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Review Article

Is Re-Creation Of Human Identity Possible Using Tooth Prints? An Experimental Study to Aid in Identification

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Abstract

Enamel in teeth, as documented is the hardest substance in the entire human body. Tooth prints are the enamel rod end patterns on the tooth surface. Could this fact be a boon in utilizing it for an individual's identification in the hands of forensic experts? A study has been attempted towards the same. These tooth prints were recorded for sixty extracted tooth specimens after acid etching using a cellophane tape. Subsequently a digital image of the print was obtained which was subjected to biometric conversion using Verifinger standard SDK version 6.0 software followed by the use of Automated Fingerprint Identification System (AFIS) software for comparison of the tooth prints. In results we observed that tooth prints were composed of varied patterns and sub patterns. A comparison was made between the tooth prints of different and the same individual and also between different classes of teeth (incisors, canines, premolars and molars). None of the patterns exhibited intra- and inter- individual similarity. Nor did any particular class of the tooth could be preferentially used over the other for an individual identification. This field demands a need for further exploration towards the use of tooth prints for establishing an individual's identity.

Keywords: Ename,Tooth prints,Forensic experts.

Introduction

Forensic investigations are based on finding differences – polymorphisms, between different individuals. These differences can take many forms such as differences in facial appearances, differences in hair color etc. Some variations are unique and some are not. Indeed individual identification is the tenet of biology.[1] Positive identification traditionally involves a comparison of data unique to an individual like finger prints, palm prints, foot prints, DNA identification and radiographic superimposition. [1]These identification methods have limitations and may not be efficient when bodies are decomposed, burned or in cases when only small fragments of calcified tissues are left.[2]

To identify individuals is an ongoing request made to the dentists throughout the world.[3] Dental evidence may produce compelling associations to aid in the victim's identity and establish facts that can affect direction and ultimate outcome of investigative caseword. This is more so, because teeth are relatively resistant to environmental factors and post-mortem proteolysis. Human dentition is considered as a hard tissue analog to fingerprints (reliable tools only in a body obtained prior to decomposition or mutilation).[3] In fact enamel is the least reactive of the three hard tissues of the teeth and resists decomposition. Superior organization and mineralization give dental enamel its outstanding physical properties, making it the hardest tissue in the vertebrate body.[4] In 1991, Skinner & Anderson had attempted at individualization using Striae of Retzius in enamel by correlating it with the known stressors of life to recognize a missing child, though there was a limitation of age dependency.[3] An attempt has been made in this study to see if enamel in teeth, the most durable part of the body could be used in an individual identification.

Enamel is a product of ectoderm derived

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cells called ameloblasts.[5] The basic structural unit of enamel is the enamel rods (enamel prisms). Formation of enamel is a highly organized process wherein ameloblasts(cells forming enamel) lay down the enamel rods (enamel prisms) in an undulating and inter-twining path. This is reflected on outer surface of enamel as patterns of ends of a series of adjacent enamel rods. Tooth Prints is the word used to describe these enamel rod end patterns. Ameloglyphics is the word used for the study of patterns of enamel rods *(amelo* – enamel, *glyphics* – carvings).[2] Enamel does not remodel nor does it remain in close contact with the cells which synthesize it, rather the ameloblasts retract away from the enamel surface once it has matured and the tooth has erupted. Enamel prisms morphology reflects the morphology of ameloblasts in a species specific manner. Alterations to the matrix are reflected as defects in the structural organization of enamel.[1] The enamel rod end patterns could be duplicated by various methods like using cellulose acetate paper, rubber base impression materials etc.[2] In the present study a cellophane tape has been used to obtain the replica of enamel surface. The same cellophane tape is much frequently used method by the finger prints experts to obtain an imprint of the finger.

Biometrics refers to identification of individuals using biological traits, such as those based on retinal or iris scanning, fingerprints, or faces recognition.[2] Verifinger standard SDK version 6.0 is biometric software designed to compare and analyze finger prints.

Aim

To investigate if tooth prints patterns could be used for an individual's identification to aid in forensic investigations.

