Cemental Tear: Radiographic-clinical characteristics and its Predisposing factors

So-Jin Kim[1,2], Byung-Cheol Kang[1,3], Sun-Heon Kim[1,4], Hyun-Ju Chung[1,2†]

[1]Chonnam National University Dental Science Research Institute, [2]Chonnam National University School of Dentistry Department of Periodontology, [3]Chonnam National University School of Dentistry Department of Oral and Maxillofacial Radiology, [4]Chonnam National University School of Dentistry Department of Oral Anatomy,

접수: 2019년 12월 1일/ 수정접수: 2019년 12월 23일/ 게재 승인: 2019년 12월 24일/ 출간: 2019년 12월 31일

Root surface integrity is essential for periodontal health. The cemental tears (CETs) were more likely to have periodontal bone destruction and the treatment outcome was related to the length and apico-coronal location of the tears. We examined the radiographic CET related to the predisposing factors and the periodontal characteristics.

Periapical x-rays taken between 2009 and 2017 were screened and 82 CET teeth among 46 subjects were included. A radio-opaque fragment along the root surface and the related periodontal and periapical bone loss were evaluated radiographically, and the gingival swelling and deep periodontal pocket were examined clinically. The demographic data, clinical, and radiographic findings were recorded and analyzed using the χ^2 test.

CETs were more prevalent in the incisors of males, aged ≥ 50 years. Single or multiple CETs occurred in the cervical and middle thirds more than the apical third of the roots. CETs presented with deep pockets, abscesses, and fistulae. In cervical CETs, the periodontal space widening and angular bone loss were more prevalent ($p < 0.005$), regardless of pulp vitality, root filling, and the crown status of the affected tooth and the antagonist. The apical CETs were associated with periapical lesions and loss of pulp vitality ($p < 0.001$).

In conclusion, CETs can mimic periapical or periodontal lesions, which make their early diagnosis difficult. Therefore, CET should be considered as a differential diagnostic entity in isolated sites with rapid periodontal breakdown in elderly patients. Further research is required to examine whether the structural weakness of the cementum would cause multiple tears in the predisposed individuals.

Keywords: Cemental tear, Periapical radiography, Predisposing factors, Periodontal status

† Corresponding author: Hyun-Ju Chung
Department of Periodontology, School of Dentistry, Chonnam National University, 33 Yongbongro, Bukku, Gwangju, 61186, Korea
Tel: 82-62-530-5822; Email: hjchung@jnu.ac.kr

Introduction

Root surface integrity is essential for the periodontal health. Cemental tear (CET) refers to the destruction of integrity along the cemento-dentinal junction or within cementum[1,2] and has been described and these have been described as the detachment of a fragment of cementum from the root surface[3] and as a 'complete separation along the cemento-dental border or a partial split within the cemental tissues along an incremental line[1,4]. It was first reported histologically as cementum detachment in soft tissue adjacent to bone crest around upper incisor root of old monkey and lower incisor of 45-year-old human[5]. It should be distinguished from vertical root fracture that progress along the long axis of the root [6].

Traditionally, two types of cemental tears, cervical and apical[2], have been recognized, but recent reports have shown a more modified variety[6, 7]. They have been observed in exposed and unexposed cementum. If the tear is not exposed to the oral cavity, repair often occurs. The cervical type has been described as a periodontal lesion that enables microorganisms to proliferate and initiate active periodontal breakdown[1, 2].

CET are suggested to be a factor for periodontal bone destruction[1, 8-10] or periapical tissue destruction[1, 8, 9, 11-13]. The CET–associated lesion often presents itself on the radiograph as a periapical lesion or a periodontal lesion with angular bone loss along the root surface with variable extension, resulting in a deep probing defect because of attachment loss in some cases[2, 9,10,13-15]. According to their studies, CET has clinical characteristics such as gingival swelling, deepened periodontal pocket, destruction of surrounding periodontal tissue, and vertical bone loss observed radiographically[6]. In addition, men, aging, single-rooted teeth, vital teeth, and moderate to severe attrition were shown as the predisposing factors for CET[6, 9, 16]. This differs from the predisposing factors of vertical root fracture, which occurs mainly in multi-rooted teeth, non-vital teeth, and the age between 40 and 60 years[17].

