ORIGINAL ARTICLE

Comparison of hard tissue interrelationships at the cervical region of teeth based on tooth type and gender difference

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Abstract

Context: Cementoenamel junction (CEJ) represents the anatomic limit between the crown and root surface. With advancing age and continuous eruption, this area becomes exposed in the oral media. Consequently, CEJ will be subjected to the action of various physical and chemical factors that might alter its morphology, with the cementum being affected in most cases. **Aim:** To identify the frequency of hard tissue interrelationships present at the CEJ in relation to different genders, positions and aspects of tooth using a light microscope. **Materials and Methods:** The cervical regions of 80 permanent teeth (40 male and 40 female), extracted for orthodontic or periodontal reasons, were analyzed after longitudinal ground sections were made in the mesio-distal plane. The CEJ of the prepared sections was then studied and their frequencies were categorized as: cementum overlapping enamel, enamel overlapping cementum, edge-to-edge relationship and the presence of gap junctions. **Statistical Analysis:** Chi-square test performed using SPSS 15 software. **Results:** Edge-to-edge contact of the cementum and enamel was most frequent, followed by gap junction and cementum overlapping the enamel, respectively. Chi-square test revealed no statistically significant differences with respect to the gender and tooth aspect, whereas the result was significant when the position of the tooth was studied. **Conclusion:** The observations of the study indicate a considerable morphological diversity in the anatomical pattern of CEJ. It can be concluded that the region should be protected against dentinal sensitivity, erosion, abrasion, abfraction and resorption, as it is more prone to cervical pathologies.

Key words: Cementoenamel junction, light microscopy, permanent dentition, tooth cervix, dental cementum, tooth components

Introduction

The cementoenamel junction (CEJ) represents a unique place on the dental surface where the three hard tissues, i.e., enamel, dentin and cementum, exist in union.[1] Several relationships between cementum and enamel may be observed along the CEJ within a single tooth.[2]

During tooth development, the enamel deposition does not cease simultaneously along the entire tooth circumference.[2] When enamel deposition is completed in a particular area of the tooth bud, Hertwig's epithelial root sheath (HERS), which is composed of inner and outer dental epithelia, begins to form at the cervical margin. Odontoblasts, which differentiate under the influence of HERS, secrete the initial layer of dentin. The sheath then fragments at varying times at different sites, thus promoting the irregular

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onset of cementum formation throughout the cervical circumference, which gives rise to an irregular contour and varying interrelationships among the tissues that compose the CEJ. Consequently, the relationship between cementum and enamel at the CEJ varies.[3]

As long as the CEJ is covered by healthy gingival tissues, the cementum–enamel relationship may change from exposed dentine to edge-to-edge contact to cementum overlap, simply because of the cementum being formed with time. This sequence is stopped once the CEJ is exposed to the oral environment.[4] In young adults, the CEJ of permanent teeth is protected by the gingival tissue.[2,3] However, with an increase in the life expectancy and continuous passive eruption, there is an increased tendency for the prevalence of cervical lesions in this area.[3] After the third decade of life, continuous passive eruption of teeth results in the exposure of CEJ to the oral environment, which may lead to dentin hypersensitivity upon ingestion of hot, cold, sweet or salty foods. Tooth abrasion and erosion may also be initiated.[2]

In the oral environment, the CEJ may be subjected to the action of chemicals from various foods, oral hygiene products, and dental materials, especially tooth bleaching agents, widely used on permanent teeth. Physical agents such as tooth brushing, dental instruments, and clamps may also change the relationship between mineralized dental tissues at the CEJ, with important clinical consequences. Similarly, the morphology of CEJ should be considered in cavity preparations and restorations.[2] Morphology of the CEJ of permanent teeth is becoming an area of great clinical significance due to its association with dentinal sensitivity and susceptibility of the CEJ to pathological changes, such as root surface caries, cervical erosion, abrasion, abfraction, and resorption.[3]

Hence, the present study was carried out to identify the frequency of hard tissue interrelationships present at the CEJ, and its intercomparison was made based on the gender of an individual, position of the tooth in the dental arch, and the aspect of the tooth studied using a light microscope.

Materials and Methods

The study was conducted in the Department of Oral and Maxillofacial Pathology. Teeth extracted in the Oral Surgery Department were collected and the demographic data of the respective individuals was also recorded. A total of 80 teeth were selected for the study. The individuals were not informed about the study as all the extracted teeth are routinely discarded in the institute.

Inclusion criteria for teeth collection:

(i) Teeth extracted for orthodontic and periodontal reasons
(ii) Teeth with an intact cervical region.

