Review Article

Postmortem Identification in Forensic Odontology

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Received: September, 2016.
Accepted: January, 2017.

Abstract

Forensic odontology is that part of dentistry which deals with the identification of a deceased individual by carefully examining and studying dental evidence. Over the years, many methods have been developed to identify the identity of a person. By studying the teeth and oral cavity, a forensic dentist can determine the age, gender, race and quite possible the identity of the individual. The key component in forensic sciences is to identify and compare a particular trait which is unique to that individual. In forensic odontology, a few traits have been identified such as bitemarks, enamel rod patterns, lip patterns, and genetic information embedded within the hard tissue of the tooth.

Key Words: *Ameloglyphics, bitemarks, cryogenic grinding, forensic odontology, rugae*

Introduction

Pederson states that forensic odontology is a branch of odontology which deals with the proper handling and examination of dental evidence and with the proper evaluation and presentation of dental findings in the interest of justice.[1] Forensic odontology is an instrumental component for human identification which is used in investigating missing persons, disaster recovery, and prosecuting crimes. The most accurate method is always to recover the DNA from the evidence and send for DNA analysis. However, in many cases, it may not be possible due to unforeseen circumstances. The teeth are highly calcified having a coat made of enamel and dentin. Enamel is made of 99% inorganic substance making it the hardest and most durable substance of the human body. It can survive harsh environments such as fire, postmortem circumstances, bacterial decomposition, immersion in water, and burial.[2] This armor protects the pulp chamber which is a potential source of DNA.

Bitemark Analysis

The bitemark is an excellent tool which can be used to for sex determination. Hence, they are referred to as dental fingerprints.[3] Bitemarks are unique and specific for every individual. Characteristics in the teeth which can assist forensic dentists are missing teeth or supernumerary tooth, rotated or malposed teeth, restored teeth, alterations in the shape of teeth, spacing, crowding, size of teeth, arch shape and width, etc. These characteristic features are recorded from the crime scene and compared with the suspected biters dentition. Gender can be differentiated by comparing tooth size, root length and crown diameter, canine dimorphism, tooth morphology and sexing, dental index, and odontometric differences.[4]

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Quick Response Code:

Website: www.ijofo.org

DOI: 10.4103/2542-5013.205247

Ameloglyphics

Amelo refers to enamel while glyphics mean carving. Hence, ameloglyphics or the study of tooth prints is the study of enamel rod patterns. During amelogenesis, enamel does not remodel once it has been laid down. The ameloblast move away from the enamel that has been formed, hence, there is no remodeling of enamel. The specific morphology laid behind is therefore very characteristic of an individual. A study done by Manjunath *et al*. investigating enamel patterns in 30 males and 30 females volunteers using cellulose acetate peel technique revealed that the enamel rod pattern were unique and different for every tooth, every individual, and showed gender variation.[5] The same study also revealed that the wavy branched subpattern was the predominant subpattern observed among the examined teeth. Another study by Juneja *et al*. showed that tooth prints were reproducible in tooth exposed to high temperatures up to 750°C and up to 20 min immersion in 36.46% concentrated hydrochloric acid solution. Hence, tooth prints will prove to be an invaluable tool when soft tissue samples are not attainable such as in cases of air crash and bomb blasts.[6]

Cheiloscopy

First described by Fischer in 1902, cheiloscopy is the study of lip prints.[7] Fischer described the systems of furrows on the red part of human lips. Just like a fingerprint, the furrows and grooves on the sulci labiorum form a pattern unique and permanent to each individual. At the 6th week of intrauterine life, the lip prints can already be identified, and it has been

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How to cite this article: Yang JN, Raj JD. Postmortem identification in forensic odontology. Int J Forensic Odontol 2017;2:27-9.