Lin et al [16] showed that cases with CET were detectable on preoperative radiographs and that those teeth were more likely to have periodontal bone destructions. They reported the relationship between treatment outcome of CET and the length and apico-coronal location of the separated root fragments. In this study, we screened the radiographic CET to evaluate the predisposing factors and the association with periodontal conditions. Clinical diagnosis of CET is not easy, thus, a definitive diagnosis requires direct removal of CET under surgical opening and histopathological examination of fragments[15]. Nevertheless, an early and accurate diagnosis of CET is important as it affects the accuracy of prognosis of affected teeth and to confirm its predisposing factors. For that reason, it is necessary to identify CET clinically or radiographically and to relate it to the predisposing factors. It is also important to establish evidence-based guidelines for treatment outcome predictors of CETs. Therefore, this retrospective study was performed to develop a CET classification system (extent, location, and status of separation) and to investigate the association of CETs with periodontal conditions according to the CET criteria, radiographically and clinically. Aging, trauma, occlusal trauma, and intrinsic structure weakness of the cementodentinal junction have been suggested as predispositions related to cemental tears[9, 10, 18-20]. We hypothesized that age, sex, tooth type, occlusal trauma, pulp vitality, prior endodontic treatment, and crown status could be the predisposing factors for CET.

Materials and Methods

Study setting

Radiographic data for this retrospective study were obtained from Chonnam National University Dental Hospitals, Department of oral and maxillofacial radiology. The registered teeth were classified as highly suspicious of CETs between January 2009 and December 2017 based on one of the following criteria: (1) a discernable radiopacity of separated root structure with a concomitant loss of adjacent periodontal or periapical bone on preoperative radiographs (Fig. 1.)[13,15]; (2) teeth had clinical signs and symptoms and/or persistent periapical radiolucency even after endodontic treatment or retreatment, with or without the presence of suspected radiopaque cementum-like structure[13]; and (3) teeth had recurrent periodontal inflammation and/or periodontal bone destruction even after scaling, root planing, or surgical intervention, with or without a suspicious radiopacity that separated root structure on preoperative radiographs[15]. Figure 1 shows the clinical and radiographic pictures of a CET teeth. In the 1st patient, gingival swelling was observed between two maxillary central incisors, and a partially separated CET fragment was shown at the bone crestal level on the mesial side of right central incisor from cervical third to the middle third. In the 2nd patient, CET fragment was shown in the apical 1/3 of right mandibular central incisors associated with apical radiolucency in 41-year-old male patient. Even though root canal treatment was performed, the fragment and its lesion progressed and fistula occurred in right radiograph after 1 year of management. All the samples were evaluated together by two specialists for periodontics and for oral and maxillofacial radiology with consistency to confirm the presence of CETs before the inclusion of cases for data analysis in this study.

Data collection

A total of 82 teeth with suspicious CETs were included among 46 subjects. Information regarding age, gender of subjects, tooth number, tooth region, crown status, pulp vitality, extent of fragment, and state of the antagonist were recorded. The structured dental chart for each affected tooth with a possible CET was designed to record the potential predisposing factors and clinical characteristics retrospectively by reviewing the documents and the dental records. The predisposing factors included age, sex, tooth type, absence or presence of a prosthesis, antagonist teeth, prior root canal treatment, and tooth vitality. The recorded clinical characteristics included the chief complaint, a sinus tract condition, swelling (abscess), deep probing pocket depth, pain, and the presence of a radiopaque cementum-like fragment on the side of roots on preoperative radiographs, periodontal or periapical bone destruction, periodontal ligament (PDL) widening and angular bone loss.

Figure.1. Clinical and radiographic findings. A. Cervical cemental tear (CET) of partially separated form shown at the bone crestal level on the mesial side of the right maxillary central incisor from cervical to the middle 1/3 of root in 74-year-old male patient showing gingival swelling. Two year later, middle to apical CET was shown on distal surface of the same tooth in the right radiograph (in upper part). B. Apical CET was shown in right mandibular central incisors associated with apical radiolucency in 41-year-old male patient. Even though root canal treatment was performed, the fragment and its lesion progressed and fistula occurred in right radiograph after 1 year of management (in lower part).

