ORIGINAL ARTICLE

Cementum as an age determinant: A forensic view

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Abstract

Context: Forensic age estimation (FAE) defines an expertise in forensic medicine, which aims to define in the most accurate way to determine the unknown chronological age of the person involved in judicial or legal proceedings. Dental cementum is a vital tissue which demonstrates continuous apposition throughout the life of the tooth. This appositional changes of cementum helps in approximation of age inforensic investigations. **Aims:** To correlate age by measuring the overlap or coronal migration of thecementum at thecementoenamel junction (CEJ) and the thickness of the cementum at the apical third of the root. **Settings and Design:** A hundred freshly extracted teethfrom patients ranging from ages 17-55were longitudinal buccolingually ground sectioned using a mounted lathe wheel and Arkansas stone. **Materials and Methods:** 100 freshly extracted teeth of age group ranging from 17-55 years were taken. These teeth were longitudinally ground sectioned to a thickness of 8-10μm using a mounted lathe wheel and Arkansas stone. Afterwards the teeth were examined under a light microscope using a micrometer eyepiece for measuring the overlap or coronal migration of the cementum at the CEJ and the thickness of the cementum at the apical one-third of root. **Statistical Analysis:** Measurements of the overlap or the coronal migration of the cementum at the CEJ and the thickness of the cementum at the apical one-third of the root are correlated with age. **Results:** Results of the study indicated that the cementum at the CEJ migrated coronally during theaging process in case of the impacted teeth. There is also a significant increase in the thickness of the cementum at the apical onethird of rootin the case of both the impacted and erupted teeth. **Conclusion:** Approximation of age by measuring overlap or coronal migration of the cementum at the CEJ and the thickness of the cementum at the apical one-third of the rootsets new alleys in FAE.

Key words: Cementoenamel junction, forensic age estimation, micrometer eyepiece

Introduction

Forensic odontology, as a science, did not appear before 1897 when Dr. Oscar Amoedo, the father of forensic odontology, wrote his doctoral thesis entitled "L' Art Dentaire en MedecineLegale" describing the utility of dentistry in forensic medicine with particular emphasis on identification. Keiser-Neilson in 1970 defined forensic odontology, or forensic dentistry, as "that branch of forensic medicine which in the interest of justice deals with the proper handling and examination of dental evidence and with the proper evaluation and presentation of the dental findings."[1]

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The three hard tissues of the tooth, i.e., the enamel, dentin and cementum, undergo structural changes throughout life. Environmental effects and aging are the factors primarily

responsible for these changes.[2,3] Of these three tissues, the dental cementum is a vital tissue which demonstrates continuous apposition throughout the life and is not equally distributed on the root surface. The thickness of cementum is greater on the apical areas while thinner near the cementoenamel junction (CEJ). The cementum appears to be independent of both the pulp and dentine for its nutritional requirements. A pulp less tooth still presents vital cementum as the nutritional supply to it is chiefly derived from periodontal ligament.[4-9] Deposition of cementum on a healthy tooth continues throughout life. This deposit is greater in the apical area than that of CEJ.[10]

Hence the present study is based on the apposition of cementum at two ends of the root, i.e. one at the CEJ or coronal end, and the other at root tip or apical end. At the ends specified above, the coronal displacement and the thickness of the cementum are measured and correlated with age. The present study was done in comparison with erupted and impacted third molars.

Materials and Methods

A hundred and thirty mandibular third molars from patients ages 17-55 years old were extracted with care to minimize damage. After extraction, they were fixed in 10% formalin and were grouped into 4 groups according to age range: Group A included ages 17 to 25 years old, Group B included ages 26 to 35 years, Group C included ages 36 to 45 years, and Group D included ages 46 to 55 years. Later the extracted teeth were examined under the stereomicroscope, so as to select the appropriate ones for the study of CEJ.

Exclusion criteria

Teeth that were restored, subjected to endodontic treatment, grossly decayed, damaged during extraction, or with root resorption were excluded.

