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RESEARCH ARTICLE

Cementoenamel Junction in Egyptian Maxillary First Premolar: Scanning Electron Microscopy and Energy-Dispersive X-ray Analysis Study

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Abstract

Background: There is a controversy regarding shapes and distribution of the mineralized tissues that compose the cementoenamel junction (CEJ). **Objective:** The aim of this study was to investigate the morphology and frequency of various relationships of cementum, enamel and dentin at CEJ of Egyptian maxillary first premolars. **Materials and Methods**: The CEJ of a group of 50 caries and defect-free human maxillary first premolars extracted for orthodontic reasons was examined using stereomicroscopy, scanning electron microscopy (SEM) and transmitted light microscopy.The chemical profile of the tissues composing the CEJ was recorded using energy-dispersive X-ray analysis (EDXA) and was statistically analysed. **Results:** Light microscopic examination of ground sections revealed that edge-to-edge interrelation between root cementum and enamel was predominant (50 %). Cementum overlapping enamel was less prevalent than previously reported as it presented 36% of the samples. In approximately 10% of the samples, gap between cementum and enamel was observed. A fourth type of junction that was only reported by few authors, in which enamel overlapped cementum, had been detected in a small proportion (4%) of the samples. Statistical analysis of EDXA results showed that the highest Carbon wt % was in coronal cementum. Meanwhile, the highest Oxygen wt % was detected in the enamel overlapping cementum. However, the enamel showed the highest wt % of Phosphorus. Surprisingly, bare dentin demonstrated the highest wt % of Calcium.**Conclusions:**The present study demonstrated the highest frequency of edge to edge contact of cementum and enamel, contradicting the traditional frequencies which proves that the anatomical profile of CEJ might be race dependent.

INTRODUCTION

The load bearing mineralized tissues of a tooth are well integrated by biomechanically efficient interfaces that include dentinoenamel junction (DEJ) in the crown and cementodentinal junction in the root (Lin and Douglas, 1994; Marshall et al., 2003; Zaslansky et al., 2006; Ho et al., 2009). There is a third interface called the cementoenamel junction (CEJ) which is the anatomical junction of tooth enamel and cementum. The CEJ serves as an important point of reference in clinical dentistry, as it is usually the site where gingival fibers attach to a healthy tooth.The irregularity and fragility of CEJ structures indicate that this region is weak and should be handled with care and protected during application of chemicals and utilization of clamps, dental instruments, and restorative materials (Francischone and Consolaro, 2008).

Despite available information, there is still doubt regarding the true morphological implications of the CEJ in the genesis of pathological processes, especially external cervical resorption after dental trauma, orthodontic movement, or internal bleaching procedures (George and Miller, 1986; Friedman et al., 1988; Moody; 1991).

Three possible relationships of the mineralised tissues composing the CEJ have been described in text books of Oral Histology. In approximately 60% of cases the enamel is overlapped by cementum. In approximately 30% of cases an edge-to-edge relationship between cementum and enamel is seen and in the remaining 10% of cases, enamel and cementum fail to meet, resulting in a strip of exposed dentin (Berkovitz et al., 1992; Nanci,2013). The first researcher who defined the types and prevalence of CEJ was Cloquet in 1899. However,using optical microscopy, Neuvald and Consolaro (2000) observed a fourth type of CEJ in which cementum was overlapped by enamel. They reported that there was a great morphological diversity shown by the CEJ in the same tooth, as well as within individual teeth of any type. Because of this variability, the previous investigators added that it would be more appropriate to call the junction a dentin-cemento-enamel junction. Nowadays, with the increase in both life expectancy and in the number of teeth present in the dental arch at advanced ages, a higher prevalence of lesions at cervical level was noticed (Teodorovici et al., 2010).

The purpose of this study was to examine the CEJ types of maxillary first premolar in the Egyptian population by observing the relationship between enamel, cementum, and dentin using stereo, light and scanning electron microscopy, as well as investigating the chemical profile of the tissues composing the CEJ using energy-dispersive X-ray analysis (EDXA).

Materials and methods

Fifty five permanent human maxillary first premolar teeth extracted for orthodontic reasons were obtained from the Surgery Department of Faculty of Dentistry Ain Shams University, Cairo, Egypt. The teeth were selected with no cervical lesions or other morphological anomalies. Immediately after extraction, teeth were cleaned using a soft tooth brush taking special care to avoid any damage to the cervical region and stored in distilled water at room temperature until the time of investigation. The integrity of the CEJ was analyzed using a stereomicroscope (SMXX, Carl Zeiss-Jena) (Germany). As a result, five teeth with defects in this region such ascaries, fracture or erosion were excluded from the sample. In the remaining 50 teeth, CEJ types were preliminary identified by stereomicroscope and planned for subsequent examination using scanning electron microscopy (SEM), light microscopy and energy-dispersive X-ray analysis (EDXA).

SEM- EDXA examination

FEI/ Inspect S scanning electron microscope attached with energy-dispersive X-ray analyser (SEM-EDXA Unit, Main Defense Chemical Laboratory, Cairo) was used. All specimens were mounted onto metal holder using removable adhesiveso that the CEJ of the buccal surface was subjected to examination at 30 kV using secondary electron LFD detector under magnification between 250 and 5000 with a spot size of 5.6. The relationship between the enamel, cementum and dentin was noted and photographed. The type of tissue relationship of all teeth was recorded and classified into four possible types:Type 1:cementum overlapping enamel, Type2: cementum and enamel edge-to-edge, Type3: presence of exposed dentin between enamel and cementum,Type 4:enamel overlapping cementum.

For energy dispersive x-ray analysis (EDXA), the CEJ tissues of the buccal surface of each tooth were analysed regarding the chemical profile represented by Calcuim (Ca), Phosphorus (P) ,Carbon (C), Oxygen (O)and other elements if present in weight % using EDAX Genesis FEI Inspect S (USA- Holland).

Statistical analysis

For statistical analysis, the EDXA chemical profile results of the following tissues in weight %were tabulated: coronal enamel, enamel overlapping cementum, root cementum, coronal cementum and bare dentin. Statistical analysis was performed by Microsoft Office 2013 (Excel) and Statistical Package for Social Science (SPSS) version 20. Data were presented as mean and standard deviation. The significant level was set at $P \leq 0.05$. Kolmogorov-Smirnova and Shapiro-Wilktests were used to assess data normality. One way ANOVA test was used to compare between groups followed by Tukey'spost hoc test.

