

Amelogyphics: A Biometric Analysis

Pradyumna Ku Sahoo¹, Smita R. Priyadarshini²

¹Associate Professor, Department of Prosthodontics, ²Associate Professor, Department of Oral Medicine & Radiology, Institute of Dental Sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar-751003, Odisha, India

Abstract

Forensic Odontology is a budding science that utilizes dental knowledge in the court of law. It has now proved itself as an important science in medico-legal issues and personal or individual identification, gender & age determination. Amelogyphics stands for imprints of the tooth and the enamel rod end patterns on the surfaces of the tooth. Teeth are resistant to environmental alterations like fire, desiccation, or decomposition. Enamel rod patterns are unique and are different for every individual. This review covers the basics of using enamel rod end patterns that are employed in personal identification in natural calamities.

Keywords: Forensic odontology; Amelogyphics; Tooth prints.

Introduction

Forensic odontology is a branch of dentistry that involves the application & identification of individuals comparing the ante- and post-mortem records. Like fingerprints, amelogyphics are analogue to identification and is unique with a record that remains for lifetime.¹ There should be working establishments & centers with facilities at the dental laboratories. Even it should be mandatory to maintain records for all dental clinic & hospitals either government or private.²

Amelo stands for enamel whereas glyphic suggests that carving thus Amelogyphics stands for enamel rod patterns and tooth prints. Enamel could be a spin-off of germ layer cells.³ Enamel rod is the structural unit which is synthesized by specialized cells the ameloblasts. Ameloblasts form enamel rods in associate undulating and inter-twining with the enamel rods.¹

Enamel descends from the ectoderm. It is a complex organized procedure derived from specialized cells the ameloblasts. They are laid in an undulating and inter-twining path that provides a high tensile strength that traverse in different directions.⁴

Biometrics-play a vital role in determining the tooth prints. They have constraints when decomposed, burned, fragments of calcified tissues are the remnants. As enamel is highly mineralized that forms enamel prism or rods (Hunter Schreger bands)so it withstands the degradation procedures during post mortem.⁵ Biometric analysis of enamel conceals each intra- and inter-individual variation that is distinctive and specific to either gender. The formation of the enamel prisms may be categorized into 3 main patterns with Prisms being circular, aligned in parallel rows and keyhole look types.⁶

Orientation of enamel rods: The orientation of enamel rods is perpendicular to the dentin surfaces they are slightly different in deciduous and the permanent dentition. In deciduous dentition, enamel rods lie in a horizontal plane in the cervical and middle third that becomes oblique in the incisal and occlusal third with vertical in the incisal edge or the cusp tips.³

In permanent dentition arrangement is similar to deciduous teeth in the occlusal and middle thirds but

Corresponding Author:

Dr. Smita R. Priyadarshini

Associate Professor, Department of Oral Medicine & Radiology, Institute of Dental Sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar 751003, Odisha, India
e-mail: smitapriyadarshini@soa.ac.in

show a rootward inclination or outward orientation in cervical third. The enamel rods also known as enamel prisms are described as circular, parallel or key whole appearance type patterns. In another classification they classified these enamel rods into Wavy branched & un-branched, Linear branched & un-branched, Whorl open, closed and Loop varieties⁷.

Recording Enamel rod end patterns: There are several techniques for recording the patterns of enamel rods that are useful in mass disasters. In Amelogyphics, recording of enamel rod is done by using acid etchant, acetate peel technique, and automated biometrics for producing accurate enamel rod end patterns.⁴ Macroscopically pattern of enamel rods appears incrementally on the tooth surface as perikymata but microscopically, they have a unique direction, which is different from adjoining group of enamel rods unique to ever person.^{8,9}

1. Acid Etching: It removes the surface mineral element within the rod and rod sheath. But as the rods and rod sheaths have different mineral density, the etching leads to uneven dissolution of the surface enamel with the removal of the smear layer.

Procedure: Initially the tooth is scaled and polished acid etched using 37% orthophosphoric acid for 30 s the preferred site being the buccal/lingual surface of tooth. Thereafter the surfaces are rinsed with water, dried & conditioned using a drop of acetone and covered using cellulose acetate film and left undisturbed for 20 minutes which is pulled gently and transferred to a clean glass slide for microscopy. Slides are visualized under a light microscope under different magnifications along with a digital camera that is sent for biometric conversion using fingerprint analysis software.¹⁰

Uses: It can be used as an accurate personal identification tool. Amelogyphics is an easy, cheap and fast procedure. It can be readily used as an adjunct antemortem dental record of firefighters, soldiers, jet pilots, etc.

2. Peel technique: It enables the study of the tooth structures in a 3-dimensional form that is completely mineralized as enamel. This process doesn't require the routine decalcification, sawing, and mounting.¹¹

Procedure: It is a modification of the cellulose acetate peel technique Here the enamel rod end patterns are duplicated on cellulose ester paper,

rubber base impression materials, plastic wrap tape. It completely reproduces the distinctive patterns, sub-patterns of surface enamel rod end. Verifinger software readily matches the enamel rod end patterns with specific identification.⁶

Advantages: This process is simple & inexpensive with a rapid method in making replicas of dental hard tissue surfaces.¹²

3. Automated Biometric analysis: Biometric-based identification is primarily used for fingerprint recognition, facial recognition, and iris scanning using automated systems and software tools. Similarly, amyleglyphics have certain desirable prerequisite characteristics, like uniqueness, easy transmit ability, to acquire as uninvasive as and distinguishable to humans. Software applications like M2SYS fingerprint SDK software system, Sig ID biometric fingerprint software system, Verifinger standard SDK etc.^{7,13}

