

ORIGINAL ARTICLE

MORPHOLOGICAL ANALYSIS OF CEMENTOENAMEL JUNCTION TYPES IN PREMOLARS AND MOLARS OF A SAMPLE OF PAKISTANI POPULATION

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Background: Cementoenamel junction represents the demarcation between enamel covered crown and cementum covered root surface. There is paucity of population specific data of the morphological variability of cementoenamel junctions of permanent and primary teeth. The objective of this study was to investigate the morphological diversity and interrelationship of cementoenamel junction of premolar and molar teeth in permanent dentition of a sample of Pakistani population with potential forensic and anthropological implications. **Methods:** This cross-sectional study was conducted at Oral Biology department of Dr Ishrat ul Ebad khan institute of oral health science, Dow University from March till September 2016. Seventy-five maxillary and mandibular permanent premolar and molars from adult patients of both sexes were selected and sectioned. Longitudinal ground sections were prepared to study the morphological interrelationship between Cementum and Enamel in each specimen to be viewed under light microscope. A chi-square test was applied between the categorical variables. **Results:** Results showed 57.3% of sections had cementum overlapping enamel interrelation, 32% showed edge to edge cementum and enamel relation and 9.3% showed that cementum and enamel failed to meet resulting in exposed dentine, while 1.3% sample showed enamel over cementum relation. No significant correlation was found between gender, type of tooth, maxillary, mandibular arches and the morphological variation of CEJ ($p>0.05$). **Conclusion:** It can be concluded that there are considerable morphological variations in CEJ of premolars and molars with preponderance of cementum overlapping enamel in these teeth. Based on these findings, dentists are advised to be mindful of dental procedures involving the CEJ and that these interventions should be performed meticulously avoiding any detachment of cementum and subsequent exposure of dentin resulting in dentin hypersensitivity.

Keywords: Cementoenamel junction; Light microscopy; Ground section

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INTRODUCTION

The cementoenamel junction (CEJ) is a complex structure that unites the brittle overlying enamel with the Cementum. It serves as an important anatomical land mark and demarcation between dental hard tissues. Cementum is a calcified hard and avascular tissue that resembles bone in its chemical composition only but differs significantly in its structural composition¹ that provides anchorage to the periodontal ligament in healthy tooth². Anatomically CEJ or cervical line marks the neck of the tooth and it is area where enamel of the crown meets cementum that covers the dentin in the root.³ In clinical dentistry significance of this land mark can be highlighted by the fact that it serves as an important reference point for diagnosing the severity of gingival and periodontal conditions and in performing different clinical procedures like scaling, root planning and periodontal surgeries.⁴ CEJ is a very fine fragile area of around 40–60 microns so special care

should be exercised while handling tooth in clinical procedures e.g. rubber dam placement or cavity preparation, manual root planning using periodontal scalers, curettes and hoes as it can easily be damaged exposing the dentine causing hypersensitivity. Susceptibility to non-carious cervical lesion like erosion, attrition and abfraction are also associated with destruction of tissues at CEJ caused by the occlusal loads and mechanical stress produced during normal physiological activities like brushing and mastication.^{5,6}

Based on literature review of morphology and distribution of mineralized tissues that compose CEJ, three different types of tissue interrelations exist between enamel and cementum, enamel overlapped by cementum 60–65%; enamel and cementum edge-to-edge 30%; and a gap, revealing a strip of exposed dentin 10%.⁷ Other studies have depicted three types of mineralized tissue interrelation but each study showed varying percentage of interrelation among the three

morphologies.^{8,9} Studies based on optical microscopy and Scanning Electron Microscopy have revealed a fourth type of interrelation of cementum and enamel; cementum overlapped by enamel.^{10,11} The growing importance of cementum in repair and regeneration of periodontal tissues and as a measure for controlling root surface caries has been given due attention by researchers and clinicians.

Currently available data regarding the anatomy of this mineralized tissue show considerable disparity and there exists a need to explore deeper to understand the morphological variation of CEJ with regards to different type of tooth, arch, gender and even ethnicity. In the absence of local studies that explain variations in morphology of this load bearing structure of tooth, the aim of this cross-sectional study was to investigate the morphological variation of CEJ in premolars and molars in permanent dentition in a sample of Pakistani population as considerable variation in different studies has been reported. Furthermore, the most prevalent relationship of cementum with enamel will be discerned.

This study was therefore performed to comprehend the different morphological variations of cemento-enamel junction and to recognize the most prevalent relationship of cementum with enamel and to compare its variability among the teeth, arches, and gender in a sample of Pakistani population.

