ORIGINAL RESEARCH

Study of Enamel Rod End Patterns Using Acetate Peel Technique and Automated Biometrics For Personal Identification

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ABSTRACT

Background: Personal identification is becoming very important in the present world. It is usually achieved by use of passwords, physical tokens, DNA analysis etc. Ameloblast cells lay down the enamel rods in a highly organized manner and is reflected on the outer surface of enamel as rod end patterns. This enamel rod end patterns are unique to an individual and can be used for personal identification. For this purpose, we studied the pattern of enamel rod endings on surface by using automated biometrics, analyzed and compared the various patterns obtained. **Materials and Method:** 30 extracted teeth were collected from different individuals & some from same individuals for inter-individual & intra-individual comparison. Enamel rod end patterns were assessed on photomicrograph of acetate peel imprints. The photomicrographs were then subjected to biometric analysis using Verifinger® standard SDK version 5.0 software. **Results:** None of the 30 tooth prints obtained showed distinct similarity to each other and the tooth prints yielded mainly three distinct sub- patterns namely linear(branched), linear (un branched) & wavy(branched). **Conclusion:** The uniqueness of the tooth print could be used as a valuable tool in forensic science for personal identification.

KEYWORDS: Acetate Peel Technique, Enamel Rod End Patterns, Forensic Science, Identification, Tooth Prints

INTRODUCTION

Personal identification 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. It is usually achieved by the use of passwords, fingerprints and more recently, DNA analysis.[1] The term 'biometrics' is used to refer to identification techniques based on physical characteristics. They are sometimes referred to as 'positive identification' because they are claimed to provide greater confidence of accurate identification. Biometric-based identification methods like fingerprint verification, facial recognition have been improved over the years having the capacity to distinguish individuals reliably.[2] Verifinger® Standard SDK Version 5.0 a biometric software is designed to compare and analyze finger prints.[3]

When the bodies are decomposed or in extreme burnt cases commonly used identification methods usually fail or have certain limitations. But enamel and dentin of the teeth are highly calcified structures in the body that resist decomposition.[4]

Formation of enamel is a highly organized process in which the ameloblasts lay down the enamel rods in an undulated and interwining path. This is reflected on the outer surface of the enamel as patterns of the ends of a series of adjacent enamel

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rods. Manjunath et al have coined a term 'Amyloglyphics' which means the study of patterns of enamel rods (amelo meaning enamel; glyphics meaning carvings).[1]

These enamel rod end patterns or tooth prints could be duplicated by various methods like using cellulose acetate paper, rubber base impression materials,cellophane tape. Cellulose acetate peel technique produces complete and unique patterns and sub-patterns of surface enamel rod endings, no empty spaces or incomplete patterns are seen. Verifinger software readily matches the enamel rod end patterns with specific identification number where as cellophane tape and rubber base impression materials shows incomplete enamel rod end patterns.[3]

In the present study the cellulose acetate peel technique was used to obtain the replica of enamel surface and Verifinger® standard SDK version 5.0 software was used to compare and analyze the various patterns obtained.

MATERIALS AND METHODS

30 different extracted teeth were collected. Some teeth were collected from different individuals and some from the same individual for inter-individual and intra-individual comparison.

***Exclusion criteria*:** Teeth with decay, attrition, abrasion, erosion, hypoplasia, fracture and/ or restorations were omitted from the study group.

All the extracted teeth were scaled and polished (figure 1A). The middle thirds of the facial surface of the tooth was etched with 37% orthophosphoric acid for 20 seconds (figure 1B), washed with water and dried. A thin layer of acetone was 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 (figure 1C). The acetone dissolves a layer of cellulose acetate and the dissolute settles down along the irregularities on the enamel surface. The film was gently peeled after 20 minutes and observed under light microscope. A photomicrograph of the acetate peel was obtained at 10x magnification. (Figure 2 A) The photomicrograph was subjected to biometric analysis using Verifinger® standard SDK version 5.0 software (figure 2 B, C). 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.

Tooth prints obtained from different teeth were analyzed for similarity among teeth of different individuals and among same individuals.