Minutiae points are the broken lines that appear as endings of lines, dots, small lines, ponds, bifurcations. Multiple bifurcations are collectively termed minutiae. The minutiae sets can be coordinated using many techniques. In the case of fingerprints, matching a print poses a big computational problem due to the following three factors: Poor quality, very large fingerprint database, structural alteration of the fingerprint images.¹⁴ These become irrelevant in tooth prints because being a hard surface enamel rod ending produces a good quality digital image and does not show distortion as in the fingerprints.⁸ Thus forensic investigation, the team should compulsorily have dental personnel who specializes in forensic odontology.¹⁵

Need for Further Research: Dental caries being a complex process involving microbiologic action resulting in destruction as well as loss of tooth structure. Amelogyphics can be utilized in determining tooth surfaces affected by caries than on relatively unaffected surfaces. Until now it doesn't illustrate any predisposing structural variations in dental caries or any variation in the shape or orientation of the rods.^{9,16} Even as we are aging, changes occur in the enamel structure due to continuous micro and macro wearing like attrition, abrasion & erosion of the tooth surfaces. Thus inducing a possible change in the structure of the rods. So the pattern is to be recorded and checked for any specific pattern. Thus requiring a need for further research.¹⁷

Conclusion

Enamel is the hardest structure in the body, it is exposed to continuous wear & tear. Processes like routine tooth brushing, abrasion, erosion, exposure to acidic occupational hazards, wear the enamel to expose the underneath layer. Since teeth can withstand extreme temperatures, dental findings should be a technique of choice for disasters. Thus, the biometrics reveals that the enamel rod-end patterns are unique for individuals. The reproducibility and reliability of the pattern suggests its utility as a reliable tool for identification in mass disasters.

Conflict of Interests: None

Ethical Permission: Approved

Funding: Nil

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 Odontol* 2008; 1:33-6.
2. Manjunath K, Sivapathasundharam B, Saraswathi TR. Analysis of enamel rod end patterns on the tooth surface for personal identification - amelogyphics. *J Forensic Sci* 2012; 57:789-93.
3. Rajkumar K. Enamel. In: Rajkumar R, Ramya R, editors. *Text Book of Oral Anatomy, Histology, Physiology and Tooth Morphology*. 1 st ed. India: Wolters Kluwer Health 2012
4. Jorge P, Swift ED. Fundamental concepts of enamel and dentin adhesion. In: Roberson T, Heyman H, Swift ED, editors. *Text Book of Art and Science of Operative Dentistry*. 4 th ed. 2004.
5. Jorge P, Swift ED. Fundamental concepts of enamel and dentin adhesion. In: Roberson T, Heyman H, Swift ED, editors. *Text Book of Art and Science of Operative Dentistry*. 4 th ed. 2004.
6. Van MB. Bonding to enamel and dentin. In: Summitt JB, editors. *Text Book of Fundamental of Operative Dentistry*. 2 nd ed. 2001.
7. Füsün A, Füsün O, Sema B, Solen K. Acetate peel technique: A rapid way of preparing sequential surface replicas of dental hard tissues for microscopic examination. *Arch Oral Biol* 2005; 50:837-42.
8. Manjunath K, Sriram G, Saraswathi TR, Sivapathasundharam B, Porchelvam S. Reliability of automated biometrics in the analysis of enamel rod end patterns. *J Forensic Dent Sci* 2009; 1:32-6.
9. Sansare K. Forensic odontology, historical perspective. *Indian J Dent Res* 1995; 6:55-57.
10. Sha SK, Rao BV, Rao MS, Kumari KVH, Chinna SK, Sahu D. Are Tooth Prints a Hard Tissue Equivalence of Finger Print in Mass Disaster: A Rationalized Review. *J Pharm Bioallied Sci*. 2017;9(Suppl 1): S29–S33.
11. Christopher, Vineetha, et al. "Can dead man tooth do tell tales? Tooth prints in forensic identification." *Journal of forensic dental sciences* vol. 9,1 (2017): 47.
12. Ashwinirani SR, Suragimath G, Sande RA, Kulkarni P, Nimbale A, Shankar T, et al. Comparison of lip print patterns in two Indian subpopulations and its correlation in ABO blood groups. *J Clin Diagn Res*. 2014; 8:40–3.
13. Bijjargi SC, Malligere SB, Sangle AV, Saraswathi FK, Majid IA, Ashwinirani SR. A new attempt in comparison between 3 racial groups in India – Based on lip prints (Cheiloscopy) *Int J Appl Dent Sci*. 2015; 1:20–3.
14. Stimson PG, Mertz CA. *Forensic Dentistry*. Boca Raton: CRC Press Publication; 1997. pp. 185–216.
15. Suragimath G, Ashwinirani SR, Christopher V, Bijjargi S, Pawar R, Nayak A. Gender determination by radiographic analysis of mental foramen in Maharashtra population of India. *J Forensic Dent Sci*. 2016; 8:176.
16. Gupta N, Jadhav K, Ahmed Mujib BR, Amberkar VS. Is the re-creation of human identity possible using tooth prints? An experimental study to aid in identification. *Forensic Sci Int*. 2009; 192:67–71.
17. Girish H, Murgod S, Ravath CM, Hegde RB. Amelogyphics and predilection of dental caries. *J Oral Maxillofac Pathol*. 2013; 17:181–4.