After the presence of a radio-opaque fragment along the root surface and the related periodontal and periapical bone loss was assessed radiographically, the clinical signs such as gingival swelling, deep periodontal pocket and fistula in the patient records were also recorded as the major features of CETs retrospectively. For each case, demographic data, dental history, clinical and radiographic findings were recorded and analyzed by Chi-square test. Table 1 presents the criteria for each parameter in classification of CET based on Lin et al (2011, 2014)[6, 7].

Table 1 Criteria for Cemental tear (CET) classification

Parameters	Separation	Proximal surface	Extent
Criteria	Partial	Mesial (M)	Crestal (C)
	Complete separation	Distal (D)	Middle (M)
		Both MD	Apical (A)

Statistical Analysis

For each CET and patient, 15 variables were recorded from the structured dental chart, transferred into a Microsoft Excel (Microsoft, Redmond, WA) database and calculated the frequency distribution for predisposing factors and clinical characteristics using a pivot table (Table 2). Descriptive and univariate analyses were then performed using SPSS 23.0 software for Windows (IBM SPSS Inc, Chicago, IL). Univariate analysis (percent frequencies) was performed on all 82 samples to evaluate the variables of tooth type, clinical characteristics, and predisposing factors as described previously[6, 7]. Bivariate analysis (chi-square or Fisher exact test) was performed on the 82 CET samples and 46 subjects to establish the relationship among the variables of predisposing factors and clinical and radiographic characteristics.

Table 2. The variables used to analyze the univariate distribution and bivariate relationship of investigated factors

Predisposing Factors	Variables
Demographic findings	Gender, Age, Tooth type
Radiographic characteristics	CET Separation, Mesiodistal location, Apicocoronal location, Periodontal bone loss, Angular bone loss, Periapical bony lesion, PDL widening
Clinical Characteristics	Chief complaint, Sinus tract, Swelling, Accompanied soft tissue problem, Pocket depth, Crown status of tooth and antagonist, Root canal treatment or Pulp vitality

Results

Demographic and clinical characteristics

The study population comprised 46 patients with age ranged from 41 to 88 year and their mean age of 64.4 ± 11.7 years. At the subject level, 30 men (65.2%) and 16 women (34.8%) were included, and at the tooth level, 48 teeth of male (58.5%) and 34 teeth of female (41.5%) were examined. Regarding clinical symptoms, there were no clinical symptoms in 33 teeth (40.2%), presenting deep periodontal pockets in 21 (25.6%), gingival swelling in 7 (8.5%), pain in 2 (2.4%), abscess or pus discharge in 12 (14.6%), and fistula formation in 7 (8.5%) among symptomatic teeth. The average probing pocket depth for all teeth examined was 6.1 ± 2.6 mm (3.7 ± 1.0 mm for asymptomatic, 7.2 ± 2.4 mm for symptomatic) (Table 3).

Table 3. Predisposing factors and Clinical and radiographic findings for 82 CET cases

