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A Comparative Study of Tooth Print in Surfaces of Normal and Fluorosed Teeth as a Biomarker in Forensics for Person Identification

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Abstract:-

- ***Aim***

The aim is to study, compare and analyse the enamel rod end patterns in healthy and fluorosed teeth for person identification.

- ***Methodology***

A total of 120 participants were taken for our study, categorized into 2 groups, Group I consists of fluorosed teeth and Group II consists of Normal teeth, each group comprised of 30 males and 30 females. In anteriors, maxillary central incisor and canine and in posteriors, first premolars were selected. So a total of 360 samples were recorded for the analysis. Acetate peel technique was used for recording the tooth print and Verifinger® standard SDK version 11.1 software was used for analysis.

- ***Results***

Our study showed that the fluorosed teeth showed a difference from complete to incomplete or inter-rupted pattern unlike normal teeth which had a complete pattern only. The variation in the enamel rod end patterns between normal and fluorosed teeth was statistically significant in central incisor and canine respectively but not in premolars. Also the variation in enamel rod end patterns between the gender was statistically significant among central incisor, canine and premolar.

- ***Conclusion***

Ameloglyphics is a recent evolving forensic tool for personal identification. The procedure is painless and is based on the enamel rod patterns on the surface of tooth.

Keywords:- *Person Identification, Enamel Rod Pattern, Ameloglyphics, Forensic Odontology.*

I. INTRODUCTION

Forensic Odontology is defined as a branch of dentistry which, in the interest of justice, deals with proper handling and examination of dental evidence along with the proper evaluation and presentation of dental findings[1]. Forensic Odontology plays an important role in the recognition of deceased individuals and in conditions such as identifying the age, sex and person identification of unknown human remains, analysis of bite marks and lip prints, as evidence in child abuse and in civil and criminal litigation[2]. The common methods include photographs, iris, fingerprints, DNA analysis and dental records[3]. However, some identification methods cannot be used when the bodies are burnt or decomposed[4]. Teeth are used as an important tool for personal identification in forensic investigation, even when the soft tissues do not provide sufficient information[5].

The study of enamel rod end pattern is known as ameloglyphics (amelo meaning enamel and glyphics meaning carvings). Tooth prints are unique, exhibiting variations between the teeth of different individuals and of the same individual. This property can be used as a valuable tool in forensic dentistry for individual identification of those working in dangerous occupations such as fire fighters, soldiers, jet pilots and people who live in potentially unstable areas[6].

Amelogenesis is the process of synthesis of enamel by ameloblasts in an uniform manner. The ameloblasts secrete enamel with intertwined enamel rods. This is reflected on the enamel surface as enamel rod end patterns[6]. In deciduous teeth, the enamel rods in the cervical and middle third regions are in a horizontal direction, whereas they are oblique and almost vertical in the incisal edges or the cusp tips[7]. In permanent teeth, the occlusal and middle third arrangement of rods are similar to deciduous teeth but in the cervical third, the enamel rods show an apical inclination.

Both environmental and genetic factors have an influence in the process of odontogenesis and amelogenesis. Optimal level of fluoride reduces the incidence of dental caries and maintains the integrity of oral tissues but when consumed more during developmental stages it can lead to deleterious effects such as dental and skeletal fluorosis[9]. Dental fluorosis forms as a result of variation in environmental factors like excessive ingestion of fluoride during amelogenesis. Fluorosed teeth shows disturbance in the arrangement of enamel rod patterns[8].

In 1998, Neurotechnology developed VeriFinger SDK software for biometric system integrators. Originally, fingerprint analysis was done with this software and it could also be used for analysis of tooth prints. VeriFinger SDK

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software is a valid biometric device for the analysis of enamel rod end patterns[10]. Our study aims to assess and analyse the uniqueness of enamel rod end pattern in fluorosed teeth and normal healthy teeth and use it as a biomarker for personal identification in forensic investigation.

II. METHODOLOGY

The current study got approved by the institutional ethical committee and informed consent was obtained. The study population was selected randomly from local people of Madurai, Tamilnadu having normal and fluorosed teeth. Patients with fluorosed teeth {mild & moderate} and healthy teeth were included in this study. Patients with a history of decay, fractured teeth, attrited and abraded teeth , teeth affected by Amelogenesis Imperfecta, Congenital Syphilis, Hypo-calcemia, Tetracycline stained teeth, and Turner's hypoplasia, were excluded from the study.

Prior to the sample collection, informed consent was obtained from the participant and oral prophylaxis (scaling and polishing) was done in order to analyse the enamel rod end patterns in the labial or buccal surface middle 3rd of the maxillary central incisors, canines and 1st premolars.