In this study two classes of tooth; molars and premolars were used as they present different degree of variability for the distribution of mineralized tissue.

MATERIAL AND METHOD

After gaining approval from Institutional Review Board of Dow University of Health Sciences Ref. No: IRB-395/DUHS/Approval/2016/183, this cross-sectional study was conducted at Oral Biology department of Dr Ishrat ul Ebad Khan Institute of Oral Health Sciences of Dow University from March till September 2016. The sample included maxillary and mandibular premolars and molars extracted teeth that were obtained from patients after verbal consent. The sample size for the study was calculated to be 75 for 95% confidence interval using Open Epi software. Random sampling technique was used for the selection of teeth. The teeth were collected from Oral and Maxillofacial Surgery department of Dr. Ishrat ul Ebad Khan Institute of Oral Health Sciences at Dow University of Health Sciences.

Teeth with restorations, caries, attrition, abrasion, resorption, erosion and developmental

anomaly were excluded from this study. Only teeth with intact cervical area and without any restorations were included in this study. The teeth were washed with sterile water and were then preserved in 10% formalin solution immediately after extractions till the ground sections were prepared.

For making ground section, hand grinding method was used. Grinding was done manually first with use of carborundum stone.^{12,13} The tooth was kept facing its lateral surface to trimmer and is grinded till 4–5 mm thickness was achieved under constant water spray. The water spray helps to cool the tooth as it aids in reducing the heat generated due to friction of grinding. Then further grinding was performed at slow speed bench grinder till the section of 3–4 mm thickness was obtained. At this stage special care should be taken while handling the tooth as it is very thin and could fracture easily. Tooth was grinded on this surface till 1mm thickness was reached. After that, further grinding was performed using Fine pumice powder till the paper-thin section of 0.25-mm thickness was achieved. The teeth were longitudinally sectioned in buccolingual dimensions. Cleaned and dried sections were mounted on slide using DPX mounting media and viewed under light microscope as per our protocol.¹⁴

Longitudinal ground sections were prepared using manual grinding technique and then they were subsequently observed and photographed under Light microscope (Nikon Company) with 10X magnification. To take a record of microscopic findings, different tissue relations were classified in to:

- 1) Cementum overlapping enamel - I (Fig I, II)
- 2) Cementum and enamel; edge to edge - II. (Fig I, II)
- 3) Cement and enamel fail to meet – III. (Fig I, II)
- 4) Enamel overlapping Cementum – IV. (Fig I)

Statistical analysis was performed with the Statistical Package for Social Sciences (SPSS for windows version 21.0). Frequencies were calculated for observing the distribution of mineralized tissue in the sample. To determine the association between categorical variables gender, maxillary and mandibular arch, type of tooth (premolars and molars) with the microscopically observed CEJ morphology, Chi-Square test was applied.

RESULTS

A total of 75 tooth sections were examined, out of which 39 teeth were extracted of males and 36 teeth were that of female. The CEJs of all permanent teeth were morphologically similar, without specific characteristics.

The distribution of interrelations between cementum and enamel observed under transmitted light microscope in terms of frequency and percentages. The CEJ in all permanent teeth were presented with four

different relationships. Cementum overlapping enamel was observed in 57.3% of sections. Cementum and enamel in an edge to edge relationship was observed in 32% of the sections. 9.3 % of the sections showed third type of interrelation presenting with a gap between cementum and enamel with intervening exposed dentin. Only 1.3% of the sample showed the rare relationship of enamel over cementum variety. (Table-1)

The relation of categorical variables with the types of cementum and enamel interrelation can be depicted in Table-2. No significant correlation was observed between type of tooth (premolar/molar), arch (maxilla/mandible), gender: (male/female) and morphology of CEJ. (Table-2)

Table-1: Frequency of types of CEJ with percentages

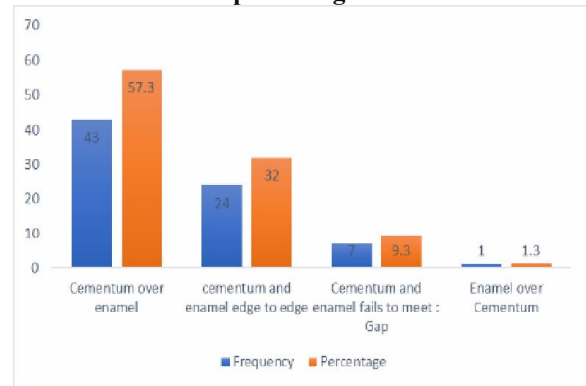


Table-2: The frequency of types of CEJ with respect to tooth, arch and gender

		Cemento enamel junction					p-value
		Cementum over enamel	Cementum and enamel edge to edge	Cementum and enamel fails to meet: GAP	Enamel over cementum		
Tooth	Premolar	40	23	13	4		*
	Molar	35	20	11	3	1	
Arch	Maxilla	39	21	12	3	-	*
	Mandible	36	22	12	4	1	
Gender	Male	39	20	13	5	1	*
	Female	36	23	11	2	-	