Following SEM examination and statistical analysis of EDXA results, ground sections of the same teeth were prepared by cutting through the buccolingual plane perpendicular to the cervical margin of the crown by means of diamond disks, under continuous cooling with water. Each sample was processed by finishing and polishing with disks of paper with decreasing granulation.The prepared sections were then dehydrated by immersing them in ascending concentrations of alcohol, after which they were mounted on glass slides. The buccal cervical region of the ground sections was examined using an Olympus transmitted light microscope to establish the relationship of the mineralized tissues composing the CEJ. The frequency of various CEJ types recorded by light microscopy was calculated and compared to that of the SEM.

Results:

Stereomicroscopic results:

Stereomicroscopic examination provided suggestive preliminary images for the identification of the anatomic pattern of CEJ types, as shown in figure1 (A,B,C,D).

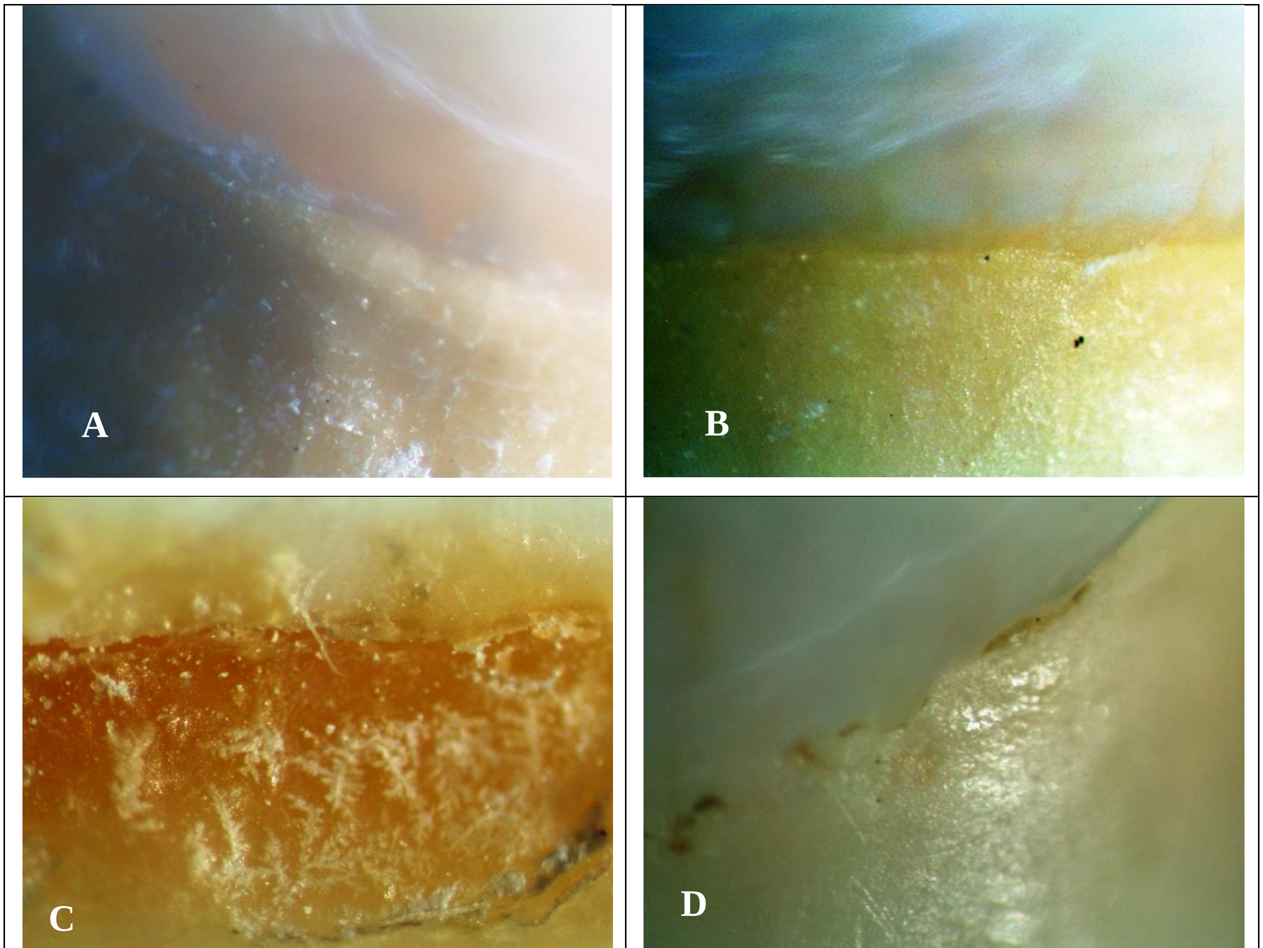


Fig.1: Stereomicroscopic photos of the buccal cervical region of maxillary first premolar**A:** Type1 CEJ (cementum overlapping enamel), **B:** Type 2 CEJ (edge to edge), **C:** Type 3 CEJ (gap junction), **D:** Type 4 CEJ (enamel overlapping cementum) (original magnification x 50).

