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Review Article

Ameloglyphics- A Mirror within You

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Abstract

Forensic Odontology is a relatively new science that utilizes the dentist's knowledge to serve the judicial system. It has established itself as an important indispensable science in medico legal matters and in particular in personal identification, gender determination and age estimation. Ameloglyphics also known as toothprints are the enamel rod end patterns on tooth surface and they are considered as a hard tissue analog to fingerprints. Teeth have the highest resistance to most environmental effects like fire, desiccation, and decomposition, and may be used as forensic evidence.

Keywords: Forensic odontology; Ameloglyphics; Toothprints

Introduction

The term 'forensic' implies 'court of law'. Forensic odontology has been defined as that branch of dentistry, which, in the interest of justice, deals with the proper handling and examination of dental evidence and with the proper evaluation, and presentation of dental findings. Forensic odontology has played a key role in identification of persons in mass disasters, in crime investigation, in ethnic studies, and in identification of decomposed and disfigured bodies like that of drowned persons, fire victims, and victims of motor vehicle accidents. The various methods employed in forensic odontology include rugoscopy, cheiloscopy, bite marks, tooth prints, radiographs, photographic study, and molecular methods [1-3]. Tooth prints are the term used to describe the enamel rod end patterns. Ameloglyphics is the term used for the study of patterns of enamel rods [4].

Enamel does not remodel once it has been formed. It also does not remain in contact with the secretary cells or ameloblasts. Once they form, ameloblasts move or retract away from the enamel surface. They leave behind the prism morphology, which is evident on the surface enamel and is species [5]. Biometric analysis revealed that the enamel rod end pattern is unique for each tooth in an individual. It shows both intra- and inters individual variation. Enamel rod end patterns were unique between the male and female subjects. Visual analysis showed that wavy branched sub pattern was the predominant sub pattern observed among examined teeth [6].

Odontogenesis is genetically modulated. The formation of enamel is a highly organized dynamic process, in which the ameloblasts lay down enamel rods in an undulating and intertwining path [6]. This is reflected on the outer surface of the enamel as a series of enamel rod end patterns. The term "Ameloglyphics" means "the study of enamel rod end patterns" (amelo-enamel, glyphics-carvings) [4].

Enamel rods/prisms

Enamel is a product of ectoderm derived cells called ameloblasts. The basic structural unit of enamel is the enamel rods (enamel prisms). 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 [7]. These enamel rods end on the tooth surface at different levels and in different directions, resulting in specific patterns on the tooth surface. The study of these enamel rod end patterns is known as ameloglyphics [4]. It has been estimated that each tooth has millions of enamel rods and that the number varies from tooth to tooth. The length of the rods is greater than the thickness of the enamel as a result of the oblique direction and wavy arrangement of the rods. It varies in different portions of the crown of the tooth, being long in the thicker portions (cuspal area) and short in the thinner portions (cervical area) (Figure 1).

The size and diameter of the enamel rods increase as they reach the outer surface. Although it is observed that the average diameter of the enamel rod is 4-5 μm, there is considerable variation along its course. It has been suggested that the diameter of the enamel rods increases in the ratio of 1:2 while passing from the dentin enamel junction to the outer surface [8].

The shape of the enamel prisms approximates to one of the three main patterns (Figure 2):

- Pattern I: Prisms are circular.
- Pattern II: Prisms are aligned in parallel rows.
- Pattern III: Prisms are arranged in staggered rows such that the tail of prism lies between two heads in the next row, giving a key whole appearance [8].

Studies with the electron microscope reveal that the enamel rods have a keyhole or paddle-shaped pattern with a rounded head and a narrow tail region. The rounded head of each rod fits closely into the concavities between the heads and tails of the rods on either side. The region between the two enamel rods in one row, thought to be the interrod substance, actually represents the tail portion of the enamel rod in the previous row. The rods measure about 4-5 μm in breadth and 9 μm in length. Many patterns are observed