A. Demographic findings		
Predisposing factors	No (%)	P values
Gender	46	
Male	30(65.2)	
Female	16(34.8)	
Age (y)	46	0.011
40~49y	5(10.9)	
50~59y	11(23.9)	
60~69y	12(26.1)	
70~79y	12(26.1)	
≥80y	6(13.0)	
No. of CET in each subject	46	0.657
1	23(50.0)	
2	15(30.0)	
≥3	8(20.0)	
CET Distribution	82	0.199
Maxillary central incisors	32(39)	
Maxillary lateral incisors	5(7.3)	
Maxillary canine	1(1.2)	
Maxillary premolar	6(7.3)	
Maxillary molar	0	
Mandibular central incisors	16(19.5)	
Mandibular lateral incisors	2(2.4)	
Mandibular canine	2(2.4)	
Mandibular premolar	7(8.5)	
Mandibular molar	10(12.2)	
B. Radiographic characteristics		
Predisposing factors	No (%)	P values
Proximal location	82	0.024
Mesial	41(50)	
Distal	26(31.7)	
Both side	15(18.3)	
Apicocoronal location	82	0.006
Cervical Cervical 1/3	12(14.6)	
Cervical ~middle	35(42.7)	
Middle 1/3	18(22.0)	
Apical Middle~apical	8(9.8)	
Apical 1/3	2(2.4)	
Cervical-middle-apical	7(8.5)	
CET Separation Mode	82	0.013
Complete	55(67.1)	
Incomplete	27(32.9)	
Root canal therapy	25(31.7)	0.425
PDL widening	63(76.8)	0.202
Angular bone loss	53(64.6)	<0.001
Periapical bone loss	37(45.1)	0.169
Bone support (to root)	82	0.416
≥3/4	11(13.4)	
1/2~3/4	29(15.4)	
1/4~1/2	25(30.5)	
<1/4	17(20.7)	
C. Clinical characteristics		
Predisposing factors	No (%)	P values
Clinical symptoms		0.012
None	33(40.2)	
Deep PD (≥5mm)	21(25.6)	
Swelling	7(8.5)	
Pain	2(2.4)	
Abscess/pus	12(14.6)	
Fistula	7(8.5)	
Probing depth (PD)	62	0.397
<3mm	2(3.1)	
36mm	26(40.6)	
≥6mm	35(56.3)	
Tooth vitality	46(56.1)	<0.001
Cervical CET	29(63.1)	
Apical CET	17(37)	
Crown status	86	0.417
Natural	53(64.6)	
Single Crown	13(15.9)	
Bridge abutment	16(19.5)	
Antagonist crown status	86	0.003
Natural	48(59)	
Single Crown	9(11)	
Bridge abutment	17(20.7)	
Denture	5(6.1)	
implant	3(3.7)	

We investigated the prevalence and distribution of CET according to the patient's age, sex and tooth region (Table 3 and Fig. 2). CET was prevalent at the ages 50s to 70s ($p<0.05$, Fig. 2A), in the upper and lower central incisors ($p<0.05$), but not at all in the upper molars (Fig. 2B). We also examined the number of teeth with CET according to age group. Most age groups had one or two CET teeth. Older patients aged between 60~79y showed multiple CET teeth with prevalence of 30% in female and 10% in male (Fig. 2C).

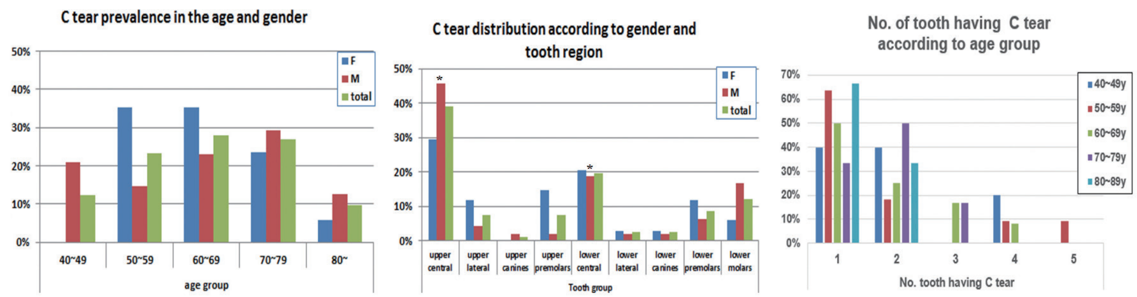

Figure.2. Prevalence and distribution of CET according to age, gender, and tooth region and CET No. in each age groups. CET was prevalent in aged between 50 to 70y (A) ($p<0.05$) and in upper and lower central incisors (B) and multiple CETs were observed in all aged groups with decreasing in aged>80y (C).

Moreover, we studied status, distribution, and extent of CET according to the tooth region. Separated fragments, which were most common in upper anterior teeth, were more prevalent than attached or combined in total ($p<0.05$) (Fig. 3A). As for the distribution of CET in each tooth type, CETs were mainly observed on the distal surface of roots of single rooted tooth except for mandibular molars showing mesial involvement($p<0.05$) (Fig. 3B). Regarding extent of CET in each tooth region, cervical CETs from cervical to middle area of root were predominant in total teeth included, and apical CETs with middle extension was prevalent especially in lower anterior teeth ($p<0.01$) (Fig. 3C).