Scanning electron microscopic results:

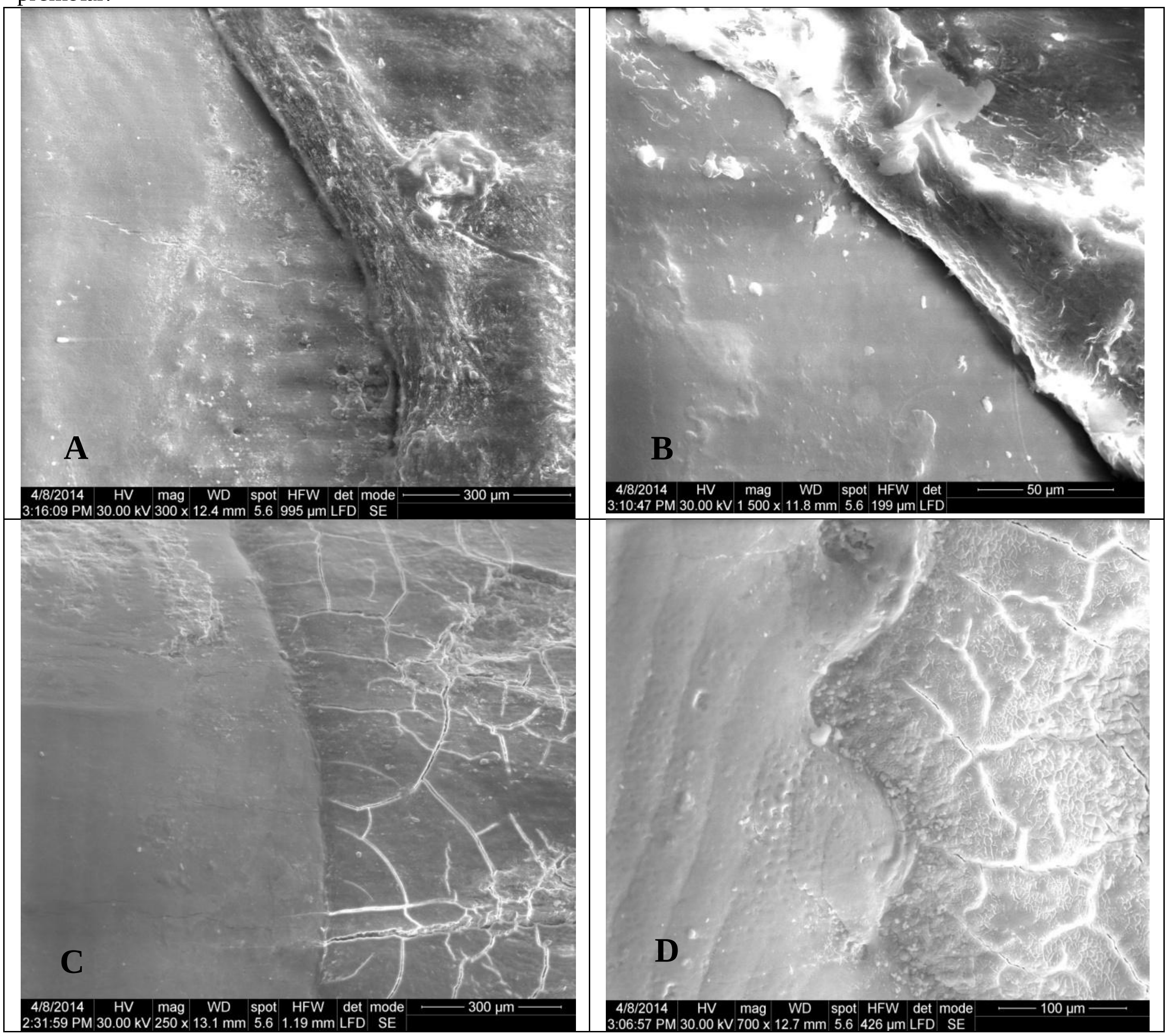
SEM examination of type 1 CEJ showed that cementum goes over the enamel surface. Small protrusions were observed in some areas of cervical enamel (fig.2A). A higher magnification of cementum covering enamel at CEJ showed peeling-off of coronal cementum. Cervical enamel was characterized by a homogenous, regular and smooth surface (fig.2B).

Meanwhile in type 2CEJ (edge to edge type), the level of CEJ was deeper than both cementum and enamel. The enamel margin was rounded. Cracks of different directions were observed on the surface of cementum (fig.2C). In some specimens of the edge to edge type, CEJ showed wave-like appearance. Some areas of enamel had pitted surface with pits of different depths in addition to the presence of parallel grooves of perikymata (fig.2D).

Examination of type 3 CEJ (gap junction) revealed an approximate size of 10 μm width. From the five cases of this junction, the gap of three specimens was partially filled with fragments of inorganic contents which according to its morphological appearance, did not correspond either to enamel or to cementum. In some specimens of this type of CEJ, the enamel showed smooth surface. However, the cementum demonstrated rounded protrusions and vertically aligned cracks (fig.2E & 2F). Meanwhile, two specimens of the gap junction demonstrated exposed dentinal tubules confirming that it was dentin (fig.2G).

Type 4 CEJ showed that cervical cementum was overlapped by an enamel band of almost uniform width. The enamel band was characterized by a homogenous, regular and smooth surface. Different sized, rounded protrusions were observed on the cementum surface (fig.2H).

Minor variability was observed in the CEJ type on the buccal surface of some samples of the maxillary first premolar.