Objectives

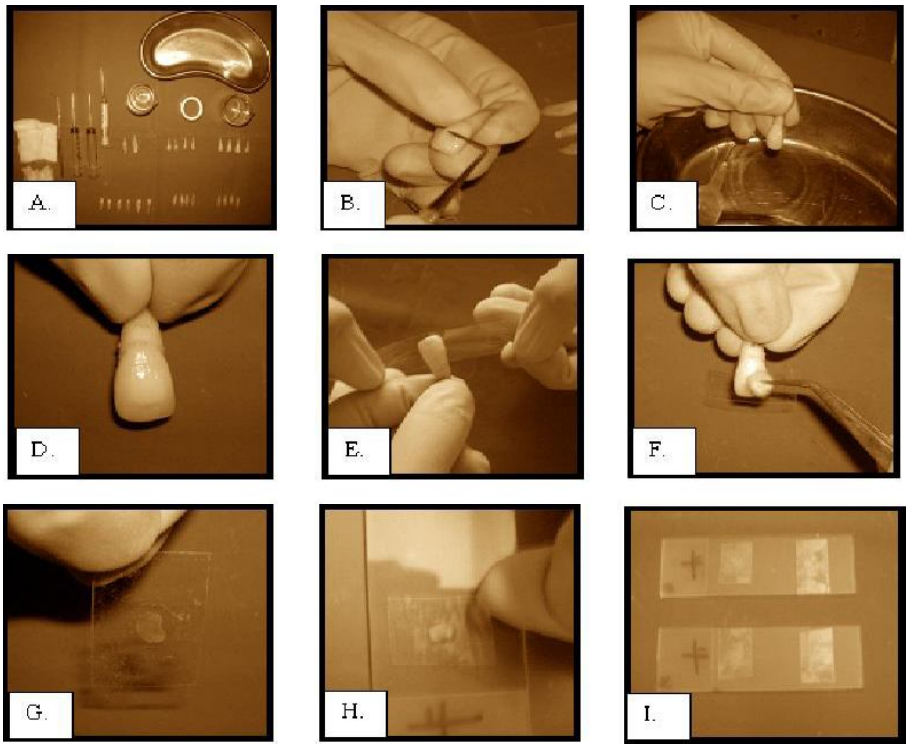
- To analyze the similarity of tooth prints of teeth from different individuals (incisors with incisors; canines with canines; premolars with premolars and molars with molars),
- To analyze similarity of tooth prints of teeth from same individual (incisors with incisors; canines with canines; premolars with premolars and molars with molars).
- To analyze which of the four classes of teeth (incisors, canines, premolars or molars) could be a best indicator of an individual identification.

Materials and Methods

In the present study, 60 different extracted teeth were collected. Of these 60 teeth, 30 were from different individuals (for inter individual comparison) and the remaining were in different numbers from the same individual (intra individual comparison). Teeth with any decay, restorations or any other regressive alterations like attrition, abrasion or erosion, hypoplasia were not a part of the selection.

All the extracted teeth were scaled. The mid of the middle third of the facial/buccal surface of the tooth was etched with 37% orthophosphoric acid for 2 minutes. The reason behind this site selection being that, the rods here run nearly horizontally from the dentino-enamel junction to the enamel surface. The etched surface was then washed with water. This was followed by a spray of ethyl alcohol on the same area. This made the drying of the etched surface easier without any leftover residual moisture prior to taking of an imprint. Next a portion of extended cellophane tape was applied over the etched area without any finger pressure. A small piece of cotton roll was applied over the same for a better adaptation of the cellophane tape. The cellophane tape was then pulled gently immediately. The portion of the cellophane tape was cut and transferred on a glass slide and observed under light microscope (Figure 1). A digital image was obtained using a digital camera (Nikon) at 40x magnification

Figure 1: A: Instruments used. B: Middle thirds of facial surface etched with 37% orthophosphoric acid. C: Water spray to be followed with spray of alcohol. D: Etched area evident as frosted surface. E: An extended cellophane tape applied over the etched area. F: Light cotton pressure applied. G: An imprint after removal of cellophane tape. H: Tooth print while transferring on the slide. I: Tooth prints transferred on the slides.



(Figure2).

The image was subjected to biometric conversion using Verifinger standard SDK version 6.0 software. The software recognizes the patterns of enamel rod endings as series of lines running in various directions. The software uses certain points called minutae for identification of each pattern. These minutae will be used by the software to compare the similarity and differences of two patterns. Minutae are discontinuities of the lines, it may be line endings the point at which the ridge stops, dot very small lines, ponds empty spaces between the two line etc.[2]