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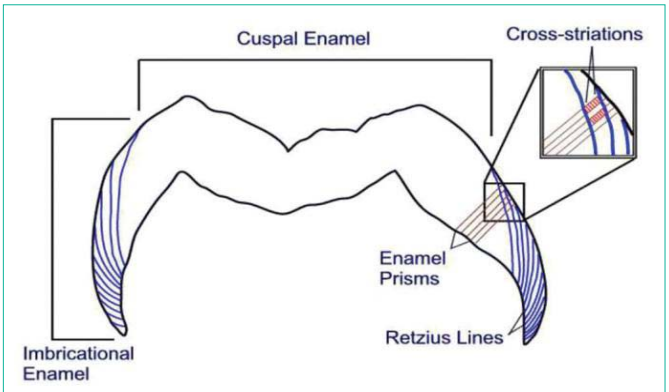

Figure 1: Arrangement of enamel rods.

regarding the arrangement of rods, but usually they are arranged with their head portion near the occlusal or the incisal surface and their tail portion pointing cervically [9]. In deciduous teeth, the enamel rods lie in a horizontal plane in the cervical and middle third. They gradually become more oblique in the incisal and occlusal third and are almost vertical in the incisal edge or the cusp tip. In permanent teeth, the arrangement is similar to deciduous teeth in the occlusal and middle third; in the cervical third, the enamel rods show a root ward inclination or pass outward [9].

Materials used in recording enamel rod patterns on tooth surface

Ameloglyphics is generally preceded by Acid etching and acetate peel technique and automated biometrics for reproducing exact enamel rod end patterns [10]. The acid etching on the surface enamel results in the removal of the surface mineral component in the rod and rod sheath. As the rods and rod sheaths have a different mineral density, the etching results in an uneven dissolution of the surface enamel along with the removal of the smear layer. 10% orthophosphoric acid in gel form is the most commonly used acid for etching.

Three types of etch patterns can be obtained:

1. Predominant dissolution of prism cores.

2. Predominant dissolution of prism peripheries.

3. No prism structure is evident [10].

The enamel rod end patterns could be duplicated by various methods such as using cellulose acetate paper, rubber base impression materials, and cellophane tape.

Method

Step 1: The selected teeth should to be scaled and polished.

Step 2: In order to avoid error in positioning the acetate film over recording area during serial recordings, a circle of 5-mm diameter should be marked on the comparatively flat area (middle thirds) on the labial surface of the tooth.

Step 3: The marked area should be conditioned with 10% orthophosphoric acid for 20 seconds.

Step 4: Rinse with water and dry the conditioned surface.

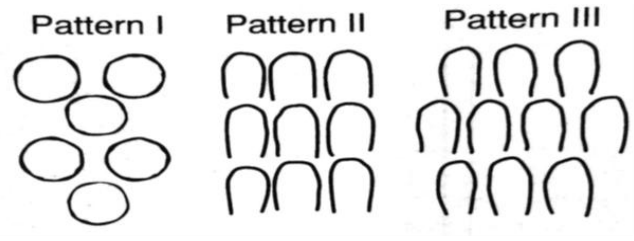

Figure 2: Patterns of enamel prisms.

Step 5: A drop of acetone to be applied on to the tooth surface and should be covered by a small piece of cellulose acetate film and left undisturbed for 20 min.

Step 6: The acetone dissolves a layer of cellulose acetate and the dissolute settles down along the irregularities on the enamel surface.

Step 7: The film should be gently peeled after 20 min and observed under light microscope.

Step 8: A photomicrograph of the acetate peel should be obtained at 40X magnification and then subjected to biometric analysis using verifinger standard SDK version 5.0 software (neurotechnology).

Step 9: The software recognizes the patterns of enamel rod endings as series of lines running in varying directions.

Step 10: The software uses certain points called minutiae for identification of each pattern.

These minutiae will be used by the software to compare the similarity/variability of two patterns [6].

Uses

- 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.

- And this record must be updated periodically to overcome the enamel loss due to wear and tear [11].

Conclusion

Study of tooth prints is a novel area of research in the field of forensic odontology. The uniqueness of these tooth prints may be utilized as a successful identification tool in forensic science. According to our study, tooth prints appear to be unique to an individual, with dissimilarities between those of different individuals and also the same individual and more importantly these prints are reproducible, even after exposing the tooth to adverse conditions like high temperature and an acidic environment. However, further studies need to be carried out to establish the usefulness of tooth prints as a substantial and unfailing forensic identification tool in cases of acid and burn injuries.

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