Exclusion criteria included teeth with morphological/developmental abnormalities, caries, fracture/trauma, erosion/abrasion, etc.

Immediately after extraction, the teeth were stored in 10% hydrogen peroxide solution. They were further categorized based on gender as male and female teeth with 40 each and based on the position as 38 anterior (incisors and canines) and 42 posterior (premolars and molars) teeth.

For the preparation of ground sections, all the teeth were reduced in the mesio-distal plane using a laboratory lathe machine under continuous water jet until the desired thickness was reached. Later, the sections were trimmed manually, initially on the coarse side of Arkansas stone, followed by the finer side. Finally, the ground sections were cleaned carefully with xylene (Merck, Mumbai, India) and mounted on glass slides using DPX mountant (Merck, Mumbai, India) and microscopic cover slips (Blue Star, Chennai, India).

CEJ of the prepared sections was then studied on the labial/buccal and lingual aspects using a binocular light microscope for the following hard tissue relationships: (i) edge-to-edge contact of cementum and enamel [Figure 1]; (ii) gap between cementum and enamel with exposed dentin [Figure 2]; (iii) cementum overlapping enamel [Figure 3]; and (iv) enamel overlapping cementum. The data obtained were recorded on the word processor program and statistically analyzed using Chi-square test.

Results

Frequency of the interrelationship of mineralized hard tissues at the CEJ was determined irrespective of the gender, tooth position, and tooth aspect. Edge-to-edge contact of the cementum and enamel was seen at 84 sites (52.5%), followed by gap between cementum and enamel with dentinal exposure at 64 sites (40%), and 12 sites (7.5%) showed the presence of cementum overlapping the enamel. However, no sample showing enamel overlapping cementum was detected during the study [Table 1].

Considering gender of the individuals, edge-to-edge relation, gap between cementum and enamel with dentinal

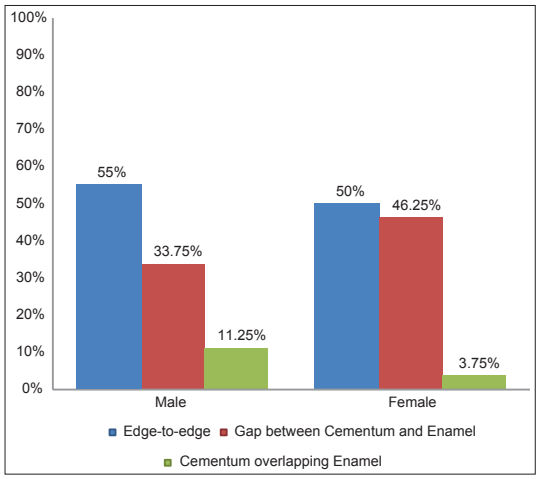
Table 1: Distribution of interrelationships between the mineralized tissues at the cementoenamel junction in the total sample (*N*=80)

Type of cementoenamel junction	Frequency seen (%)
Edge-to-edge relationship of cementum and enamel	84 (52.5)
Gap between enamel and cementum with exposed dentin	64 (40)
Cementum overlapping enamel	12 (7.5)
Enamel overlapping cementum	0 (0)

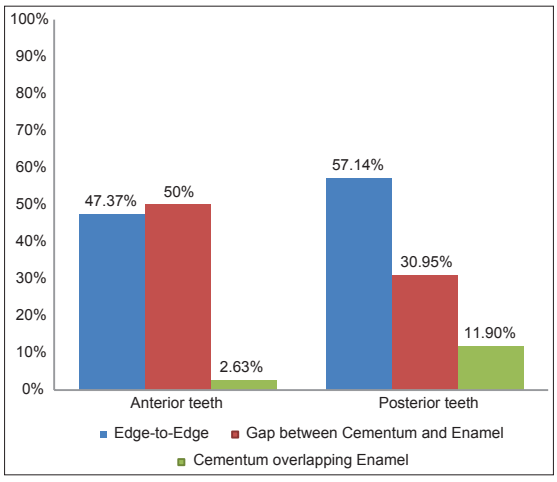
Figure 1: Photomicrograph of the ground section of a tooth showing edge-to-edge contact of the cementum and enamel at ×10 magnification using a light microscope

Figure 2: Photomicrograph of the ground section of a tooth showing the gap between cementum and enamel with dentinal exposure at ×10 magnification using a light microscope