*p = >0.05 insignificant

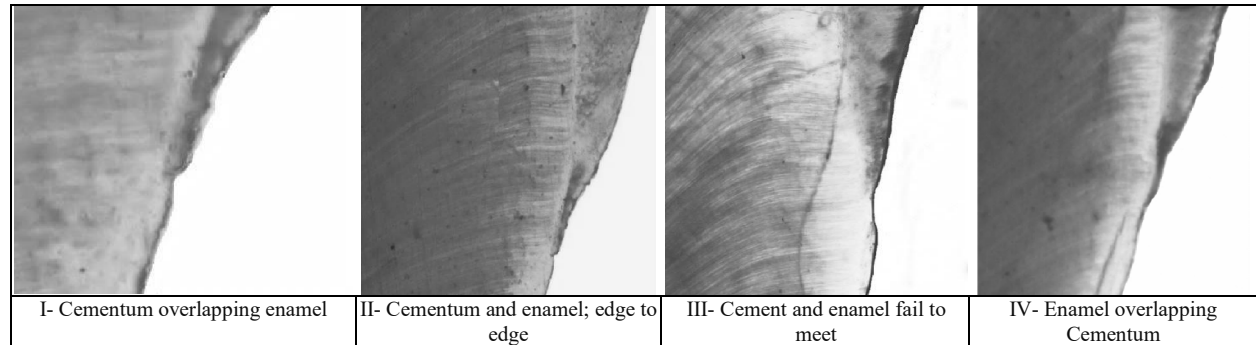


Figure-1: Molars (Photomicrographs were taken with Nikon light microscope at 10X magnification.)

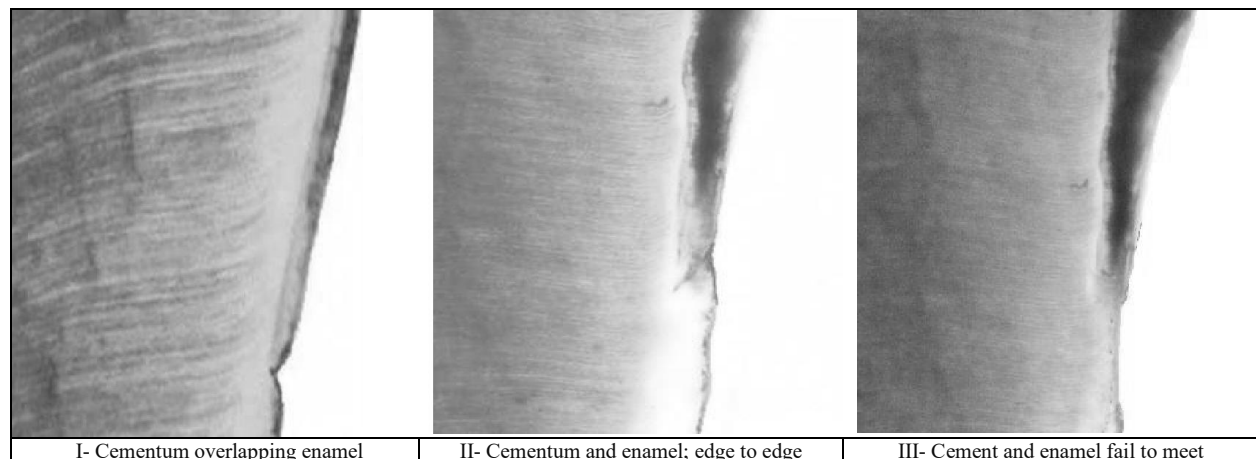


Figure-2: Premolars

DISCUSSION

The junction of Cementum and enamel at the cervix of tooth varies in its organization, structure and form even around a single tooth. At times cementum overlaps enamel and vice versa and as a result exposed dentin could exist between the two mineralized tissues. Tooth sensitivity, non-carious cervical lesions and certain other pathological conditions can also be found associated with this junction.