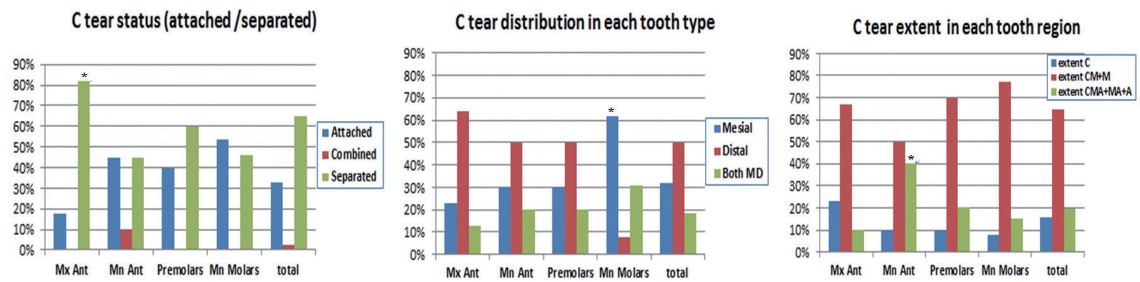

Figure.3. Status of CET (separation, surface and extent) according to the tooth region. Completely separated CETs were prevalent in upper anteriors(A), and most CETs were on mesial surface in lower molars (B)($p<0.05$) and on distal surface in other tooth region, and apical extension was prevalent in lower anteriors (C) ($p<0.01$)*.

Figure 4 shows mean probing depth of CET teeth according to symptoms, crown status and pulp vitality related to the teared region. According to the results, deeper PD was observed in symptomatic teeth (p<0.001) (Fig. 4A). Furthermore, CETs were found mostly in natural crown than with restored crown (Fig. 4B), and most teeth opposing CET tooth were in natural crown or bridge abutment (Fig. 4C). However, apical CETs were significantly associated with loss of pulp vitality (p<0.001) (Fig. 4D).

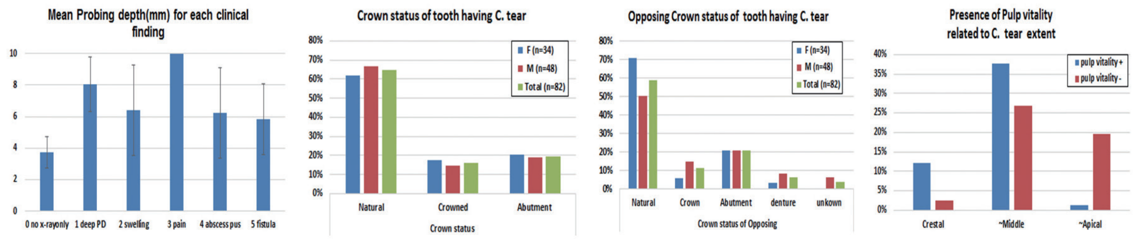

Figure.4. Clinical finding of CET according to symptom (A), crown status of affected tooth (B) and opposing tooth (C) and pulp vitality (D) related to the teared region. Deeper PD in symptomatic teeth (p<0.001), no difference in the crown condition of CET tooth and its opposing tooth, and apical CET associated with loss of pulp vitality (p<0.001).

Radiographic findings (periodontal ligament (PDL) widening, periapical lesion and periodontal bone loss) according to tooth region are shown in Fig.5. Most CETs were associated with crestal bone resorption and PDL widening, which was observed in all cases of premolars in particular (p<0.001) (Fig. 5A). Moreover, periapical bone loss was observed in about 70% of premolars, but the absence of apical bone loss was more common for the other teeth (Fig. 5B). In most cases, angular bone loss was present around CETs. However, there was less angular bone loss around mandibular anteriors, and the difference was statistically significant (p<0.001) (Fig. 5C). In addition, the bone level around CET teeth was 25-75% in most cases (Fig. 5D).