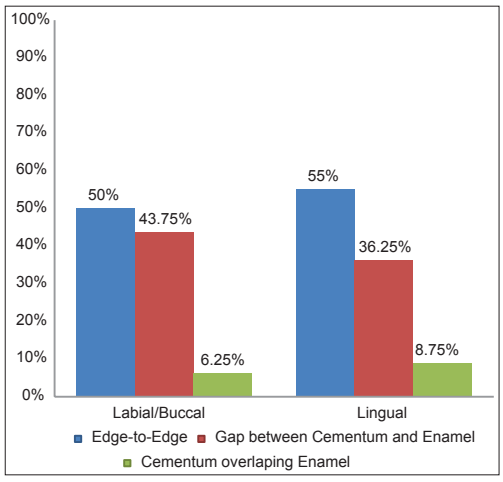
Figure 3: Photomicrograph of the ground section of a tooth showing cementum overlapping enamel at ×10 magnification using a light microscope



Graph 1: The frequency of types of CEJ with respect to the gender of an individual



Graph 2: The frequency of types of CEJ with respect to position of tooth on the dental arch



Graph 3: The frequency of types of CEJ with respect to aspects of the tooth studied

exposure, and cementum overlapping enamel were seen in 44 (55%), 27 (33.75%), and 9 (11.25%) sites in males and 40 (50%), 37 (46.25%), and 3 (3.75%) sites in females, respectively [Graph 1].

Based on the position of teeth in the dental arches, edge-to-edge relation, gap between cementum and enamel with dentinal exposure, and cementum overlapping enamel were seen in 36 (47.37%), 38 (50%), and 2 (2.63%) sites on the anterior teeth and 48 (57.14%), 26 (30.95%), and 10 (11.90%) sites on the posterior teeth, respectively [Graph 2].

Based on aspect of the involved teeth, the labial/buccal aspect showed edge-to-edge contact, gap between cementum and enamel with exposed dentin, and cementum overlapping enamel at 40 (50%), 35 (43.75%), and 5 (6.25%) sites, while the lingual aspect showed the relations at 44 (55%), 29 (36.25%), and 7 (8.75%) sites, respectively [Graph 3].

Chi-square test revealed no statistically significant differences in the frequency of type of CEJ based on the gender of an individual (P = 0.15) and tooth aspect (P = 0.65), whereas the result was significant (P = 0.01) when the position of teeth in the dental arches was considered [Table 2].

Discussion

The load-bearing mineralized tissues of a tooth are well integrated by biomechanically efficient interfaces that include dentin enamel junction (DEJ) in the crown and cementum dentin junction (CDJ) in the root.[5-8] There is a third interface in the coronal portion of the tooth called the CEJ. Traditionally, three types of CEJ have been reported. These include: (1) overlap, in which cementum overlaps enamel and is called coronal cementum (CC); (2) abutment, cementum butts with enamel; and (3) gap, a finite space between cementum and enamel, exposing cervical dentin.[9,10]

Cementum is an essential mineralized dental tissue and is a part of the attachment apparatus within the periodontium. Functionally, in the root, it is responsible for cementing the principal collagen fibers of the periodontal ligament, thus attaching the tooth to the alveolar bone.[9]

In 1899, Cloquet was the first person to describe three possible relationships among the dental hard tissues at the level of CEJ by optical microscopy. In 10% of the cases, cementum does not meet enamel, a dentine band being exposed toward the outside part; in 30% of the cases, enamel meets cementum in a head-to-head ratio; while in the remaining 60% cases, cementum covers the enamel.[1,3] These data are in agreement with the study results of Thorasen *et al*. (1917)[10] and is stated in most textbooks of oral histology.[11-13] Although controversial, of the three types, the overlap CEJ was reported to occur most frequently in human teeth.[14,15]

Grossman *et al*. (1991) stated the most predominant arrangement of tissues to be that of cementum overlapping enamel, which took three distinct forms. Exposed surfaces of dentin were infrequent, whereas scalloping of the CEJ occurred in five teeth. Also, the CEJ varied in a single tooth and between contralateral teeth.[16]

The present study demonstrated the highest frequency of edge-to-edge contact of cementum and enamel, which is in agreement with the results of certain other investigations. Teodorovici *et al*. (2010) in their study also reported similar results.[1] They had also mentioned that Bevenius (1993), in a study on freshly erupted premolars, found edge-to-edge contact in 76% of his sample.[14] A similar edge-to-edge contact was evidenced by Arambawatta *et al*. (2009), who examined by optical microscopy, 67 premolars, the percentage of head-to-head occurrence being 55.1%.[3] Schroeder and Scherle used scanning electron microscopy to examine eight freshly extracted erupted premolars and found that edge-to-edge contact of cementum and enamel was the predominant type of relationship (70%).[4]