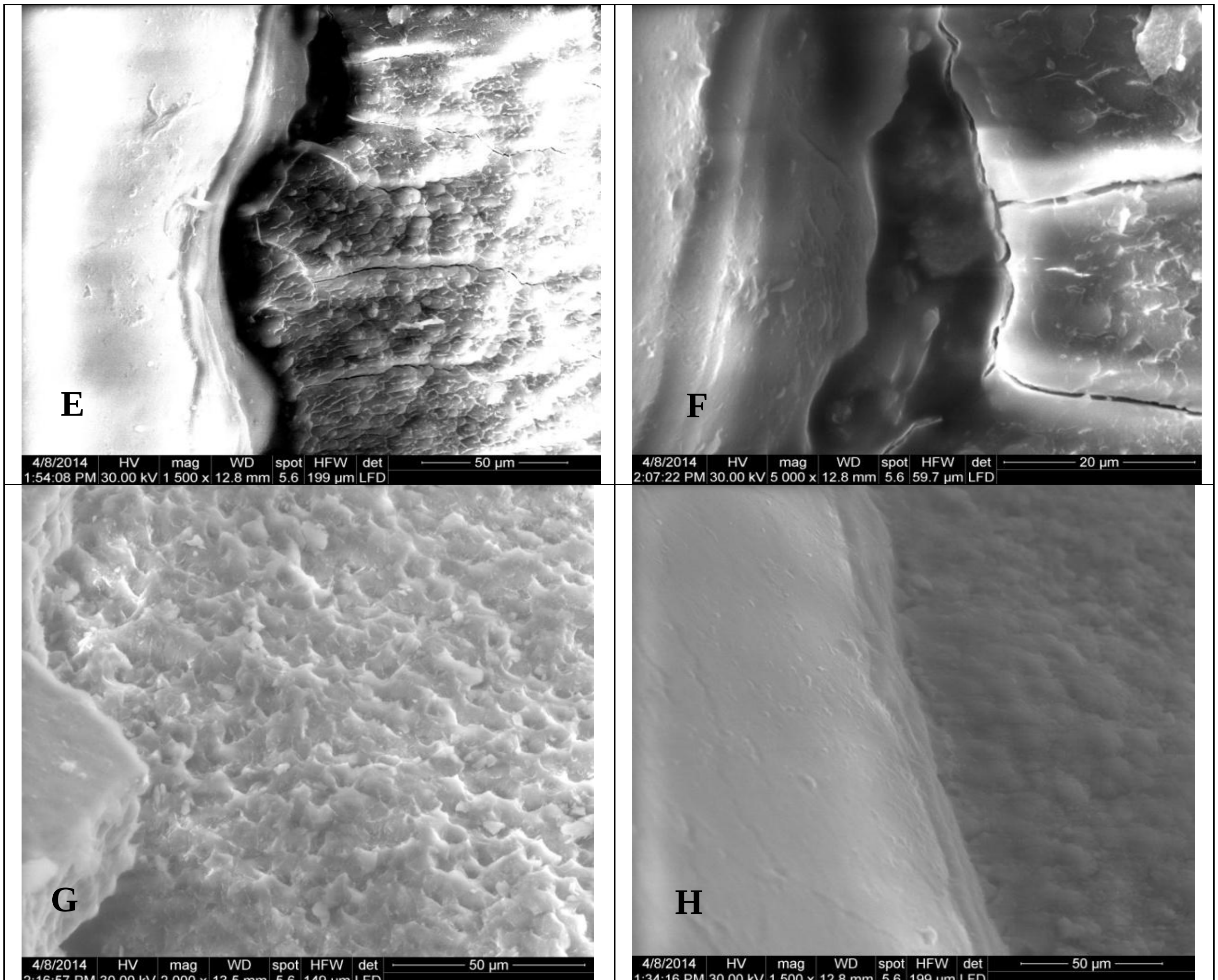


Fig.2: Scanning electron micrographs of the CEJ on the buccal surface of maxillary first premolar:
A:Cementum goes over the enamel surface. Small protrusions are observed in some areas of cervical enamel (x300). **B**: A higher magnification of cementum covering enamel showing peeling-off of coronal cementum. Cervical enamel is characterized by a homogenous, regular and smooth surface (x1500). **C:**Edge to edge type in which CEJ is below both the cementum and enamel levels. The enamel margin is rounded. Cracks of different directions are observed on the surface of cementum (x250). **D:** Edge to edge type of CEJ showing wave-like appearance. Enamel has a pitted surface with pits of different depths. Note the very marked presence of parallel grooves of perikymata. (x700).**E**: A gap junction between enamel and cementum can be observed. The enamel shows smooth surface. The cementum demonstrates rounded protrusions and vertically aligned cracks(x1500). **F:** A higher magnification of the previous electron micrographs with approximate size of 10 µmwidth, partially filled with fragments of inorganic contents which does not correspond either to enamel or cementum(x5000).**G:**Gap type of another specimen in which dentinal tubules are observed confirming that it is dentin (x2000). **H:**Cervical cementum is overlapped by an enamel band of almost uniform width. This enamel band is characterized by a homogenous, regular and smooth surface. Different sized, rounded protrusions are observed on the cementum surface(x1500).

Light microscopic results:

Examination of the four different kinds of tissue interrelations by LM revealed cementum overlapping enamel (fig.3A) in 18 of the 50 specimens with a percentage of 36 %. Enamel and cementum edge-to-edge relationship (fig.3B) existed in 25 specimens with a percentage of 50 %. Meanwhile the gap type of CEJ was recorded in 5 specimens (10 %), revealing a strip of exposed dentin of unspecified dimension or extent (fig.3C). The forth type detected in two cases only (4%) was that of enamel overlapping cementum (fig.3D).The determination of CEJ type based on ground sections examination was almost similar to SEM results.