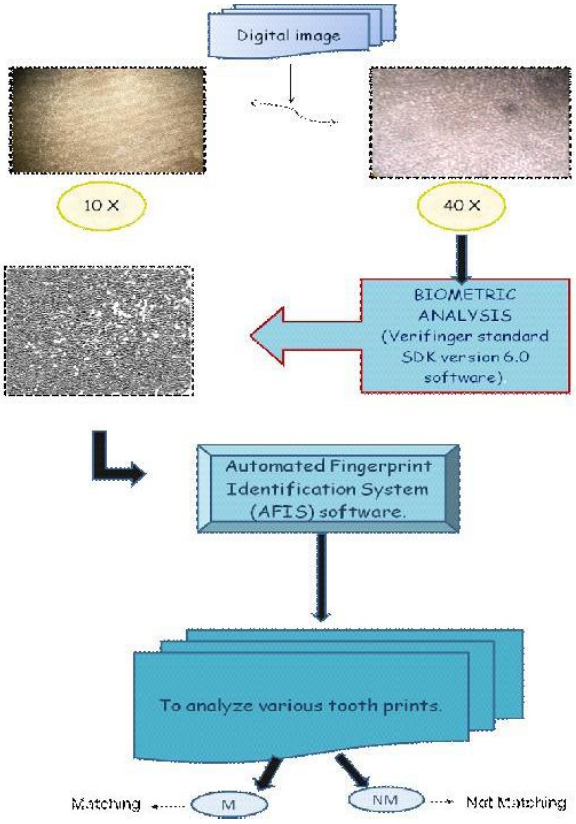
Tooth prints obtained from different teeth were analyzed for similarity among the same individuals, between different individuals and between different classes of teeth using Automated Fingerprint Identification System (AFIS) software to see if they were matching or not matching (Figure 3).

Results

In the present study a total of 60 teeth were analyzed. Each tooth print consisted of series of lines representing series of adjacent enamel rod ends. These lines created a variety of patterns and sub patterns. Some of them were like straight, linear branched, linear unbranched, turning loops, radiating whorls, open whorls, closed whorls and wavy patterns (Figure 3). A single tooth print could sometimes consist of more than one such pattern. Analysis of these patterns for the same and between different individual has yielded us totally distinct patterns.

All the 60 tooth prints so obtained were distinct from each other. A comparison of tooth prints from different individuals (incisors with incisors; canines with canines; premolars with premolars, molars with molars) and from

Figure 2: Images at 10x and 40x magnification followed by the use of the softwares for comparison



same individuals (incisors with incisors; canines with canines; premolars with premolars, molars with molars) were also dissimilar (Figure 4). Nor did any the imprint of any particular class of the tooth (incisors, canines, premolars or molars) was matching with the same type to be preferentially used over the other for an individual identification.

Discussion

Enamel is a hard protective substance that covers the crown of the teeth.[6] The enamel surface presents a variable appearance, exhibiting features such as aprismatic enamel, perikymata, prism end markings, pits and elevations. The basic structural unit of enamel is the enamel prism consisting of several million hydroxyapatite crystals packed into a long thin rod 5-6 micrometers in diameter and up to 2.5 mm in length. These prisms run from the dentino-enamel junction to the surface.[7]

Acid etching removes the smear layer producing an uneven dissolution of the enamel

Figure 3: Distinct sub-patterns observed in tooth prints. A: wavy branched. B: straight. C: linear. D: turning loops. E: wavy unbranched. F: open whorls. G: branching. H: loop. I: radiating.