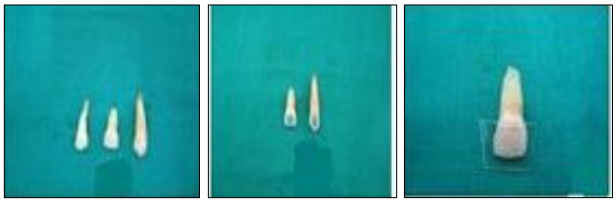

Fig No.1A Fig No.1B Fig No.1C

Figure 1: A: Tooth scaled and polished. B: Middle thirds of facial surface etched with 37% orthophosphoric acid. C: Cellulose acetate film with a thin layer of acetone placed

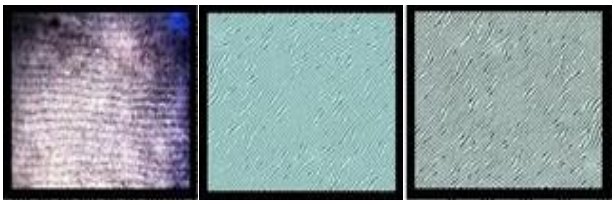

Fig No.2A Fig No.2B Fig No.2C

Figure 2: A: Photomicrograph of acetate peel (10X) .B: Biometric generation of tooth print with minutae using verifinger®. C: Tooth print obtained representing the series of endings of adjacent enamel rods.

RESULTS

30 teeth were analyzed. Each tooth print obtained composed of series of lines representing series of adjacent enamel rod ends. These lines were seen running in varying directions creating distinct sub-patterns. Analysis of the 30 tooth prints yielded 3 distinct sub-patterns namely linear(branched) (Figure 3-A), linear(unbranched) (Figure 3-B) & wavy (branched) (Figure 3- C).Each tooth print was a combination of these sub-patterns.

None of the 30 tooth prints obtained showed distinct similarity to each other. Tooth prints obtained from different individuals were dissimilar. (Figure 4-A & B) Similarly tooth prints obtained

from same individuals were also dissimilar. (Figure 5-A & B).

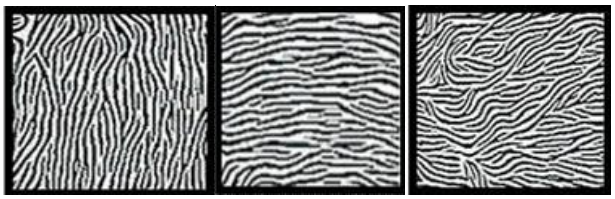

Fig No.3A Fig No.3B Fig No.3C

Figure 3: Distinct sub-patterns observed in tooth prints like A: linear-branched, B: linear-unbranched, C: wavy-branched.

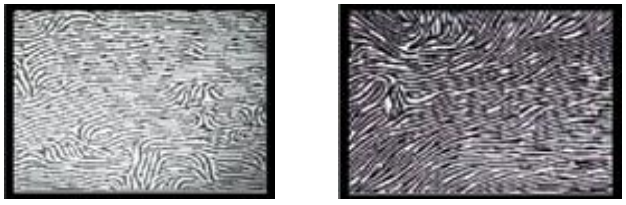

Fig No.4A Fig No.4B

Figure 4: Interindividual variation in the pattern of tooth prints. A: Mr. X, tooth no.23. B: Mr. Y tooth no. 13

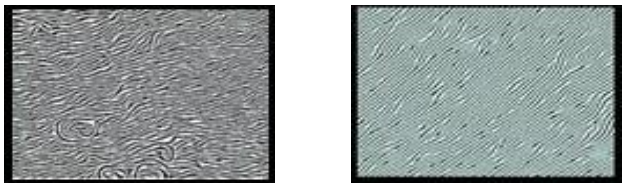

Fig No.5A Fig No.5B

Figure 5: Intraindividual variation in the pattern of tooth prints. A:Mrs.A ,tooth no.34.B:Mrs.A, tooth no. 44