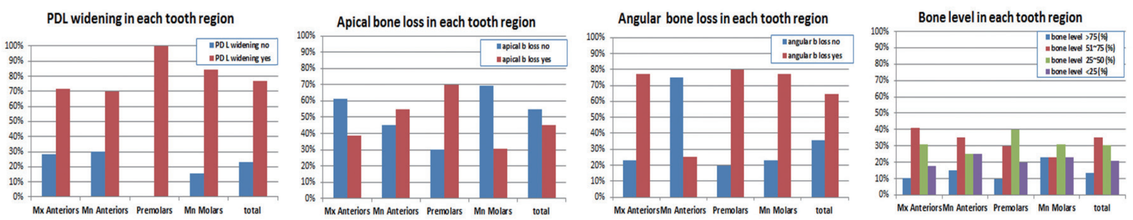

Figure.5. Radiographic finding of CET in relation to periodontal space widening (A), periapical (B) and periodontal bone loss (C, D). All premolars presented periodontal space widening (A) and lower anteriors presented significantly less angular bone loss (C) (p<0.001).

Discussion

The etio-pathogenesis of CET is not yet clear and because it is often asymptomatic, it is not uncommon that it is discovered coincidentally through periapical x-ray. Moreover, CETs that occur on non-proximal surfaces are difficult to diagnose through x-ray and requires surgery for proper diagnosis[4, 21] . Location and morphology of CETs varies as well. It can occur at the cemento-dentinal junction (CDJ) or within the cementum and can be a complete or partial detachment of the cementum primarily occurs in the cementum-dentin interface[1, 2, 21]. In this study, we investigated periapical x-rays of CET-related teeth from 2009 to 2017. A total of 82 CET teeth were included from 46 patients aged between 41 and 88y. It is necessary to develop a classification system for CETs to provide a guideline how to manage the cemental tear for the predictable outcome and to investigate the association of CETs with periodontal conditions according to the CET criteria radiographically and clinically, based on the system described by Lin et al. (2011)[6]. Patient's gender, age, in relation to location of teeth within the dental arch, status of separation, extent and distribution of CET was comprehensively investigated. Clinical symptoms, probing pocket depth (PD), status of crown restoration, pulp vitality, periodontal ligament (PDL) widening, and periodontal or apical bone loss of CET teeth, as well as rate of incidence in relation to the status of crown restoration of opposing dentition was investigated to get the information on the predisposing factors.

CETs were more prevalent in incisors (68%), in male (65.2%), older than 50 years (88%). CETs occurred in single or multiple, and were present in cervical (57%), middle (22%), and apical third of roots (21%). Analysis of clinical characteristics showed that teeth with CETs were prone to have abscess, swelling, or fistula (34%), and deep pocket ≥6 mm (80%). In cervical CET, periodontal space widening (76%) and angular bone loss (65%) was prevalent, regardless of tooth vitality, root filling, and the crown status of corresponding and opposing teeth. The apical CETs were associated with periapical lesion and loss of pulp vitality ($p<0.001$) and angular periodontal bone loss was associated with cervical and middle entity ($p<0.005$).

According to the results, average age of patients having CET teeth was 64.4 year and it was more prevalent in male patients (65.2%) than female patients, which was in agreement with previous authors. Probably, males have stronger occlusal forces than females[22] or there are intrinsic differences of cementum between genders as Jeng et al. (2018) discussed[23]. During aging, physiochemical alteration of the cemento-dentinal interface, increased fibrosis and the decreased collagen extensibility make the cementum more prone to detachment[19, 23]. A possible explanation is the cementum changes through aging[4, 16, 21]. Throughout life, the thickness of cementum in elders and teenagers differ 3 to 5 times, depending on the root portion and tooth type[24-26]. In aged patients, the adhesion of proteoglycan (between dentin and cementum) weakened. In addition, the function of collagen is to restrict the stretching of periodontal ligament (PDL). When the extension of PDL is not controlled properly, it may exert extensive or inadequate force on cementum and contribute to the separation of cementum from dentin. Patients in their ages between 50 and 79 years showed the similar prevalence rate (23.2~28%) while patients over the age of 80 years had the lowest (9.8%). This is in accordance with the research results of Lin et al. (2011, 2012)[6, 16] and others[11]. It is probably due to the situation that patients older than 80 years of age lost more teeth due to various reasons including periodontal disease or already severely progressed teeth probably owing to past cemental tear. Unfortunately, we did not collect the data for the number of remaining teeth in each individual. Interestingly, there was a difference in results for male and female patients for the rate of incidence relating to age. There was no CETs in female patients younger than 50y of age and the rate decreased from patients as their age after increased to peak from their 50's to 60's while it increased until their 70's in male patients. Besides, the No. of CET showed different patterns among the aged groups between 2 genders. In female between 50 and 69 years old, 40% has multiple teeth (≥3) having cemental tear, whereas less than 20% of male patients has multiple teeth (≥3) having cemental tear less between 40 to 80 year old even though the sample size was too low (n=16 for female). The structural weakness of the cementum could be as the probable cause of multiple cemental tears in aged females[4, 27]. Further research should be recommended regarding this difference between 2 genders.