After examination under a stereomicroscope, a total of 100 teeth, 50 impacted teeth and 50 erupted teeth, were selected. Group A included 16 impacted and 9 erupted teeth, Group B included 19 impacted and 6 erupted teeth, Group C included 8 impacted and 17 erupted teeth, and Group D included 7 impacted and 18 erupted teeth. The selected teeth were sectioned longitudinally in a buccolingual aspect to a thickness of 8-12 μm using a mounted lathe wheel and Arkansas stone. After that these sections were cleared, mounted, and examined under a light microscope using the micrometer eyepiece for measuring the overlap or coronal migration of the cementum at the CEJ and the thickness of the cementum at the apical third of the root.

The overlap or coronal migration of the cementum at the CEJ was measured from the edge of the cementum to the edge of enamel at the CEJ on both sides of the tooth section and the average value of it was taken as final reading. Positive scores were given for the cementum overlapping enamel [Figure 1], zero scores were given if the enamel and cementum were edge to edge [Figure 2], and negative scores were given if the cementum and enamel did not meet each other [Figure 3].

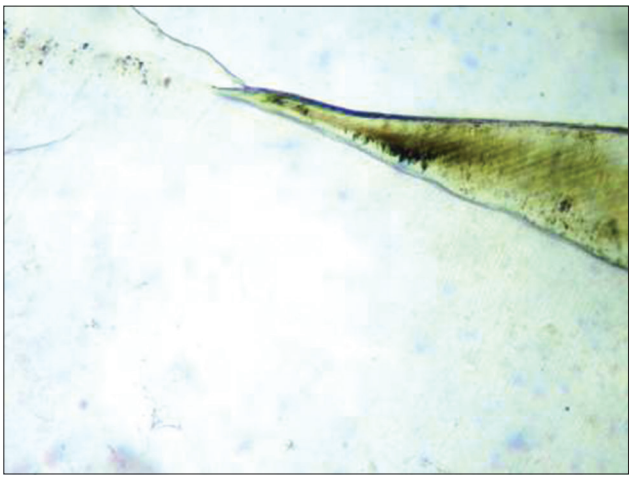


Figure 1: Overlapping type of CEJ

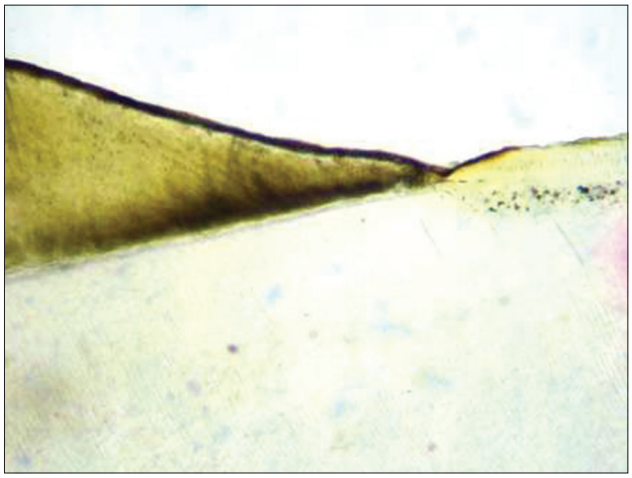


Figure 2: Edge-to-edge(butt-type) CEJ

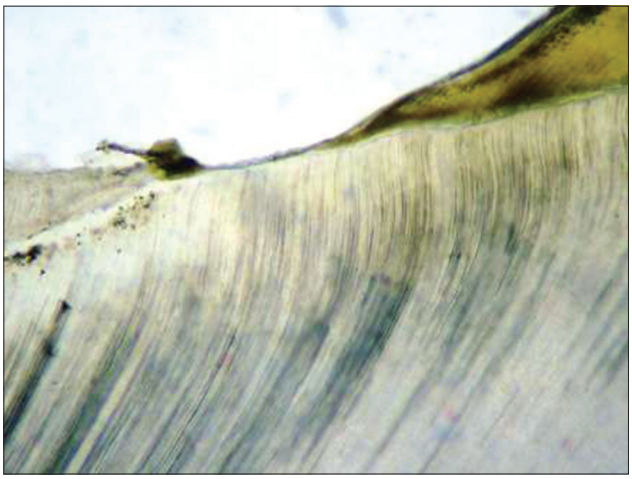


Figure 3: Gap-type CEJ

At the apical third of the root, measurements were taken from the surface of cementum to the dentin-cementum junction. These measurements at the apical third of the root were done by making apical third portion of the root into six sections (3 + 3) on both sides of section. The first one-third towards coronal end; the second one-third is between coronal and lower one-third towards the apical end; and the third one-third is the lower most apical portion [Figure 4]. The average of all 6 sections was taken as the final reading. The measurements were recorded in μm and further analyzed statistically.

Results

The overlap or coronal migration of cementum at the CEJ