proved that lip prints are unchangeable and will recover even after trauma or diseases affecting the lips like herpes.[8] Tsuchihashi then proposed a classification for lip prints which is commonly followed.[9] Type I are clear-cut vertical grooves that run across the entire lips; Type Ia are grooves which are similar to Type I but do not cover the entire lip; Type II are branched grooves (branching Y-shaped pattern); Type III are criss-cross pattern; Type IV are reticular patterns; and Type V are miscellaneous patterns. Remya *et al*. studied lip prints among 100 males and 100 females within the age limit of 18–23 years and revealed that there were no similarities among all volunteers, and the majority of the volunteers had Type IV (26%) lip print followed by Type Ia (23.5%) and Type V (7.5%). The study also revealed that Type III (33%) was predominantly seen in females and Type IV (38%) was predominantly seen in males.[10] A study by Gowhar *et al*. with a sample size of 50 males and 50 females manage to correctly recognize 42 females and 46 males using lip prints alone.[11]

Palatoscopy

Palatoscopy or palatal rugoscopy is the study of the palatal rugae for the purpose of human identification. The palatal rugae are irregular and asymmetrical elevations or ridges arranged in transverse direction found on the mucosa in the anterior one-third of the palate. It is said that the palatal rugae aids in swallowing, speech and in improving the relationship between food and the taste receptors of the tongue.[12,13] The shape and pattern of the palatal rugae are also unique to each individual and therefore qualify to be used as an identification tool. A study done by Almeida *et al*. determined that the palatal rugae are stable landmarks which remain the same during normal growth and postorthodontic treatment.[14] The palatal rugae are also reproduced exactly on the same site it had if is destroyed by chemical, heat or disease. However, Peavy and Kendrick reported that minor changes may occur to palatal ruage close to the alveolar arch where dental extractions are performed.[15] Limson and Julian also noted that extractions may cause changes in the direction of palatal rugae.[16] There are various systems to classify the palatal rugae including Lysell classification, Lima (1968) classification Carrea (1955) classification, Trobo classifi cation, Kapali *et al*. classifi cation, Bansuri classifi cation, and Thomas *et al*. classifi cation as described in a review by Sabarigirinathan C *et al*.[17] The simplest method to inspect the rugae is by intraoral inspection. Intraoral photographs and impressions may be used to preserve evidence to be used for comparison.

Cryogenic Grinding

Cryogenic grinding is a method whereby the tooth is made extremely brittle by cooling it and then pulverizing it into a fine powder. It is also known as freezer milling, freezer grinding or cryomilling and is pioneered by Sweet and Hildebrand.[2] The tooth is first immersed into liquid nitrogen and then pulverized using a freezer mill. Liquid nitrogen serves two purposes where it cools the tooth making it brittle and secondly it protects the DNA from heat degradation. In the freezer mill, an alternating current is produced which moves the magnetic plunger back and forth which impacts the tooth against an anvil at both ends of the freezer mill until it becomes a fine powder. Following that, lysis buffer is added to open the membranes of the cells and nucleus. Following that the DNA is isolated purified and concentrated and is then ready to be amplified using polymerase chain reaction. One gram of tooth powder was found to be able to yield approximately 18.4 μg of DNA material.[2] Other methods used to extract DNA from the tooth are by doing an endodontic access, vertical or horizontal splitting or by crushing. However, the disadvantages of the endodontic access and splitting of teeth are the possible contamination from the environment and DNA degeneration from burs and carborundum discs used. Cryogenic grinding is preferred as it can prevent contamination from the environment as the pulverization of samples are done in a closed system, and individual components can be cleaned and sterilized thus reducing cross contamination.

Conclusion

The uniqueness and dissimilarities between individuals make it possible for personal identification. Various parts of the oral cavity are potential landmarks which can be utilized to aid in human identification. Each method has their advantages and disadvantages. Depending on the situation, multiple methods can always may be combined and used to help narrow down the possibilities. Hence, the knowledge of a forensic odontologist in various methods greatly influences the efficiency of human identification.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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