Original Article

Age Determination among Different Age Groups using Enamel-etching patterns: Scanning Electron Microscopy Analysis

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Abstract

Background: The determination of age and sex is among the important aspects of forensic anthropology and vital in medicolegal investigations. Enamel is the hardest known substance in the human body. As tooth matures, the surface layer of the enamel presents hypermineralization features, which could influence the features of the etching pattern.

Aim: The purpose of the present study is to assess if the enamel surface can be used as a parameter to determine the age.

Materials and Methods: Sixty freshly extracted teeth from individuals with known age group were collected and etching procedure was done, and then subjected to scanning electron microscope analysis.

Statistical Analysis: Chi-square test was done using SPSS software (Statistical Package for the Social Sciences (SPSS), USA).

Results and Conclusion: The predominant etching pattern seen in 20–30 year age group after acid etching for 15 s is Type I pattern (66%), while in 50–60 year age group, it is Type II pattern (61.6%). A significant difference was observed in the respective age groups among the type of etching pattern. This technique can be a very useful adjunct for age determination in the field of forensic odontology.

Key Words: *Acid etching, enamel etching, forensic odontology*

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Introduction

The determination of age and sex is among the most important aspects of forensic anthropology and vital in medicolegal investigations. Forensic investigators rely on the accuracy of age indicators to determine the age of an individual based on skeletal remains.[1]

Enamel is the hardest known substance in the human body. Young patient's teeth have an aprismatic layer of 30 μm lost with time. However, as the age advances, the hard tissue of the teeth becomes more mineralized when exposed to the oral environment. This causes the surface layer of enamel to present hypermineralization features, which could influence the pattern of etching.[2]

- Type I (honeycomb pattern) had enamel prism cores selectively removed
- Type II (cobblestone pattern) had peripheral regions of the prisms removed leaving relatively unaffected prism core[3]
- Type III had areas corresponding to both Types I and II
- Type IV pattern is pitted and seen mostly in cervical areas. It was demonstrated that etched prismless enamel displays no rod or prism patterns[4]
- Type V pattern is flat and smooth lacking microirregularities often seen in fluoride-treated teeth or in patients residing in high-fluoride area.[5]

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Aim

The purpose of the present study is to assess if the enamel surface can be used as a parameter to determine the age.

Materials and Methods

Sixty freshly extracted human molars with no caries on the buccal aspect with age group ranging between 20 to 30 years and 50 to 60 years were collected from the Department of Oral and Maxillofacial Surgery, Saveetha Dental College, Chennai. The extracted teeth were divided into two groups of age groups, i.e., 20–30 years and 50–60 years. Informed consent was obtained from the patients for the usage of teeth for the study. Ethical clearance was obtained from the Human Ethical Committee and Saveetha Review Board [Figure 1]. Teeth were sectioned at the cemento-enamel junction using a diamond disc, and the roots were discarded. The crowns of the teeth were cut on a mesiodistal line, and the buccal surfaces were retained for experiments.

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The buccal surfaces of the sixty half-teeth were ground with 600-grit silicon carbide paper. The sectioned tooth was then put in an envelope and sealed. The envelope was opened and the first invigilator was asked to etch the tooth's buccal surface with 37% orthophosphoric acid (N-etchIvaclor Vivadent, Switzerland) for 15 s [Figure 2]. It was rinsed for 10 s and air-dried [Figure 3]. These samples were then again sealed in disposable envelopes and taken for scanning electron microscopy (SEM) analysis.

The etching effect of enamel surfaces was assessed by using SEM. All samples were coated with gold electrodepositing using a sputter coater (Cressington Sputter Coater, USA) [Figure 4] and prepared for surface SEM analysis (FEI QUANTA 200F). SEM analysis was carried out at Sophisticated Analytical Instrument Facility - SAIF, IIT - Madras.

The second invigilator who was experienced in SEM analysis analyzed the etching patterns in each of the nine quadrants (occlusal, middle, and cervical third) seen on the buccal surface and they were recorded. Hence, both the assessing invigilators were blinded. After recording the values, statistical analysis was done.