Previously three types of CEJ have been reported in the available literature, these include: 1) overlap; Cementum overlaps the enamel 2) abutment; Cementum joins with enamel end to end 3) gap; Cementum fails to meet the enamel, leaving exposed cervical dentin. Recent optical microscopic studies have revealed a fourth type of cements/enamel junction; Cementum overlapped by enamel.¹¹

The distribution of mineralized tissue in present sample gives results that are found to be consistent with the previous studies describing four types of morphological variations.¹⁰

The fourth type of CEJ was observed in only 1.3% of sample. This could be attributed to comparatively smaller sample size or could be due to uneven sectioning owing to manual grinding method.

Cementum overlapping enamel and edge to edge interrelationship of enamel and cementum were the most common variations of CEJ morphology of our study and these findings are consistent with that of Schroeder¹⁵ and Neuvald¹⁰, as cementum over enamel interrelationship was the most frequent feature observed while cementum and enamel tissues edge to edge relation was observed in more than one third of the cements/enamel junction. These findings are contrary to the findings of Arambawatta¹¹ and Leonardi *et al*¹⁶ observed no gaps between enamel and cementum, whilst in our samples exposed dentin was observed rarely in specimens.

Arambatwatta, investigated premolar teeth extracted for orthodontic reasons under light microscope and found four types of interrelation between enamel and cementum and reported the edge to edge relationship of cementum and enamel to be the most common, this study also give four different morphologies but cementum over enamel was the prevalent morphology.¹¹ Grossman examined the sections under scanning electron microscope to differentiate the morphology of CEJ and reported cementum overlapping enamel to be predominant in the specimens, that is congruous with the findings of our study.¹⁷

Although there are limitations of assessing the morphology of CEJ in ground sections of teeth due to unavailability of the entire perimeter of CEJ

for recording purposes, the findings of our study are still in accordance with studies that have used SEM, confocal microscopy and even CBCT.^{9,15}

Morphological variations of CEJ account for clinical conditions and associated symptoms of root caries, cervical resorption and dentinal hypersensitivity.¹¹ Dentists and dental hygienists have to be mindful of these morphological variations of CEJ while performing periodontal procedures like scaling and root planning.² When cementum over enamel interrelation exists, it is helpful for clinicians to gain a smoothness in this area in one stroke, but if there is an edge to edge relation of cementum and enamel a single stroke can remove the delicate lining of CEJ, leaving an exposed dentine which may progress into cervical lesion or may cause dentinal hypersensitivity (18, 19). CEJ appears to be an area of weakness for the progression of non-carious cervical lesion (erosion, abrasion, and abfraction) as well as cervical external resorption.^{5,10,20} Exposed dentin in the oral environment leads to influx of bacteria resulting in either caries or resorption depending on the severity of the bacterial insult.

CEJ also act as an important land mark for the assessment of clinical attachment level (CAL) in the diagnosis of periodontitis.^{20,21} Cemental annulations on teeth have been correlated reliably for adults above 25 years for chronological age estimation as these represent incremental lines.²² One important aspect regarding regeneration of cementum is that circumferential coverage of cementum by the attached gingiva and crestal alveolar bone results in deposition of acellular and afibrillar cementum on the exposed dentin resulting in an edge to edge relationship of cementum and enamel with progression to cementum over enamel interrelationship owing to continued deposition of cementum.²³ Thus the relationship of cementum and enamel may vary depending on the repair and regeneration of cementum within the confines of attached gingiva and crestal bone.⁹

External cervical resorption owing to dental trauma, fixed orthodontic treatment and bleaching procedures contribute towards local structural alterations in the outline and relationship of the mineralized tissues comprising the cements/enamel junction.

CONCLUSION

Based on the findings of this study, considerable morphological variations in CEJ of premolars and molars have been detected. Cementum overlapping enamel was the predominant type of CEJ depicted in this study. It is paramount to understand the structural peculiarities of cements/enamel junction to elucidate the structure function relationship in health and

disease. Dentists should be mindful of dental procedures involving the CEJ and that these interventions should be performed meticulously avoiding any detachment of cementum and subsequent exposure of dentin resulting in dentin hypersensitivity.

No statistically significant relationship exists in relation to gender, type of tooth and differences between maxillary and mandibular arches were found and further studies with increased sample size are needed to appreciate these variations.

Ethical Considerations: This research was performed in accordance with the Declaration of Helsinki. The study does not involve any human subjects, including research on identifiable human material and data. This study was approved by Institutional Review Board of Dow University of Health Sciences Ref. No.: IRB-395/DUHS/Approval/2016/183.

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AUTHORS' CONTRIBUTION

SJAZ: Literature search, write-up. ASA: Conceptualization of study design. ATS: Proof reading. IA: Data interpretation.

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