A drop of acetone was placed over a small piece of cellophane sheet and placed over the surface of the tooth immediately without any finger pressure. A layer of cellophane sheet is dissolved and the dissolute settles down along the irregularities on the enamel surface, thereby resulting in the enamel rod end pattern (tooth print). The sheet was slowly peeled off after 3 minutes. A portion of sheet was placed on a glass slide and observed under a digital microscope in a low power. The imprint area was focused and photographed with a digital microscope OLYMPUS BX 53 and these photomicrographs were subjected to biometric analysis using Verifinger Neurotec Biometric 11.1 SDK [software developmental kit] software. This software identified the pattern of enamel rod endings as continuous lines in various directions. The software used minutiae to identify each pattern. These minutiae are used to compare the similarity (or) variability of two patterns.

The patterns of tooth prints were compared among males and females of normal and fluorosed teeth in central incisor, canine and premolar. Also the patterns among different age groups in the same sets of teeth were also compared. Manjunath et al[4] classified tooth print patterns as linear branched, linear unbranched, wavy branched, wavy unbranched, whorl open, whorl closed, loop and stem like pattern. Each enamel rod end pattern were seen in fusion of subpatterns and was predominated by a single subpattern.

III. STATISTICAL ANALYSIS

The information obtained from the selected cases were recorded in an Excel sheet. Data analysis was done using SPSS Statistical package – Version 20. Descriptive statistics were used to find the frequencies and percentage among the study groups. Chi square test was used to find the significant difference between the study groups.

IV. RESULTS

The present study showed a combination of distinct sub-patterns, but was predominated by wavy branched in all the tooth types (Table-1,2,3). In both normal and fluorosed teeth, wavy branched was predominant in central incisor and canine of males, whereas wavy unbranched was predominant in central incisor and wavy branched and linear unbranched in canine of females (Table-4,5). In contrast, in premolar, males had predominant linear branch while females had predominant wavy branched pattern (Table-6).

Table – 1 Shows Various Enamel Rod End Patterns in Normal and Fluorosed Teeth in Central Incisor

Group	*Patterns*	*Frequency*	*Percent*	*Value*	*P Value*
Normal Teeth	Wavy branched	18	30.0	16.646	0.005
	Wavy un-branched	16	26.7		
	Linear branched	10	16.7		
	Linear un-branched	14	23.3		
	Stem like pattern	2	3.3		
	Total	60	100.0		
Fluorosed teeth	Wavy branched	13	21.7		
	Wavy un-branched	13	21.7		
	Linear branched	7	11.7		
	Linear un-branched	14	23.3		
	Incomplete	13	21.7		
	Total	60	100.0		

Table – 2 Shows Various Enamel Rod End Patterns in Normal and Fluorosed Teeth in Canine.

Group	*Patterns*	*Frequency*	*Percent*	*Value*	*P Value*
Normal Teeth	Wavy branched	25	41.7		
	Wavy un-branched	12	20.0		
	Linear branched	11	18.3		
	Linear un-branched	12	20.0		
	Total	60	100.0		

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Group	*Patterns*	*Frequency*	*Percent*	*Value*	*P Value*
Fluorosed teeth	Wavy branched	15	25.0	12.315	0.031
	Wavy un-branched	11	18.3		
	Linear branched	9	15.0		
	Linear un-branched	16	26.7		
	Stem like pattern	1	1.7		
	Incomplete	8	13.3		
	Total		100.0		

Table – 3 Shows Various Enamel Rod End Patterns in Normal and Fluorosed Teeth in Premolar.

Group	*Patterns*	*Frequency*	*Percent*	*Value*	*P Value*
Normal Teeth	Wavy branched	19	31.7	9.034	0.06
	Wavy un-branched	19	31.7		
	Linear branched	12	20.0		
	Linear un-branched	10	16.7		
	Total	60	100.0		
Fluorosed teeth	Wavy branched	15	25.0		
	Wavy un-branched	15	25.0		
	Linear branched	13	21.7		
	Linear un-branched	9	15.0		
	Incomplete	8	13.3		
	Total	60	100.0		

Table – 4 shows various enamel rod end patterns among males and females in central incisor.

Group	*Patterns*	*Frequency*		*Percent*	*Value*	*P Value*
		male	*Female*			
Central Incisor	Wavy branched	23	8	31	16.408	0.006
	Wavy un-branched	8	21	29		
	Linear branched	9	8	17		
	Linear un-branched	12	16	28		
	Stem like pattern	0	2	2		
	Incomplete	8	5	13		
	Total	60	60	120		

Table – 5 shows various enamel rod end patterns among males and females in canine.