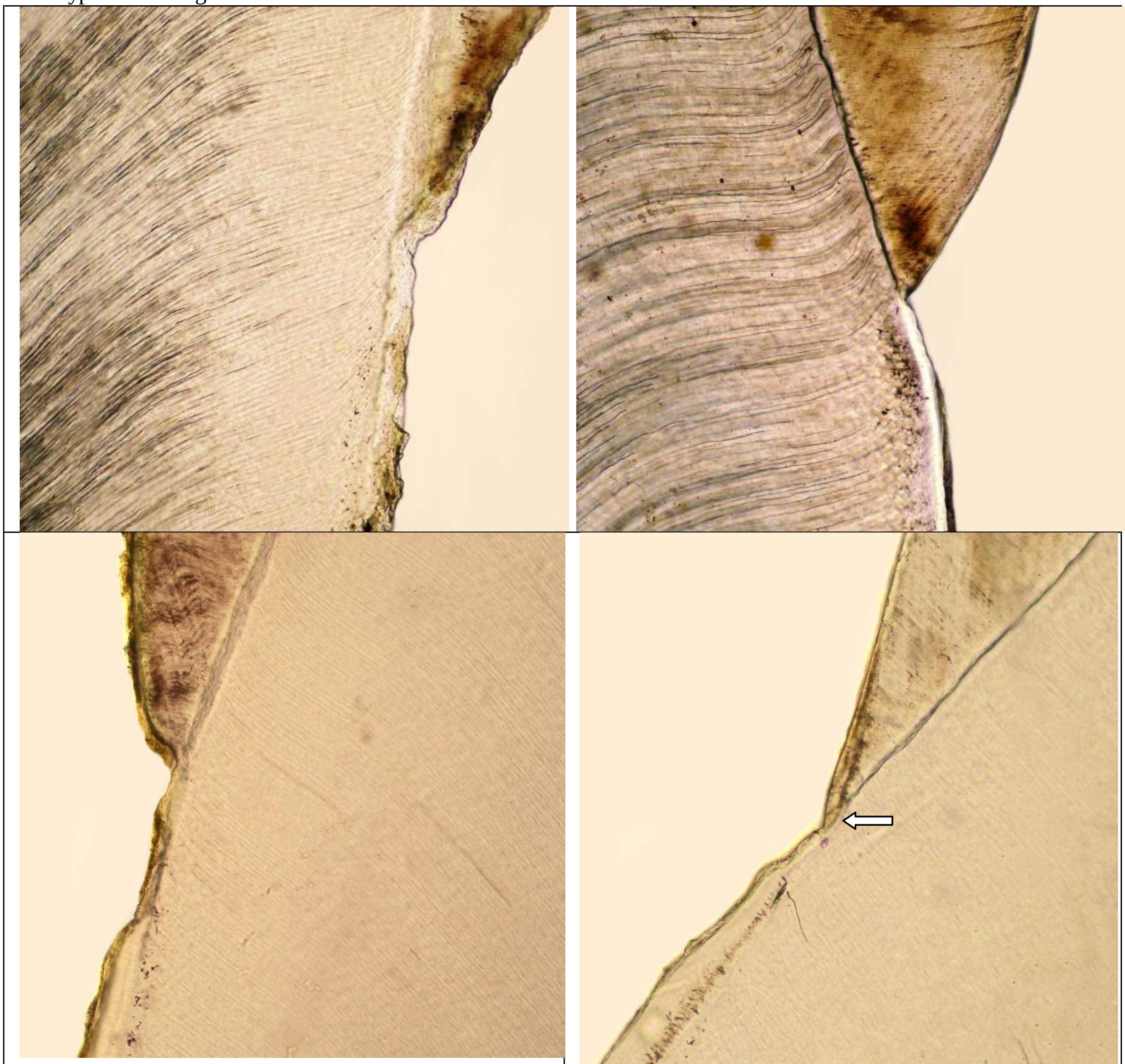


Fig.3: Light microscopic pictures of ground sections showing the CEJ on the buccal surface of maxillary first premolar: **A**: Type1: cementum overlapping enamel, **B**: Type 2: edge to edge, **C**: Type 3: gap junction, **D**: Type 4: enamel overlapping cementum {arrow} (original mag.x100).

EDXA results:

The main elements detected by EDXA in coronal cementum, enamel, cervical root cementum , bare dentin and enamel overlapping cementum were C, O, P and Ca. Their mean weight % in the tissues composing the CEJ was statistically summarized in tables 1, 2, 3 and 4 respectively.Traces of other elements e.g. Mg, Na,Cl, S, Si, K and Si were not present in all tissues and represented minor percentage so they were not statistically analysed. Figure 4 is a chart of the chemical profile of cervical root cementum as an example of the five studied tissues.

The mean wt % of Mg was 1.03% in cervical root cementum, 0.59% in bare dentin and 1.39% in enamel overlapping cementum. Meanwhile Na mean wt % was 1.28% in cervical root cementum, 1.49% in enamel, 1.3% in bare dentin and 1.2% in enamel overlapping cementum. The mean wt % of Cl was 0.49% in coronal cementum, 0.46% in enamel, 0.55% in bare dentin and 0.57% in enamel covering cementum. The mean wt % of S was 0.52% in coronal cementum and 0.57% in enamel covering cementum. Si was only detected in cementum with a mean wt % of 0.42% in coronal cementum and 0.93% in cervical root cementum. Finally K was detected in coronal cementum with a mean wt % of 0.35%.

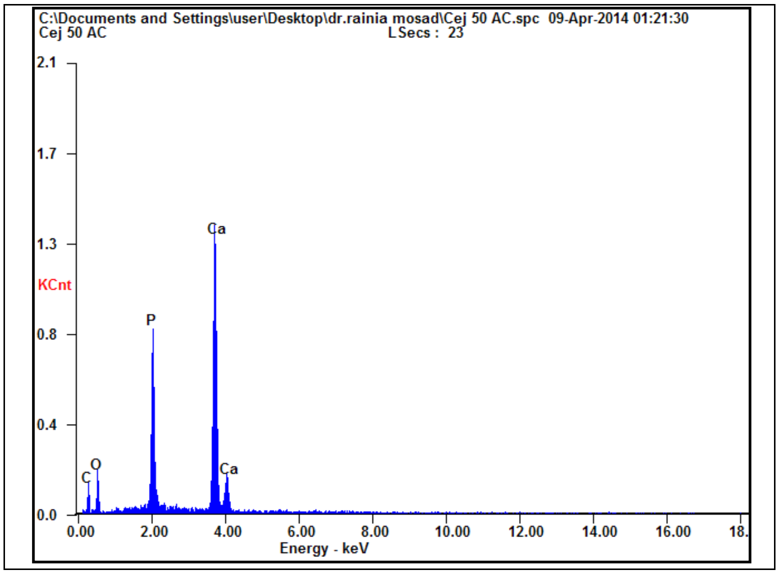


Fig 4:EDXA chart of chemical profile obtained from cervical root cementum

Statistical results:

Carbon:

Coronal cementum showed an increased value of Carbon followed by cervical root cementum followed by enamel overlapping cementum followed by enamel followed by bare dentin (table 1).One way ANOVA showed a significant difference between the five studied tissues. Tukey's post hoc test showed a significant difference between each tissue when compared with the others.

Tissue	Mean Carbon wt%	Std. Deviation	P value
coronal cementum	52.6986	.35498	<0.001
Enamel	13.4143	.93172	
cervical root cementum	30.6914	.70935	
bare dentin	9.6429	.53730	
enamel overlapping cementum	26.3857	.70812	

Table 1: showing the mean and standard deviation of Carbon weight % in the tissues composing the CEJ

Oxygen:

Enamel overlapping cementum showed an increased value of Oxygen followed by bare dentin followed by enamel followed by cervical root followed by coronal cementum (table 2).One way ANOVA showed a significant difference between the studied tissues.

Tissue	Mean Oxygen wt %	Std. Deviation	P value
coronal cementum	21.7571[a]	.74801	<0.001
Enamel	35.6714[bc]	13.75860	
cervical root cementum	26.9000[ab]	1.08167	
bare dentin	41.5571[c]	.43534	
enamel overlapping cementum	42.6100[c]	.70335	

Table 2:showing the mean and standard deviation of Oxygen weight % in the tissues composing the CEJ. Similar superscript letters in table 2 indicate no significant difference when studied by Tukey's post hoc test.