The average of the measurements obtained in case of erupted and impacted teeth were statistically analyzed using the Pearson product-moment correlation coefficient (PPMCC). The minimum and maximum measurements, their means in μm, and the standard deviation (SD) of the four study groups are given in Tables 1 and 2. In the case of the impacted teeth, a significant linear correlation exists between coronal migration of cementum at the CEJ and age [Table 3]. Where as in the case of the erupted teeth, there is no statistical significance between coronal migration of the cementum at the CEJ with that of age [Table 4].

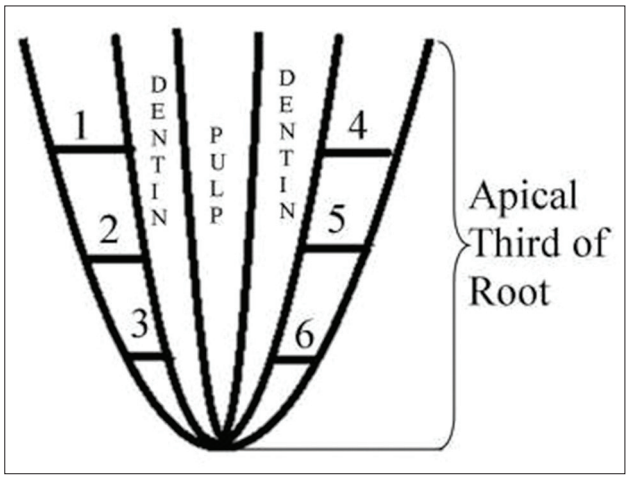


Figure 4: Diagramatic representation of apical third of the root, showing 6 different areas considered for measuring thickness of the cementum at apical third of root on both sides

Thickness of cementum at apical third of the root

At the apical third of the root, measurements were taken from the surface of cementum to the dentin-cementum junction, considering the apical third of the root into six sections (3 + 3) on both sides of section. The averages of all the six sections were taken for both the erupted and impacted teeth and was statistically analyzed using the PPMCC.

The minimum and maximum measurements, their means in μm, and the standard deviation (SD) of the four study groups are given in Tables 1 and 2. The PPMCC showed a significant correlation between the thickness of the cementum at apical third of the root and age for both erupted and impacted teeth [Tables 3 and 4].

The mean ages of four study groups the impacted and erupted teeth are given in Tables 5 and 6.

Discussion

Age estimation in the forensic context is necessary for identification of both living and dead. In dead, it principally aids in identification of missing persons. In living, age estimation in children is important to solve judicial or civil problems concerned with age. In adults, it is helpful

Table 1: Measurements of coronal displacement of cementum at CEJ and Thickness of cementum at apical third of the root in impacted teeth

Age (years)	No. of impacted teeth (*n*)	Average distancebetween cementum and enamel in '*μ*m' at CEJ			Average thickness of cementum at apical third of the root in '*μ*m'		
		Min/max	Mean	Standard deviation (SD)	Min/max	Mean	Standard deviation (SD)
17-25	16	77/164	117	25.28	184/276	232	24.75
26-35	19	156/238	199	27.95	256/386	325	29.87
36-45	8	228/454	327	85.36	362/475	432	37.41
46-55	7	442/686	558	90.42	485/554	512	30.12

