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Research Article

STUDY OF ENAMEL ROD PATTERNS IN MULTIPLE TEETH: A BIOMETRIC ANALYSIS

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Abstract :

As there is deficiency of conventional personal identification, which lead to major problems in identifation of an individual. Enamel rod end patterns are unique for each tooth in an individual and may be used for personal identification. Study is aimed to identify an individual based on biometrics data as well as to study enamel rod pattern of multiple teeth i.e. maxillary central incisor and lateral incisor in an individual and comparing with the enamel rod pattern of other individuals by using biometrics software (Verifinger® standard SDK version 5.0) in analyzing enamel rod end pattern. In present study enamel rod end patterns were taken from a specific area from two extracted teeth i.e. maxillary central incisor and lateral incisor with clinically normal crown from ten different individuals by using acetate peel technique. Minutiae scores obtained from each tooth print was subjected to statistical analysis using Student t test for comparison. In present study, it was seen that Verifinger® software was able to identify the enamel rod end patterns and give minutiae scores. Comparison of the minutiae scores of records of Central incisor (A) and Lateral Incisor (B) teeth of ten individuals using Paired t test, showed that results are significant indicating that each tooth has different enamel rod end pattern. Hence study reveals that for specific identification of the individual, multiple teeth record of an individual should be kept which will help in identification of the individual. Further studies should be done on more teeth which will reveal specificity of technique for personal identification and verification.

Keywords: Enamel rod end pattern, Verifinger®, acetate peel, Biometrics

INTRODUCTION

In forensic science, finger prints, dental patterns and more recently DNA analyses are used for personal identification, but these identification methods may not be efficient when bodies are decomposed, burnt, or in cases where only small fragments of calcified tissues are available for identification. In such situations, dental hard tissues gain importance for identification based on the condition of the deceased. Teeth can withstand extreme temperatures and are resistant to postmortem decomposition. Therefore, the use of dental evidence is the method of choice in establishing an identity from badly burned, traumatized, decomposed and skeletonized remains.

Enamel rod end patterns are unique for each tooth in an individual and may be used as an adjunct with other methods for personal identification. This technique is simple, inexpensive, and rapid method which can be performed by even a dental auxiliary staff. Usually, this method of personal identification can be included as adjunct ante-mortem dental records of fire fighters, soldiers, jet pilots, divers, and people who live or travel to politically unstable areas.

The term "biometrics" refers to identification techniques which are based on specific physical characteristics. It is a technology of identification or authentication of a person which transforms a biological, morphological or behavioral characteristic in a digital value.
When the patterns studied are consistently recognized and provide greater confidence, they are referred to as "positive identification". Biometric-based identification and verification methodologies such as fingerprint verification, iris scanning and facial recognition have been steadily improved and refined in automated systems and softwares, which have the capacity to distinguish individuals reliably. Unique identification of an individual based on biometric information, should have certain desirable prerequisite characteristics: Highly unique to each individual, easily transmittable, able to be acquired as un-intrusively as possible and distinguishable by humans without much special training.[1]
Verifinger standard SDK, and the like, Verifinger® standard SDK version 5.0 software was developed by Neurotechnologia in 1998 to compare and analyze finger prints.[2] Liza et al. used
this software for automated biometric analysis of Hunter Schreger bands in enamel for personal identification.[3]
Manjunath et al in 2009 used this software for analysis of rod end pattern. Only a single study is published in respect of the software Verifinger® standard SDK version 5.0 to analyse the enamel rod end pattern. Hence, the present study was designed to analyze the reliability and sensitivity of automated biometrics system (Verifinger® standard SDK version 5.0) in analyzing enamel rod end patterns as well as to compare the enamel rod pattern in two selected teeth i.e. maxillary central incisor and lateral incisor in teeth of same individual.

AIMS AND OBJECTIVES

The present study was carried out with the following objectives-

- To identify an individual based on biometrics data.
- To study enamel rod pattern of multiple teeth i.e. maxillary central incisor and lateral incisor in an individual and comparing with the enamel rod pattern of other individuals by using biometrics software (Verifinger® standard SDK version 5.0).

MATERIAL AND METHODS

In this present study two extracted teeth i.e. maxillary central incisor and lateral incisor with clinically normal crown from ten different individuals were collected. Teeth with decay attrition, abrasion, erosion, hypoplasia, fracture, and/or restoration were not selected for the study, All the extracted teeth were scaled and polished.

Recording enamel rod patterns using acetate peel technique

In order to avoid error in positioning the acetate film over recording area during serial recordings, a circle of 6-mm diameter was drawn on the comparatively flat area (middle thirds) of the labial surface of each tooth, The labial surface of the tooth was ground using aerotor handpiece except the circular area. Ungrounded circular area of the tooth was etched with 10% orthophosphoric acid for 20 seconds, 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 15 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 40x magnification. To assess the reliability of the software, three individual acetate peel recordings were performed on each tooth, ln order to minimize bias during recording of enamel rod end patterns, the following measures were taken:

• All the photomicrographs were taken at a magnification of 40x objective and 10x eyepiece of an Lawrance & Mayo microscope.

• The photomicrographs were taken without zooming the camera lens.

• The circular photomicrographs hence obtained were cropped to 2000 × 1500 pixels in microsoft Office picture manager.

Ana1ysis of acetate peel recordings

'The cropped photomicrograph was subjected to biometric analysis using Verifinger® standard SDK version 5.0. The software obtains the patterns and sub-patterns of enamel rod endings as series of lines running in varying directions, and assigns a specific identification number, minutiae score, and stores the pattern in the database. Verifinger® standard SDK version 5.0 uses certain points called minutiae for identification and comparison of various patterns analyzed. Minutiae are discontinuities of lines, line endings, dots, very small lines, ponds, and/or empty spaces between two lines.