Phosphorus:

Enamel showed an increased value of Phosphorus followed by cervical root cementum followed by enamel overlapping cementum followed by coronal cementum followed by bare dentin (table 3). One way ANOVA showed a significant difference between the studied tissues. Tukey's post hoc test showed a significant difference between each tissue when compared with the others.

Tissue	Mean Phosphorus wt %	Std. Deviation	P value
coronal cementum	4.4571	.37353	<0.001
Enamel	16.7043	.65533	
cervical root cementum	13.4143	.82750	
bare dentin	1.5100	.43631	
enamel overlapping cementum	10.1286	.60749	

Table 3: showing the mean and standard deviation of Phosphorus weight % in the tissues composing the CEJ.

Calcium:

Bare dentin showed an increased value of Calcium followed by Enamel followed by cervical root cementum then enamel overlapping cementum and finally coronal cementum (table 4). One way ANOVA showed a significant difference between studied tissues.

Tissue	Mean Calcium wt %	Std. Deviation	P value
coronal cementum	18.2871[a]	.37044	<0.001
Enamel	29.1114[b]	.84078	
cervical root cementum	28.4000[b]	1.01817	
bare dentin	30.5543	.96814	
enamel overlapping cementum	18.4214[a]	.93178	

Table 4: showing the mean and standard deviation of Calcuim weight % in the tissues composing the CEJ. Similar superscript letters in table 4 indicate no significant difference when studied by Tukey's post hoc.

Discussion:

Analysis of the anatomy of the CEJ is helpful in explaining pathological processes that occur in this region, as well as for the identification of the biological phenomena involved in the initiation of pathological processes, such as external cervical resorption (Neuvaldand Consolaro, 2000).

The teeth used in the present study comprised carefully selected premolar teeth extracted for orthodontic reasons. In young adults, the CEJ of permanent teeth is covered by gingival tissues. However,with increasing age, continuous passive tooth eruption exposes the CEJ to the oral environment. The CEJ is then subjected to various chemical as well as physical agents, such as tooth brushing which alter its morphology (Arambawatta et al., 2009). It is reasonable to assume, however, that theCEJs of the teeth in this study were not exposed to the oral environment and were therefore intact.

SEM early used by Akai et al. (1978) to evaluate the CEJ, not only allows a more critical study of surface morphology, but also make analysis of the cervical perimeter of the tooth possible. Koulaouzidou et al.(1996) also reported that SEM analysis provided the most suggestive images of the anatomic pattern of CEJ as its use offers more accuracy and precision in determining the types of interrelation between enamel, cementum, and dentin. Schroederand Scherle (1988) found that SEM reveals the real structural interrelations present in the CEJ. They stated that the previously used method of examining ground sections of the CEJ with the light microscope may fail to demonstrate the true structural features, at least when the cementum layers are very thin and the ground sections are comparatively thick.The ground method of CEJ observation also circumvented some major sources of artefact formation due to shrinkage during specimen preparation, which may previously have caused misinterpretation of gap relationships as reported by Bevenius et al (1993). In a previous study performed by Arambawatta et al(2009), using light microscopy to examine the CEJ, it was reported that ground sections results are limited as they enable analysis of only two focal points of the CEJ and does not allow examination of the entire circumference of the CEJ. In spite of Arambawatta et al. (2009) opinion about ground sections, their results about the frequency of CEJ types although not the same percentage, but are in accordance with the order of frequency in other studies (Manjunath et al., 2008; Teodorovici et al.,2010; Astekar et al.,2014)in which SEM was used.

In the present study, determination of CEJ types was done through ground sections examination since it is the method that confirm the presence of the fourth CEJ type –enamel covering cementum- as previously reported (Neuvald and Consolaro, 2000; Arambawatta et a.l, 2009). Meanwhile the use of SEM enabled us to examine the CEJ type through the whole circumference of the buccal surface of maxillary first premolars. However, the determination of CEJ type using light microscopic examination of ground sections confirmed SEM results.

In edge-to-edge cases, evidence suggests a chemical combination in the contact area between cementum and enamel because of the identical inorganic structural elements, the hydroxyapatite (Akai et al.,1978). In the present study, edge to edge type of CEJ showed wave-like appearance. Similarly, scalloping of the CEJ was observed by Grossman and Hargreaves (1991). Although the cementum overlapping enamel was previously reported to occur most frequently in human teeth (Rose et al,2004; Nanci,2013), in the current study, the edge to edge CEJ type was the most predominant which is accordance with several studies (Muller and van Wyk,1984; Schroeder and Scherle,1988; Bevenius etal., 1993; Manjunath et al., 2008; Arambawatta et al., 2009; Teodorovici et al., 2010; Astekar et al.,2014). Cementum overlapping enamel was less frequent (36%) than edge to edge type in the present study. In an attempt to explain this finding, Boyde et al. (2006) reported that it is a challenge to find teeth containing coronal cementum and he attributed this to three reasons: 1) naturally, coronal cementum length could vary around the circumference of a crown, which can lead to several types of CEJ within a tooth depending on the sectioning plane. 2) The extraction process may induce significant damage and disrupt the coronal cementum, thus creating an artefact. 3) Because of its anatomical location, and cementum in general being a relatively softer mineralized tissue; tooth brushing, flossing and other dental hygiene related events could lead to loss of coronal cementum.

The presence of follicular cells in the ectomesenchyme and adjacent to the exposed areas of the newly deposited enamel cause induction of cementogenesis (Akai et al.,1978). Enamel and dentin at the cervical portion of the tooth are frequently covered by a collagen-free matrix referred to as acellular afibrillar cementum (AAC). It is believed that AAC deposition occurs when the reduced dental epithelium is displaced or disrupted, and mesenchymal cells from the dental follicle gain access to the tooth surface, differentiate into cementoblasts, and secrete noncollagenous proteins typically found in collagen-based mineralized tissues. The data also suggest that AAC may be deposited by cells of epithelial origin. Furthermore, they lend support to the possibility that cells derived from Hertwig's epithelial root sheath may likewise be capable of producing cementum matrix proteins (Bosshardt and Nanci,1997). Coronal cementum is continuous with primary root cementum apically and appears to integrate micromechanically via a weak interface with enamel unlike the DEJ and CDJ.The higher content of non collagenous organic matter in the coronal cementum could serve as a chemical adhesive resisting coronal cementum peel-off, which could be observed in some SEM specimens (Ho et al., 2009).