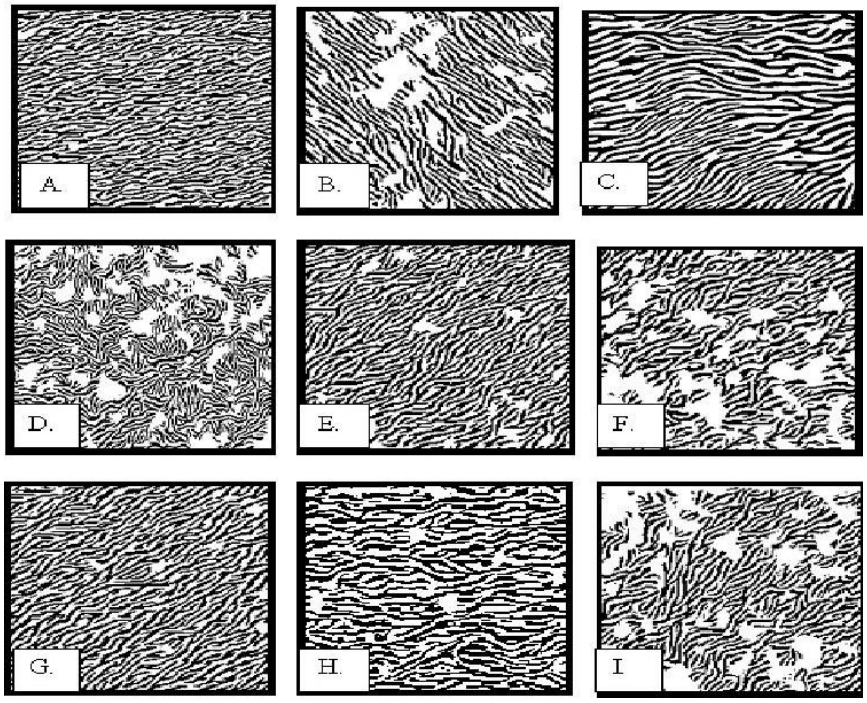
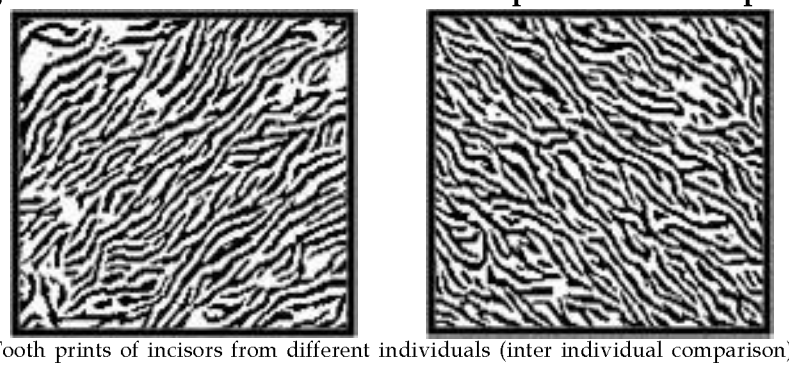
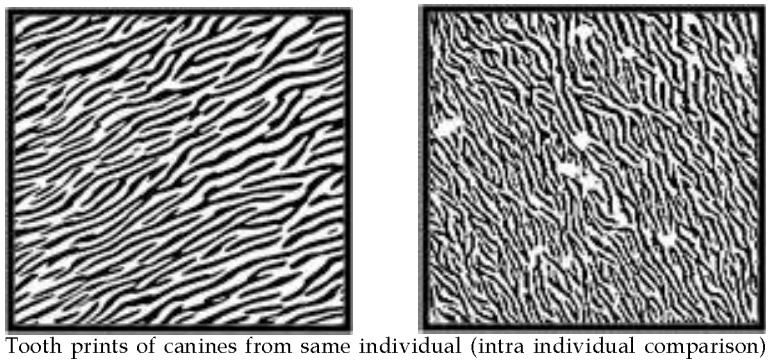


Figure 4: Inter and Intra individual comparison of tooth prints



Tooth prints of incisors from different individuals (inter individual comparison)



Tooth prints of canines from same individual (intra individual comparison)

rods and their sheath or enamel heads and their tails so that a relatively smooth surface becomes pitted and irregular.[3] Acid etching removes the surface 10 micrometers producing different enamel etching patterns. These include type I, in which there is predominant dissolution of prism cores; type II, in which there is predominant etching of prism peripheries; and type III, in which no prism structures are evident.[8]

In the study of tooth prints, we found that they are entirely different from one and another, when compared between teeth of the same and even for different individuals. Even with a slight change of field of tooth print of same individual and even the same tooth, the pattern had changed. This could probably be due to differential movement of adjacent ameloblasts in relation to the same tooth during the formation of enamel. The variations in environmental factors surrounding a developing tooth like with time might be also causing an obvious effect. These factors could include placement of the developing tooth bud, temperature, pressure, nutrition to the ameloblasts cells etc. Genetics might also have a role in predetermining the type of pattern.

Some pitfalls in the study need a mention. From the dentino-enamel junction the rods run a somewhat tortuous course to the surface of the tooth and rarely run straight throughout. This would lead to a different rod end pattern at varying depths even in the same tooth. Rods have an arcade outline near the DEJ and keyhole shaped at the enamel surface creating an obvious difference at varying depths. Rod ends are more pronounced in newly erupted teeth.[9] The various surface structures of enamel are lost subsequent to the attrition and abrasion. This could further change the enamel rod end patterns with time. But as such teeth were with regressive alterations were not included in the study group diagnosis is questionable if investigations are required for such teeth. There was a difficulty in maintaining a consistency in localization of field at 40x magnification for different teeth.

Conclusion

One of the new areas of research in the field of enamel is tooth prints. The tooth prints are unique to an individual, with dissimilarities

between those of different individuals and also the same individual. So on the whole seems to be not of much importance in a diagnostic case word. Still a lot needs to be explored about enamel rod end patterns in relation to deciduous teeth, teeth with developmental disorders and differences as per the type of etching patterns. The significance of tooth prints in forensic investigations so totally demands further studies, and more importantly with a consistency of results to recognize the truth behind these wonderful rods end patterns.

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