The present study indicated the occurrence of gap between the cementum and enamel with dentinal exposure in 40% cases. Ceppi *et al*. (2006) stated the presence of gaps with dentin exposure as a very rare observation in their study on primary teeth,[17] whereas Leonardi *et al*. (1995) observed no gaps between enamel and cementum in their study.[18] As stated by Francischone *et al*. (2008) in their article, Cloquet observed dentin gaps in 28% of the teeth examined whereas,

Table 2: Variation in the frequency of different interrelationships between the mineralized tissues seen at the cementoenamel junction, considering the gender, tooth position, and tooth aspect

Parameters of the study	Characteristics	Sample size (%)	Edge-to-edge contact (%)	Gap between cementum and enamel (%)	Cementum overlapping enamel (%)	*P* value
Gender of individual	Male	80 (100)	44 (55)	27 (33.75)	9 (11.25)	0.15 (NS)
	Female	80 (100)	40 (50)	37 (46.25)	3 (3.75)	
Tooth position	Anterior	76 (100)	36 (47.37)	38 (50)	2 (2.63)	0.01 (S)
	Posterior	84 (100)	48 (57.14)	26 (30.95)	10 (11.90)	
Tooth aspect	Buccal/labial	80 (100)	40 (50)	35 (43.75)	5 (6.25)	0.65 (NS)
	Lingual	80 (100)	44 (55)	29 (36.25)	7 (8.75)	

NS: Not Significant S: Significant

Thorasen observed them in 5-10% of the examined permanent teeth.[2,10] Arambawatta *et al*. (2009) stated the presence of gaps between cementum and enamel with dentinal exposure in approximately one-third (approx. 33%) of the sample in their study. The presence of gaps with dentinal exposure suggests that CEJ is a site strongly predisposed to the development of pathological changes during clinical procedures such as placement of clamps, stainless steel crowns, and restorative materials and utilization of dental instruments, especially dental bleaching.[3]

The present study showed the occurrence of cementum overlapping enamel in 7.5% cases. Arambawatta *et al*. (2009) in their study found cementum covering enamel in 12.6% cases.[3] Bevenius *et al.* (1993) reported a 14% occurrence of cementum overlapping enamel in their study.[14]

No site showing the fourth type of tissue relationship, i.e., enamel overlapping cementum, was found in the present study. Francischone *et al.* (2008) reported that in their analysis, the relationship of enamel overlapping cementum was not seen anywhere.[2] Arambawatta *et al.* (2009) also reported its presence to be very rare in their study.[3] Neuvald *et al.* (2000) and Ceppi *et al*. (2006) showed the presence of this hard tissue interrelationship in permanent teeth and deciduous teeth, respectively.[17,19] As this feature is without developmental foundations, the observation of enamel overlapping cementum has been attributed to a methodological or an interpretative error.[4]

In the present study, gap between cementum and enamel with dentinal exposure was more frequent in the anterior teeth while edge-to-edge relation between cementum and enamel was more common in the posterior teeth. Teodorovici *et al.* (2010) reported the presence of empty spaces between enamel and cementum with dentinal exposure to be more frequent in the maxillary teeth from the frontal area.[1] Dentine exposure was more frequently seen on buccal and lingual (about 22-24%) than on mesial and distal surfaces (about 13%).[4]

The present study showed no significant differences when the hard tissue interrelationships were studied among males and females and at labial/buccal – lingual aspects. Birrer (1952), in his data on the frequency distribution of any type of relationship on all four surfaces, revealed that a particular relationship, e.g. dentine exposure, is seen to occur in variable percentages, i.e., 11.4% on lingual and 23.1% on buccal aspects.[20] These findings are also confirmed in the studies by Schroeder *et al*. (1988) and Arambawatta *et al*. (2009).[3,4]

Conclusion

The above observations indicate a considerable morphological diversity in the anatomical pattern of CEJ, both for any tooth type and for any individual tooth surface, irrespective of the gender of an individual. The edge-to-edge relation and overlapping of cementum and enamel are comparatively more protective for a tooth than the relations with dentinal exposure in the routine dental procedures such as cavity or crown cutting, simple scaling procedures, fitting of the clamps, stainless steel crowns, etc., resulting in alteration of the morphology of CEJ and making the tooth more prone to physical and chemical injuries.

The presence of gap with dentinal exposure makes all the three hard tissues, namely, enamel, dentine and cementum, available for pellicle formation. As a result, the open dentinal tubules become a harbor of microorganisms, making the region more prone to pathologies. It is thus possible to consider the cervical region as being more prone to external resorption.

Further studies can be carried out with a larger sample size to validate the results of the present study. With the ground sections being able to show CEJ at only two focal points, newer methods should be devised in which CEJ along the entire circumference of the tooth can be studied. The findings of the present study may provide a baseline for future studies of the cervical region of teeth.

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