In the current study, the gap junction represented 10% of the CEJ types which agrees with the previously documented frequency in Oral Histology text books.The completion of crown formation is followed by activation of Hertwig's epithelial root sheath, radicular dentin formation and disintegration of Hertwig's epithelial root sheath allowing cementum deposition on dentin (Ten Cate, 2003). Failure of disintegration of this root sheath at the appropriate time leads to the formation of the gap type of CEJ. In the absence of cementum formation at the crucial period of time, the lack of attachment of periodontal fibers may probably lead to delayed eruption (Manjunath et al., 2008). Another explanation for gap junction occurrenceis based on the phenomenon of apoptosis i.e. cell disintegration, present in dental embryogenesis. During differentiation, the loss of control of the timing of apoptosis would lead to a delay in the disintegration of Hertwig’s root sheath cells during initial root formation. If the epithelial sheath of the root persists, there is a lack of cementum deposition along the dentinal surface apical to the enamel resulting in the gap relationship. Normally these areas of dentin exposed tothe periodontal environment are covered by extracellular matrix which keeps the dentin specific proteins isolated from immune cell recognition. Another possibility corresponds to the precocious occurrence of apoptosis in Hertwig’s root sheath before the production of intermediate cementum leading, in a focal way, to cementogenesis (Neuvald and Consolaro,2000).

As long as the CEJ is covered by healthy gingival tissues, the cementum–enamel relationship may change from exposed dentin to edge to edge contact to cementum overlap, simply because of the cementum being formed with time (Astekar et al,2014).This sequence is stopped once the CEJ is exposed to the oral environment(Schroeder and Scherle,1988).

In the present study, the fourth type i.e., enamel over cementum, represented only 4%of the studied sample. Arambawatta et al. (2009) stated that the occurrence of this fourth type is difficult to explain from an embryological point of view, because cementum formation begins after completion of enamel formation. Muller and van Wyk (1984) regarded this type as an optical illusion that resulted due to the thickness of ground sections. However, this type of junction was observed in our SEM results. Likewise, Ceppi et al. (2006) and Teodorovici et al.(2010) reported a similar CEJ morphology in their SEM investigation on primary mandibular incisors.

Several studies reviewed the morphology of the CEJ in permanent dentition. Muller and van Wyk (1984) examined 150-µm-thick sections from 152 teeth extracted from a South African population and reported that 17.7% showed gap junction and 45.2% revealed an edge-to-edge relationship.Schroeder and Scherle (1988) used scanning electron microscopy combined with light microscopy to examine eight extracted freshly erupted premolars and found that edge-to-edge contact of cementum and enamel was the predominant type(70%) of relationship and that gap junction was very rare (1%). In 1993, Bevenius et al. used a replica technique for scanning electron microscopy-combined with polarization microscopy of thin (<40 µm) ground sections to investigate the CEJ of 50 premolars extracted from a Swedenpopulation. They noted that edge-to-edge contact of cementum and enamel was most frequent (76%), and that overlapping of cementum (14%) was less prevalent than previously reported.In another study conducted in Sri Lanka, the cervical region of ground sections of 67 premolars extracted for orthodontic reasons were analyzed using transmitted light microscopy: An edge-to-edge relation was predominant (55.1%). In approximately one-third of the sample, gap junction was observed. Cementum overlapping enamel was less prevalent than previously reported, and enamel overlapping cementum was seen in a very small proportion of the sample (Arambawatta et al., 2009).In a study by Teodorovici et al. (2010) on a Romanian population, SEM of buccal and lingual surfaces of maxillary premolars revealed that most the frequent CEJ relation was the edge to edge type followed by gap junction then cementum covering the enamel. The enamel covering the cementum was the rarest type.

Previous studies performed on various populations in which the frequency of CEJ types is different, support the hypothesis that the anatomical profile of CEJ might be dependent on race (Muller and van Wyk,1984).

Grossman and Hargreaves(1991) stated that the CEJ varied in a single tooth. The investigators concluded that the distribution of the three hard tissues found at the cervix are unpredictable and irregular.Although Francischoneand Consolaro (2008) and Nanci (2013) reported that all tooth circumferences could exhibit an interchange and combination of type 1, 2 and 3 CEJ relationships,in the present study, SEM showed minor variability ofCEJ types on the buccal surface of some samples of the maxillary first premolar. Francischone and Consolaro (2008) clarified the events that cause CEJ variability during tooth development as enamel deposition does not cease simultaneously along the entire tooth circumference. When enamel deposition is completed, Hertwig's epithelial root sheath begins to form at the cervical margin. Odontoblasts, which differentiate under the influence of HERS, secrete the initial layer of root dentin. The sheath then fragments at varying times at different sites, thus promoting the irregular 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 (Arambawatta et al., 2009).

Regarding EDXA results in the present study, mean Ca and P wt % was less in cervical root cementum compared to that of enamel which is concomitant with the results of Rabea et al. (2012), in their study on maxillary premolars extracted for orthodontic treatment. Surprisingly, bare dentin demonstrated the highest wt % of Calcium compared to the other studied tissues in the current study.

EDXA also demonstrated Mg as a trace element in the surface layer of cervical root cementum which is in accordance with the results of Hals and Selvig (1977) who observed a gradual increase of Mg in the cementum from periphery to deeper layers. Furthermore, it was reported that Mg content in cementum is about half that in dentin (Neiders et al., 1972) which is almost similar to our results. Previously, trace elemental concentrations of Cu, Zn, and Na were detected by electron microprobe analysis in human root cementum of healthy teeth (Barton and Van Swol, 1987). However, from these three elements, Na was the only one detected in the cervical root cementum in this study.Fluoride was not detected in cementum in the current study owing to the short period of teeth presence in the oral cavity, as it was reported that cementum has a greater capacity for adsorption of fluoride and other elements over time (Bosshardt et al., 2000).