Figure 1: Tooth sectioned horizontally using diamond disc

Figure 3: Etched buccal surface after air drying

Statistical analysis

Chi-square test was done to evaluate the percentage of various etching patterns (Type I, II, III, and IV) prevalent in age groups 20–30 years and 50–60 years.

Among the 20–30 years range, the most common pattern observed was the Type I with 66.1% (119 samples) [Figure 5]. Other patterns were Type II (18.9%), Type III (11.1%), and Type IV (3.9%) [Table 1].

Among the 50–60 years range, the most common pattern observed was the Type II with 61.1% (110 samples) [Figure 6]. Other patterns were Type I (20.6%), Type III (10%), and Type IV (8.3%) [Table 2].

Results

The predominant etching pattern seen in 20–30 years age group after acid etching for 15 s is Type I pattern (66%), while in 50–60 year age group, it is Type II pattern (61.6%) [Figure 7].

A significant difference was observed in the respective age groups among the type of etching pattern.

Discussion

Dental identification of humans occurs for a number of different reasons and in a number of different situations such as for the body of victim of violent crime, fire, road traffic accident, and workplace accident.

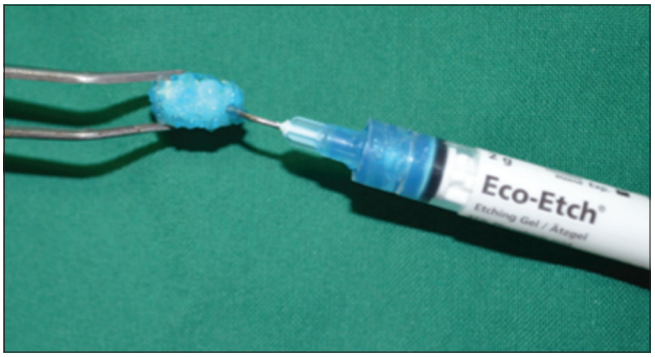

Figure 2: Etchant application on the buccal aspect of the tooth

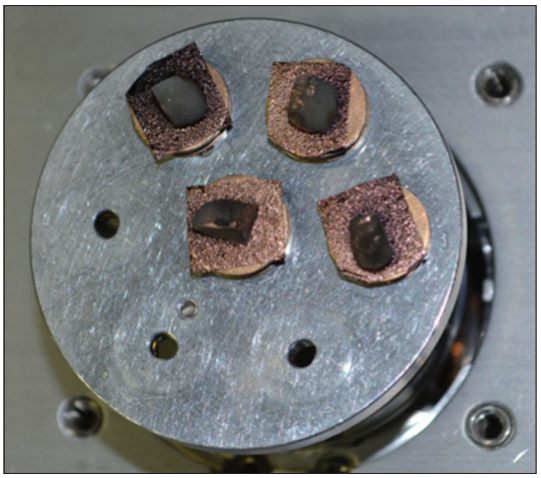

Figure 4: Gold-sputtered samples prior to scanning electron microscope analysis

Table 1: Frequencies and Chi-square test for patients in the age range of 20-30 years

Age group	Type	Frequency	Percent	*P*
20-30 years	Type 1	119	66.1	<0.001
	Type 2	34	18.9	
	Type 3	20	11.1	
	Type 4	7	3.9	
	Total	180	100.0	

Table 2: Frequencies and Chi-square test for patients in the age range of 50-60 years

Age group	Type	Frequency	Percent	*P*
20-30 years	Type 1	37	20.6	<0.001
	Type 2	110	61.1	
	Type 3	18	10.0	
	Type 4	15	8.3	
	Total	180	100.0	

Body can be disfigured to such an extent that identification by a family member is neither reliable nor desirable. Through the specialty of forensic dentistry, dentists can play a small but significant role in this process.[6]

An important feature of the teeth is that they are the most indestructible part of the body and exhibit the least turnover of natural structure.

