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Need for Newer Techniques for Personal Identification

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Abstract

Modern life is characterized by the concentration of large populations in a given area. With this comes an increased need for new and reliable methods of forensic identification to identify victims of mass disasters. Ameloglyphics (the study of enamel rod end patterns on a tooth surface) reveals that the enamel rod end pattern is unique for each tooth in an individual. It shows both intra- and inter individual variation. The use of these different patterns can also be extended to identification and possible correlation between the occurrence of several congenital defects and acquired diseases. Thus, this field demands a need for further exploration towards the use of tooth prints for establishing an individual's identity which can turn out to be an emerging aid in personal identification.

Keywords: Ameloglyphics; Tooth prints; Enamel rod end patterns

Introduction

Identification of an individual is becoming very important in the present world. It may be required in simple procedures such as logging into a computer network, in more complex situations like post-mortem identification and crime analysis. Numerous methods have been used for personal identification in forensic odontology, which include rugoscopy, cheiloscopy, bite marks, radiographs, photographic study and molecular methods. These identification methods commonly fail or have certain limitations and may not be efficient when bodies are decomposed, burned or in cases when only small fragments of calcified tissues are left [1]. A recent technique known as 'Ameloglyphics' i.e. the study of pattern of enamel rods (amelo meaning enamel; glyphics meaning carvings) is of particular interest as the enamel of teeth is a highly calcified structure in the body that resists decomposition; tooth print is composed of combination of basic sub-patterns in contrast to finger print which is composed of a single distinct pattern like whorl, loop or arch; these tooth prints, are unique to single tooth, exhibiting dissimilarity both between teeth of different individuals and of the same individual and this technique is simple, inexpensive, rapid and can also be performed by non-professionals [2]. Usually, this method of personal identification can be recommended for those individuals working in dangerous occupations such as fire fighters, soldiers, jet pilots, divers, and people who live or travel to politically unstable areas prior to their assignments and must be updated periodically to overcome the enamel loss due to wear and tear. These advantages and uniqueness of the tooth print could be used as a valuable tool in forensic science for personal identification [3].

The use of these different patterns can also be extended to identification and possible correlation between the occurrence of several congenital defects and acquired diseases. For example, the spectrum of dermatoglyphics, rugoscopy and cheiloscopy has extended from individual identification, gender determination, to predilection of occurrence of cleft lip and palate. It has also been possible to understand the familial occurrence of such congenital defects using these relatively inexpensive modalities. Likewise, the use of enamel rod end patterns can be made to identify the susceptibility of an individual to common dental ailments, which are acquired during one's lifetime [3].

Enamel is a product of ectoderm-derived cells. The process of enamel formation is a complex and organized one, carried out by specialized cells called ameloblasts. The ameloblasts lay down the enamel rods in an undulating and inter-twining path which has been attributed to high tensile strength of enamel and appearance of gnarled enamel and Hunter-Schreger bands. So, the enamel rods do not traverse the whole length of enamel in a straight path. This is reflected on the outer surface of the enamel as patterns of the ends of a series of adjacent enamel rods. These enamel rod end patterns or tooth prints could be duplicated by various methods like using cellulose acetate peel technique, cellophane tape technique, rubber base impression materials, etc [1,4]. Acetate peel technique which was first developed by paleobotanist Walton in the year 1928, to study the cellular structures of fossil plants, is a well-known and commonly used technique for replicating surface details.

Biometrics refers to identification of individuals using biological traits, such as those based on retinal or iris scanning, fingerprints, or faces recognition. Verifinger® standard SDK version 5.0 is biometric software designed to compare and analyze finger prints. This software can be used successfully to study the pattern of enamel rod endings on the enamel surface [5].

Cellulose Acetate Peel Technique

The teeth to be analyzed should be scaled and polished. Generally the middle third of the facial surface of the tooth is selected for analysis as it is most resistant to changes due to attrition, abrasion, etc. The surface then needs to be etched with acids like 37% orthophosphoric acid for 20 seconds, washed with water and dried. A thin layer of acetone is then applied over a small piece of cellulose acetate film and placed immediately over the etched surface of the tooth without any finger pressure for 20 minutes. The acetone dissolves a layer of

cellulose acetate, and the dissolute settles down along the irregularities on the enamel surface. The film is gently peeled after 20 minutes and observed under light microscope. A photomicrograph of the acetate peel is obtained at 10x magnification.

