it is subjected to stability problems due to the differences that are seen with age, burns, diseases, and use of skin creams or medications.

Lately, tongue print is increasing a great deal force as a significant apparatus in biometric verification. A study was done in which Dual tree complex wavelet transform (DT-CWT) was used to draw out some unique features of tongue (size, shape, textures). This revealed that use of the sensors and some other contributed resources in real time environment, with DT-CWT, tongue would be definitely a stepping stone in personal identification and authorization process by means of security³⁰. Though the research is in budding stage the results are promising.

Future Scope of Tongue Print: Various technologies are being used to capture and analyse tongue prints including spectral analysis, Gabor filter and wavelet transformers, all these technologies yield different results. The tongue print verification procedure can be done by tongue images, which goes to pre-processing for shape analysis and texture analysis of tongue. After matching the score of shape vector and texture code, fusion and decision is taken placed for verification and matching of the tongue. Therefore, the complexity involved in capturing and analysis for achieving accurate results becomes a limitation as it requires expensive resources and expertise. Rapid advancement in technological field will overcome these limitations and enable easy use of this tongue prints in forensic odontology and therefore the future looks promising.

Conclusion

The uniqueness of tongue prints makes it a good tool for personal identification and biometric system. Dentists can adopt the technique for tongue prints on a regular basis. The lingual photographic image which taken by dentist can serve as a guide for personal identification. Tongue prints hold a promising future in this digitalized word as a tool in forensic odontology.

Ethical Clearance: Taken from institutional ethics committee.

Source of Funding: Self.

Conflict of Interest: Nil.

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