Table 2: Measurements of Coronal displacement of cementum at CEJ and thickness of cementum at apical third of the root in erupted teeth

Age (years)	No. of erupted teeth (*n*)	Average distancebetween cementum and enamel in '*μ*m' at CEJ			Average thickness of cementum at apical third of the root in '*μ*m'		
		Min/max	Mean	Standard deviation (SD)	Min/max	Mean	Standard deviation (SD)
17-25	09	−67/−162	−79	71.22	216/314	264	38.73
26-35	06	−74/−196	−43	137.36	316/428	354	49.98
36-45	17	−78/154	−32	117.64	368/453	398	27.90
46-55	18	−135/266	−87	172.90	420/584	488	86.33

in solving civil issues. One should always remind that, whatever the case is, the role of forensic anthropologist or odontologist is to give the best estimate of biological age.[11]

Human age estimation is a procedure adopted by anthropologist, archaeologists, and forensic experts. There is no medical test or a group of tests that absolutely and accurately exacts the chronological age of a human being above 25 years.[12] Teeth in many ways form a unique part of human body as they are most durable and resilient part of the skeleton.[2]

During the lifetime of an individual, the tooth as a unit is not static. Teeth constantly undergo changes either due to aging or due to environmental factors. These factors aid in appreciable changes such as attrition, periodontal disease, deposition of secondary dentin, root translucency, cementum apposition, root resorption, color changes, and an increase in root roughness. By considering these secondary changes to age, various studies were done to estimate age of an individual.[13]

There are three types of CEJ in which the cementum overlapping enamel is seen in 60-65% cases.[9] In the present study there is a significant increase in the coronal displacement of the cementum at the CEJ in impacted teeth [Graph 1], which proves that cementum apposition is attributed to continually eruptive forces acting on the impacted teeth or phenomenon is a natural defense mechanism of the tooth.[14] Whereas in case of erupted teeth there is no significant correlation exists [Graph 2], as these teeth are exposed to the oral environment and hence are affected by both environmental and aging factors. The study conducted by Bocutoglu *et al*. in 1997 on impacted and erupted canines showed similar results.The study done by Balwant Rai *et al*. in 2006 on impacted and erupted third molars also interpreted same results. Similar results were also seen in a study done by Aparna Thombre Sharma *et al*.in 2010.[14-16]

Cementum in humans increases in thickness with age, and new layers are deposited on the outside of the dentin throughout the life of the individual. Cementum usually does not the undergo wear and tear phenomenon, unlike enamel and dentin. However it maintains healthy

Table 3: Significant correlation between coronal displacement, thickness of cementum, and age in impacted teeth

	age	Coronal displacement	Thickness
Age			
Pearson correlation	1	0.968**	0.987**
Sig. (2-tailed)		0.001	0.001
N		50	50

**Correlation is significant at the 0.01 level (2-tailed)

Table 4: Significant correlation between coronal displacement and thickness of the cementum and age in erupted teeth

	age	Coronal displacement	Thickness
Age			
Pearson correlation	1	-0.011	0.865**
Sig. (2-tailed)		0.937	0.001
N		50	50

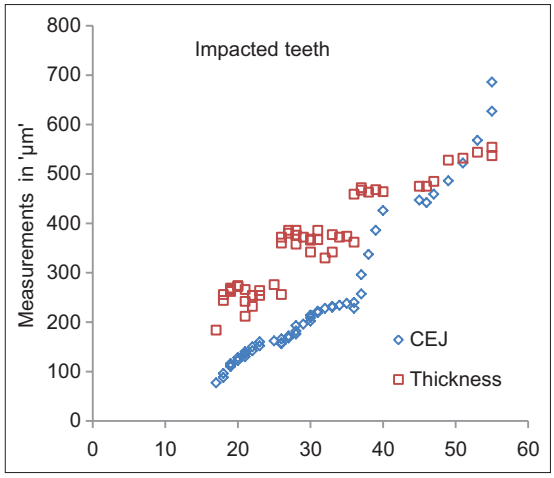
**Correlation is significant at the 0.01 level (2-tailed)