Conclusions:

Within the limitations of this study, it was demonstrated that highest CEJ type frequency in Egyptian maxillary first premolar was the edge to edge type, contradicting the traditional frequencies and supporting the hypothesis that the anatomical profile of CEJ is race dependent. The determination of CEJ type which was based on ground sections examination confirmed SEM results.

References:

Akai M, Nakata T, Yamamoto K, Fujiwara J, Tsuji Y, Kitano E. Scanning electron microscopy of cementoenamel junction. J Osaka Univ Dent Sch.1978; 18: 83–94.

Arambawatta K, Peiris R, Nanayakkara D. Morphology of the cemento-enamel junction in premolar teeth. J Oral Sci. 2009; 51: 623-627.

Astekar M, Kaur P, Dhakar N, Singh J.Comparison of hard tissue interrelationships at the cervical region of teeth based on tooth type and gender difference. J Forensic Dent Sci. 2014; 6:86-91.

Barton NS, Van Swol RL. Periodontally diseased vs normal roots as evaluated by scanning electron microscopy and electron probe analysis. J Periodontol. 1987; 58:634–638.

Berkovitz BKB, Holland GR, Moxham BJ. A colour atlas and text of oral anatomy: histology and embryology. 2nd ed, Wolfe, London. 1992.

Bevenius J, Lindskog S, Hultenby K.The Amelocemental junction in young premolar teeth. A replica study by scanning electron microscopy. Acta Odontol Scand. 1993; 51:135–142.

Bosshardt DD, Nanci A. Immunodetection of enamel- and cementum-related (bone) proteins at the enamel-free area and cervical portion of the tooth in rat molars. Bone Miner Res. 1997; 12(3): 367-379.

Bosshardt DD, Selvig KA. Dental cementum: the dynamic tissue covering of the root. Periodontol 2000. 1997; 13: 41-75.

Boyde A. Understanding the structure of the mammalian mineralized tissues through their development. Mater Res Soc Symp Proc. 2006:898 E.

Ceppi E, Dall’Oca S, Rimondini L, Pilloni A, Polimeni A.Cementoenamel junction of deciduous teeth: SEM-morphology. Eur J Paedia Dent. 2006; 7: 131-134.

Cloquet M. Notes about the anatomical relationships existent in the human dentition between the enamel and the cementum. Odontologie. 1899; 8: 115-125.

Francischone LA, Consolaro A. Morphology of the cementoenamel junction of primary teeth. J Dent Child (Chic). 2008; 75(3): 252-259.

Friedman S, Rotstein I, Libfeld H, Stabholz A, Healing I. Incidence of external root resorption and esthetic results in 58 bleached pulpless teeth. Endod Dent Traumatol.1988; 4: 23–26.

George DI, Miller RL. Idiopathic resorption of teeth. Am J Orthod.1986; 89:13–20.

Grossman ES, Hargreaves JA.Variable cementoenamel junction in one person.J Prosthet Dent.1991; 65(1): 93-97.

Hals E, Selvig KA. Correlated electron probe microanalysis and microradiography of carious and normal dental cementum. Caries Res. 1977; 11:62–65.

Ho SP, Yu B, Yun W, Marshall GW, Ryder MI, Marshall SJ. Structure, chemical composition and mechanical properties of human and rat cementum and its interface with root dentin. Acta Biomater. 2009; 5(2): 707-718.

Koulaouzidou E, Lambrianidis T, Beltes P, Lyroudia K, Papadopoulos C. Role of cementoenamel junction on the radicular penetration of 30% hydrogen peroxide during intracoronal bleaching in vitro. Endod Dent Traumatol. 1996; 12: 146–150.

Lin CP, Douglas WH. Structure-property relations and crack resistance at the bovine dentin-enamel junction. J Dent Res. 1994; 73(5): 1072–1078.

Manjunath K, Kavitha B, Saraswathi TR, Sivapathasundharam B, Manikandhan R. Indian J Dent Res.Cementum analysis in cleidocranial dysostosis. 2008;19 (3):253-256.

Marshall SJ, Balooch M, Habelitz S, Balooch G, Gallagher R, Marshall GW.The dentin-enamel junction—a natural, multilevel interface. J Eur Ceram Soc. 2003; 23: 2897–2904.

Moody GH. Multiple idiopathic root resorption: a case report and discussion of pathogenesis. J Clin Periodontol. 1991; 18: 577–580.

Muller CJF, van Wyk CW. The amelocemental junction. J Dent Assoc S Afr. 1984; 39: 799-803.

NanciA.Ten Cate's Oral histology Development, Structure, and function. 8thed. St louis: The CV Mosby Company. 2013.

Neiders ME, Eick JD, Miller WA, Leitner JW. Electron probe microanalysis of cementum and underlying dentin in young permanent teeth. J Dent Res. 1972; 51:122–130.

Neuvald L and Consolaro A. Cementoenamel Junction: Microscopic Analysis and External Cervical Resorption. Journal of Endodontics. 2000; 26 (9): 503-508.

Rabea AA, El-Zainy MA, Halawa AM, Osman AM. The effect of some acidic beverages on the surface of enamel and cementum of human premolar samples (Scanning electron microscope attached with energy dispersive x-ray analyser study). PhD thesis, 2012.

Rose LF, Mealey BL, Genco RJ, Cohen DW. Periodontics: Medicine, Surgery and Implants. Elsevier Mosby; St.Louis. 2004.

Schroeder HE, Scherle WF. Cemento-enamel junction. J Periodont Res.1988; 23: 53–59.

Ten Cate RA. Ten Cate's Oral histology Development, Structure, and function. 6 th ed. St louis: The CV Mosby Company, 2003.

Teodorovici P, Iovan G, Stoliriu S,Andrian S. On the ratio among tough dental tissues at cervical level on various groups of teeth. Journal of Romanian medical dentistry. 2010; 14(3): 198-202.

Zaslansky P, Friesem AA, Weiner S. Structure and mechanical properties of the soft zone separating bulk dentin and enamel in crowns of human teeth: insight into tooth function. J Struct Biol. 2006; 153(2): 188–199.