Statistics

Each recording was coded with a numerical which represent the patient and two digit alpha-numeric code which represent the maxillary central incisor tooth as A and maxillary lateral incisor tooth as B of each selected individual. The minutiae scores of the recording of each tooth was tabulated and statistically analyzed using Paired Student t test.

RESULTS

In the present study, single enamel rod pattern each of two teeth i.e. maxillary central incisor and maxillary lateral incisor of ten individuals were obtained using acetate peel technique, analyzed using Verifinger® standard SDK version 5.0 software. Each tooth print was stored in the database of Verifinger® with a specific identification number and minutiae score. Each tooth yielded a different pattern of tooth print in all the recordings, and Verifinger identified each duplicate recording of a tooth to be identical to the original tooth print of that particular tooth stored in the database.

Comparison of the minutiae scores of records of A and B teeth of ten individuals using Paired t test, showed that results are significant indicating that each tooth has different enamel rod end pattern.

Figure I: Tooth prints of tooth A and tooth B of patient 1 with minutiae points. Both tooth prints show dissimilar pattern

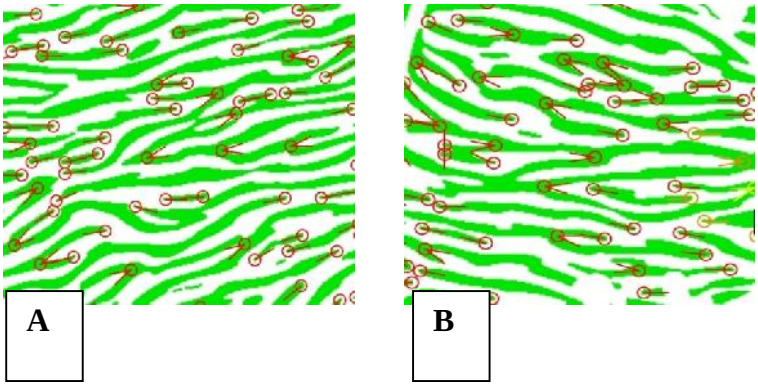

Figure II: Tooth prints of tooth A and tooth B of patient 2. Both tooth prints show dissimilar pattern

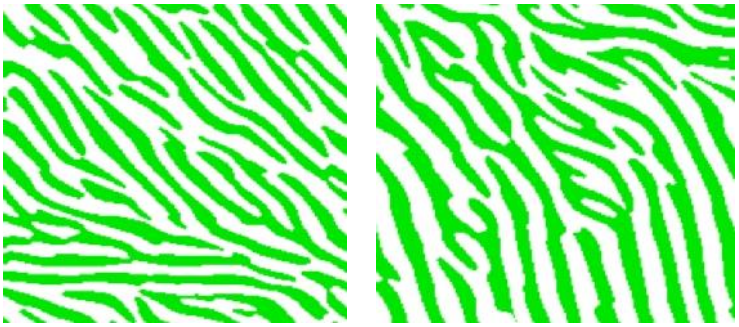

Table I: Minutiae scores of Tooth A and Tooth B of all ten patients

Patient no.	Minutiae score	
	Tooth A	Tooth B
1	1318	1722
2	1580	1121
3	1295	1681
4	1491	1011
5	1620	1281
6	1125	1895
7	1770	2112
8	1559	1910
9	1250	1861
10	1972	1482

Table II: Comparison of the minutiae scores of records of A and B teeth of ten individuals using Paired t test, Paired Samples Test

		Paired Differences				
		Mean	Std. Deviation	T	df	Sig. (2-tailed)
Pair 1	Tooth_A - Tooth_B	-1.096	493.80365	-0.702	9	0.501

DISCUSSION

Enamel covering crown of tooth is the hardest biological tissue and is highly mineralized, withstands both shearing and impact forces well.[4] The enamel rods run the whole length of enamel in an undulating and inter-twining path, which forms a specific pattern on tooth surface[5]. These enamel rod end patterns were unique for each tooth in an individual. It is specific for particular individual. These enamel rod end patterns can be obtained by various methods like using cellulose acetate film, metal shadowed colloid ion film, rubber base impression materials etc. Acetate peel technique is a well-known technique for replicating surface details.[5] Fusun et al. used acetate peel technique to study dental structures in three-dimensional view, especially from fully mineralized enamel without routine decalcifying, dehydrating, sawing and mounting processes. [6,7] Later on Manjunath et al also used acetate peel technique in his study in analysis of enamel rod end patterns.[2] Manjunath et al also used same technique in analysis of enamel rod end pattern at different levels of enamel[8]. Acetate peel technique is a simple, inexpensive, accurate and rapid method. So, this technique is selected for our study to record enamel rod end patterns from tooth surface.

In present study we have found that each tooth print has a specific pattern which is confirmed by Verifinger® standard SDK version 5.0 software. Our study is in accordance with Manjunath et al who had confirmed that Verifinger® could be used with considerable accuracy and reliability in analysis of enamel rod end patterns which is obtained from a specific area on tooth surface.

While comparing the enamel rods of maxillary central incisor with lateral incisor of each individual we found that minutiae score for each tooth is different which suggests that there is difference in the pattern of enamel rods of each teeth in each of the individual (Figure 1 and Figure 2). Hence the study reveals that for specific identification of the individual, multiple teeth record of an individual should be kept which will help in identification of the individual. Moreover further studies should be done on more teeth which will reveal the specificity of the technique in forensic odontology for personal identification and verification.

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