Group	*Patterns*	*Frequency*		*Percent*	*Value*	*P Value*
		male	*Female*			
Canine	Wavy branched	25	15	40	13.073	0.023
	Wavy un-branched	8	15	23		
	Linear branched	13	7	20		
	Linear un-branched	8	20	28		
	Stem like pattern	1	0	1		
	Incomplete	5	3	8		
	Total	60	60	120		

Table – 6 shows various enamel rod end patterns among males and females in premolar

Group	*Patterns*	*Frequency*		*Percent*	*Value*	*P Value*
		male	*Female*			
Premolar	Wavy branched	12	22	34	11.479	0.022
	Wavy un-branched	13	21	34		
	Linear branched	18	7	25		
	Linear un-branched	12	7	19		
	Incomplete	5	3	8		
	Total	60	60	120		

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V. DISCUSSION

In forensic odontology, identification of a person is a difficult task. However, some methods cannot be used when the bodies are burnt or decomposed[4]. Teeth have been used as a reliable tool for individual identification, especially when the soft tissues do not provide sufficient information.

The ameloblasts synthesize enamel such that the enamel rods are intertwined. This is reflected on enamel surface as enamel rod end patterns. The study of enamel rod end pattern is known as ameloglyphics[6]. The tooth prints are unique, exhibiting variations between the teeth of different individuals and of the same individual. This property can be used as a valuable tool in forensic dentistry for individual identification.

Genetic and environmental factors play an important role in odontogenesis and amelogenesis. Dental fluorosis forms as a result of variation in environmental factors like excessive ingestion of fluoride during amelogenesis. Fluorosed teeth shows disturbance in the arrangement of enamel rod patterns[8].

In the present study we placed a drop of acetone over a small piece of 20 micron thickness cellophane sheet which was firmly held on the middle 3rd surface of the tooth. Gentle pressure was applied for better adaptation. Acetone dissolves a small portion of the surface layer of cellophane sheet with the dissolute settling down along the irregularities on enamel surface of the teeth. The film was slowly removed after 3 minutes. The portion of the sheet was placed on a glass slide and observed under a digital microscope in low power, and photomicrographed using OLYMPUS BX 53 digital microscope and it was subjected to biometric analysis using Verifinger SDK 11.1 software.

Ramenzoni et al[3] first used the verification software to evaluate the uniqueness of Hunter-Schreger bands for individual identification. It was then followed by VeriFinger SDK v5.0 software for the analysis of enamel rod end patterns for personal identification in a satisfactory manner. Manjunath et al[11] used this software to record the enamel rod endings of ten extracted teeth and found the results to be the similar. Thus Verifinger software though originally used as a finger verification software can be used to analyse the enamel rod end patterns.

Similar to studies done by Hc Girish et al[12] and Naziya et al[6] , tooth prints were taken from the central region of middle 3rd of the labial or buccal surfaces of the tooth as the enamel rods lie in a horizontal plane from where tooth print patterns can be easily recorded in our present study. The enamel rods are placed more oblique in occlusal 3 rd surface and more inclined in the cervical 3rd of the tooth surface. This will produce an incomplete or improper recording of the tooth print pattern.

Manjunath et al[8] found 8 sub patterns, such as wavy branched, wavy unbranched, linear branched, linear unbranched, whorl open, whorl closed, loop and stem like pattern. In our study we have observed only 5 sub patterns in the normal teeth. They are wavy branched, wavy unbranched, linear branched, linear unbranched and stem like pattern and in fluorosed teeth we observed 6 sub patterns, they are wavy branched, wavy unbranched, linear branched, linear unbranched, stem like pattern and incomplete or interrupted pattern. In the present study we found that wavy branched pattern was the most predominant pattern in normal teeth which was similar to the study of Naziya et al 2019[6] .

The tooth print pattern recorded in fluorosed teeth showed variations in the pattern from complete to interrupted or incomplete enamel rod end pattern. These variations in the pattern can be attributed due to variations in the intensity of fluorosis and due to presence of pores, gaps between enamel rods and loosely arranged crystals. These defects can be caused by certain factors a) Excessive fluoride intake results in retention of enamel protein leading to hypominerlization of rod and loose crystalline arrangement of rods. b) Fluoride intake can displace the hydroxyl group in the hydroxy apatite crystals and form fluoroapatite crystals (Jie Min et al[13]).

VI. CONCLUSION

Ameloglyphics is a recent evolving forensic tool in person identification. This procedure is uncomplicated and effective. In this study we compared the fluorosed tooth print pattern and normal teeth. We attained an incomplete or interrupted tooth print pattern in fluorosed teeth along with complete pattern. The application of these tooth print pattern for person identification requires intense studies with more sample size involving the complete dentition and all the surfaces.

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