Cellophane Tape Technique

A portion of extended cellophane tape is to be applied over the conditioned area without finger pressure with a small piece of cotton roll applied over the same for better adaption of the cellophane tape. The cellophane tape is then immediately pulled off gently and placed on a clean glass slide and observed under light microscope.

Rubber-Base Impression Material Technique

The catalyst and base of light body rubber impression material needs to be evenly mixed for appropriate consistency and immediately placed on the conditioned surface. Light body type impression material is used because of its thin consistency and less viscosity, which helps record even minor details more accurately. After the setting of the impression material, the replica is carefully peeled and placed on a clean glass slide and observed under the stereomicroscope (because rubber-base impression material is not a translucent material to view under light microscope).

Out of the three techniques, cellulose acetate peel technique is reliable and preferred because it shows complete patterns and sub-patterns of enamel rod endings and no empty spaces are seen. This technique reproduces the same pattern and sub-patterns of enamel rod endings in subsequent imprints taken from the same area of the same tooth [1].

Biometric Analysis

The microphotograph is then subjected to biometric analysis using the software like Verifinger® standard SDK version 5.0, software. The software recognizes the patterns of enamel rod endings as series of lines running in varying directions. The software uses certain points called minutae for identification of each pattern and to compare the similarity/variability of two patterns. Minutae are discontinuities of the lines; it may be line endings or the point at which ridge stops, dots are very small lines and ponds empty spaces between two lines etc.. [5].

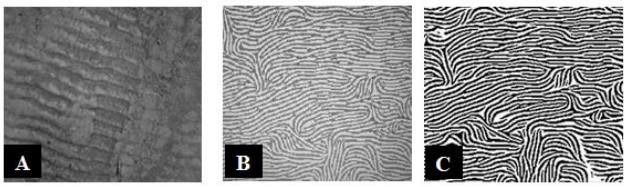

Figure 1: A) Photomicrograph of acetate peel at 10x magnification. B) Biometric generation of tooth print with minutae using verifinger®. C) Tooth print obtained representing the series of endings of adjacent enamel rods [6].

Tooth prints obtained from different teeth can be divided into 8 distinct sub-patterns namely wavy-branched, wavy-unbranched, linear-branched, linear-unbranched, whorl-open, whorl-closed, loop and stem-like. Each tooth print was a combination of these sub-patterns.

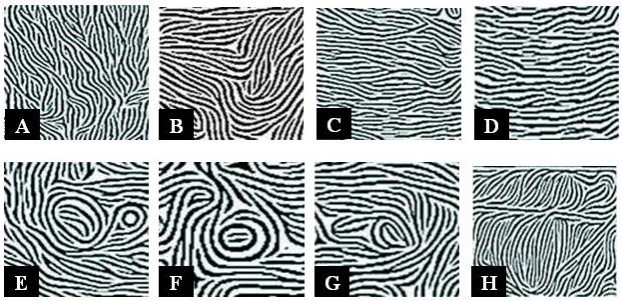

Figure 2: Distinct sub-patterns observed in tooth prints. A) wavy-branched B) wavy-unbranched C) linear-branched D) linear-unbranched E) whorl-open F) whorl-closed G) loop H) stem-like [6].

Need for Further Research

The enamel surface is always subject to both micro- and macro-wearing. Even though enamel is the hardest substance in the body, processes like abrasion, attrition and erosion wears the outermost layer of enamel rod ends, and exposes the underneath layer. The effect of these processes on the pattern of enamel rod ends needs to be determined. Theoretically the enamel rod end pattern should vary at varying depths of enamel, which needs to be verified by further studies. Even though tooth prints, are unique to an individual tooth, the value of it as a tool in forensic science for personal identification lies in its reproduction and permanency. These two attributes of tooth prints needs to be evaluated by further studies.

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