They, therefore, not only survive after death but also remain relatively unchanged thereafter for many 1000s of years.[7]

SEM provides the best possible surface view to analyze the etched enamel surface. In the present study, SEM analysis revealed that the etching effect of phosphoric acid etching was similar to that of previously described by Silverstone *et al*.[3] The prism cores and boundaries were etched by 37% phosphoric acids, causing dissolution of both inter- and intra-prismatic areas. In Type I pattern, the cores were removed and periphery remained unaffected. While in Type II etching pattern, the peripheral region of prisms was removed and prism cores were relatively unaffected.

The difference in the etch pattern in the case of older individuals could be attributed to exposure to the oral environment and this results in hypermineralized enamel.[8]

According to Lopez *et al.*, after tooth eruption, there is a continuous enamel maturation process that makes it more resistant to demineralization.[2] This maturation consists of mineral deposition from oral fluids in interprism spaces that were previously filled with water.[9] The change in etching patterns could be attributed to continuous ionic change with the environment, the human enamel is expected to behave differently to acid conditioning, depending on age and other factors.

This method can be used as an adjunct to determine the age of the patients in cases of mass disasters where other body parts are beyond the point of any forensic use. Tooth, which can withstand high temperature and pressure, can be used for the determination of age.

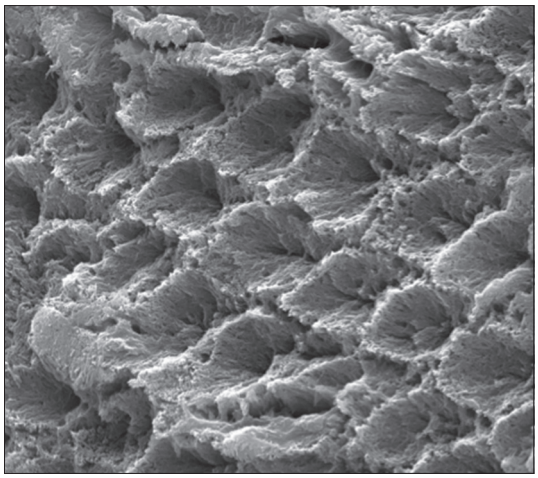

Figure 5: Type I pattern with age range of 20–30 years, under ×4000

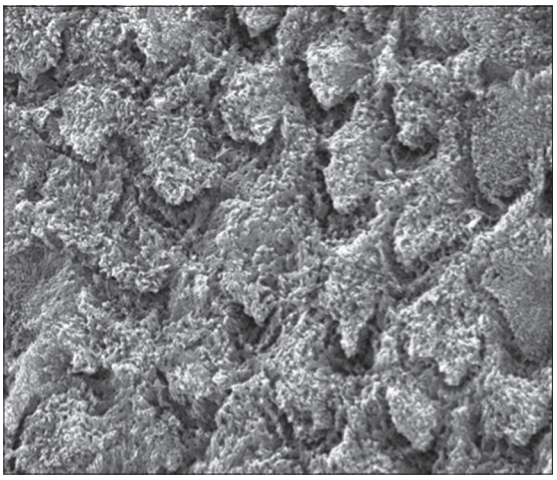

Figure 6: Type II pattern with age range of 50–60 years, under ×4000

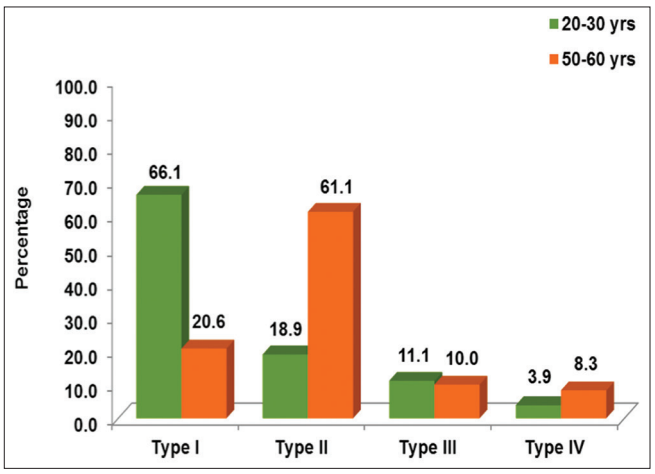

Figure 7: Graph depicting the distribution of etching patterns across age groups

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Conflicts of interest

There are no conflicts of interest.

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