DISCUSSION

Teeth have been extensively used as a source of information in forensic sciences, especially when the soft tissues cannot provide reliable information. Recently ameloglyphics have been proposed and considered as a highly reliable biometric based procedure for personal identification. Formation of enamel is a highly organized process in which the ameloblasts lay down the enamel rods in an undulating and interwining path. These undulating groups of enamel rod ends on tooth surface in different direction and at different levels form specific patterns on tooth surface. The study of these enamel rod end patterns are called ameloglyphics.[3]

Acetate peel technique is a well known technique for replicating surface details. This peel technique was first developed by paleobotanist Walton in the year 1928, to study the cellular structures of fossil plants. Later petrologists and paleontologists developed similar techniques to study both the texture and structure of the rocks and fossils. Depending on the nature of substrate and purpose of study peels can be prepared in various ways. [1] Alkaya et al. used acetate peel technique to study dental structures in three-dimensional view especially from fully mineralized enamel without routine decalcification, sawing, and mounting processes.[5] Manjunath et al. used a modified cellulose acetate peel technique for recording enamel rod endings on tooth surface and these patterns were intended for use in personal identification like a finger print which is composed of a single distinct pattern like whorl, loop or arch. On the other hand, a tooth print is composed of combination of basic sub-patterns.[1]

In 1998, Neurotechnologia developed Verifinger SDK identification software for biometric system integrators.[3] Liza et al used the same software for automated biometric study of Hunter Schreger bands in enamel for personal identification.[1]

In our study analysis of the 30 tooth prints yielded 3 distinct sub-patterns namely wavy (branched), linear (branched), linear (unbranched).This is in contrast to the study done by Manjunath et al.[1] where they found 8 distinct sub-patterns - wavy (branched), wavy(unbranched), linear (branched), linear (unbranched), whorl (open), whorl (closed), loop and stem-like.

All the examined 30 tooth prints were unique and distinctly dissimilar both between the teeth of different individuals and of the same individual. This uniqueness of the tooth print could be used as a valuable tool in forensic science for personal identification. This technique is simple, inexpensive, can give rapid results and can also be performed by nonprofessionals.[1]

Even though enamel is the hardest substance in the body, the surface is always subject to both micro and macro-wearing. Processes like abrasion, attrition and erosion wear the outermost layer of enamel rod ends, and expose the underneath layer.[6] The effect of these processes on the pattern of enamel rod ends needs to be determined. Secondly, the enamel rods do not traverse the whole length of

enamel in a straight path. Instead, they traverse in 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 course of enamel rods is not the same throughout the thickness of enamel.[7] Hence, theoretically the enamel rod end pattern should vary at varying depths of enamel. This needs to be verified by further studies.

CONCLUSION

Tooth prints are unique to a tooth but intra and inter individual dissimilarities are observed. The value of using tooth prints as a tool in forensic science for personal identification lies in its reproduction and permanency. These two attributes of tooth prints need to be evaluated by further studies.

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REFERENCES

1. Manjunath K, Sriram G, Saraswathi TR, Sivapathasundharam B. Enamel rod end patterns : A preliminary study using acetate peel technique and automated biometrics. J Forensic Odontology 2008;1:33-6.
2. Liza L, Ramenzoni, Sergio RP. Automated biometrics-based personal Identification of the hunter schreger bands of dental enamel. Proc Royal Soc B 2006;273:1155-1158.
3. Manjunath K, Sivapathasundharam B, Saraswathi TR. Efficacy of various materials in recording enamel rod endings on tooth surface for personal identification. J Forensic Dent Sci 2011;3:71-6.
4. Perry WL, Bass WM, Riggsby WS, Sirotkin K. The autodegradation of deoxyribonucleic acid (DNA) in human rib bone and its relationship to the time interval since death. J Foren Sci 1988;33:144-153.
5. Alkaya F, Ozer F, Belli S, Karakaya S. Acetate Peel Technique: a rapid way of preparing sequential surface replicas of dental hard tissues for microscopic examination. Archives Oral Biology 2005;50:837-42.
6. Roberson TM, Heymann HO, Swift EJ Jr. Sturdevant's art and science of operative dentistry, 4th ed. Mosby INC;2002.p.411-12.
7. Gaunt WA, Osborn JW, Ten Cate AR. Advanced dental histology, 2nd ed. Bristol John Wright;1971.p.95-96.

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