Table 5:The mean age of four study groups for impacted teeth

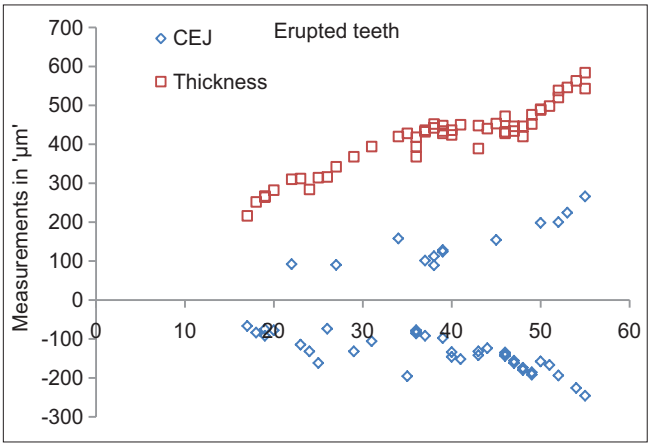
Study group	Age group	*N*	Mean	Std. deviation	Std. error mean
A	17-25	16	20.5000	2.16025	0.54006
B	26-35	19	29.6842	2.80976	0.64460
C	36-45	8	38.5000	2.97610	1.05221
D	46-55	7	50.8571	3.67099	1.38750

Table 6: The mean age of four study groups for erupted teeth

Study group	Age group	*N*	Mean	Std. deviation	Std. error mean
A	17-25	9	20.7778	2.81859	0.93953
B	26-35	6	30.3333	3.66970	1.49815
C	36-45	17	39.4706	2.87484	0.69725
D	46-55	18	49.8889	3.06573	0.72260



Graph 1: Coronal displacement and thickness of the cementum in impacted teeth measured in µm is plotted against age which showed a linear correlation



Graph 2: Coronal displacement of cementum at the CEJ and thickness of the cementum in erupted teeth measured in µm are plotted against age, showed significant linear correlation only with thickness of the cementum

periodontium by its continuous apposition.[17] Cementum is not uniform all through the length of the root; it is thinner at the cervical third and thicker at the apical third. The thickness of cementum ranges from 50 μm-150 μm.[9] Cementum is formed as a result of a continuous process throughout life and it has been shown to triple in thickness between ages 20 and 60 years.[17] In the present study, the thickness of cementum at the apical third of the root showed significant increase with age in both the erupted and impacted teeth [Graphs 1 and 2]. Zander and Hürzeler stated that the cementum was potentially a better age-estimating tissue due to its unique location in the alveolar process.[18] Gottlieb suggested that continuous cementum apposition is necessary for maintaining a healthy periodontium. Similar results were seen in the study conducted by Thomas John Stein *et al*. on vital and non-vital teeth.[14,19]

Conclusion

The problem with using "age" in a system measuring maturity and, therefore, biological age (sexual, dental, or skeletal) does not always correspond to chronological age (legal). None of the modern techniques are both easy and practical to use, as most of them result in a slight over- or underestimation, depending on the applied method, the range of human variation between sex and population, and discrepancies between biological and legal age.[20]

The present study states that there is a potential for cementum to recover around the CEJ. Cementum apposes continuously; if contributing conditions could be avoided for a reasonable period of time, this property of cementum apposition aids as an adjunct to biological age estimation, which may serve to be significant tool in forensic investigations. A large number of samples is required to know the sensitivity and specificity of this technique for the estimation of biological age and its practical implication in biological age estimation.[14,16]

However, it is generally agreed that age assessment is more accurate when derived from multiple indicators (physical, skeletal and dental maturity). In addition, the developmental differences associated with various ethnic groups must also be considered.[21,22]

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