It was shown that high occlusal force of male patients in anterior single-rooted teeth is a predisposing factor of cemental split[22, 28]. Traumatic occlusion is suggested as the major reason of cervical cemental separation [29]. It is especially true in elder people suffering from multiple teeth loss, leading to occlusal disharmony. But it shows that upper incisors and lower incisors are the most popularly affected teeth with cemental tear[6], suggesting that single root and anterior teeth with occlusal (protrusive or lateral) forces are the possible predisposing factor of cemental tears. Based on in vitro study, a collective effect of strain originated with repetitive loading on premolars can cause cracks in the cemento-enamel junction, leading abrasion and abfraction cavities, in addition to a fracture along the root surfaces, aiding the development of cemental splits[20]. Additional factors that may predispose to cemental tears include the presence of structural weakness at the cementum-dentin interface, the decreased strength of dentin because of fatigue with increasing age, and prior endodontic therapy[16, 23, 27,30]. Traumatic event such as acute injury is often described as a factor of cemental tear[4, 6, 16, 21, 27]. When excessive force is applied to the tooth and the periodontal ligaments are stressed too much, the fibers could lead to the separation of the cementum from the dentin. Cementum is embedded by Sharpey's fibers (extrinsic fibers), which connect cementum to the bone. In contrast, the connection of cementum-dentinal junction by a glycoprotein-like layer is generally weaker than the connection between cementum and PDL. Cementum is more susceptible to separate from the dentin under excessive force. Recent review report[23] on cemental tear mentioned that the cases were mainly in males, and it is more common in patients over 60 years of age even though the prevalence, incidence, etiology and mechanisms of cemental tear in general population is unknown. However, several factors are suspected to be the predisposing factors, including age[4, 6, 21], gender[6], tooth type[6, 27], trauma from occlusion[13, 27] and vitality of teeth[4, 6, 13, 21, 27].

For incidence rates of CET teeth depending on the location of the teeth within the dental arch, upper central incisor had the highest rate followed by lower central incisor, lower molars, lower premolars, upper lateral & upper premolars, lower lateral & lower canines, and upper canine. None of the maxillary molars were affected by CET (Fig 2B). This is consistent with the results of previous research[6, 9,10]. As reported in previous research, CETs might be caused by abnormal force on the periodontal ligament brought on by excessive occlusal force or parafunctional habit[1, 4, 21]. They suggest that CET occurs when the interconnection between cementum and dentin is weaker than that of cementum and ligament fiber[1, 4, 21]. Single rooted teeth, including upper central incisor, are more vulnerable to abnormal force and therefore can be deduced that it has the highest possibility of CET occurring. Previous studies[2,15,23,27] reported that most cases presented one cemental tear per individual. Watanabe et al.[27] described the clinical and pathologic features of this rare case and suggested the structural weakness of the cementum as the probable cause of multiple cemental tears. In our study, 50% of individuals showed multiple CETs, higher than these previous reports. As for the number of CET tooth by age group, most patients had one or two CET tooth and the less old age groups (<70y) had a higher occurrence of having multiple CET teeth. This can be attributed to the fact that older patients have extracted most of their teeth for various reasons and the symptoms of CET teeth are frequently expressed.

CET fragments can be partially attached to the root or can be completely separated and exist as a foreign body[1, 2, 21]. In this study, we categorized CET tooth as either ‘partial’ or ‘completely separated’ according the status of their attachment and investigated the rate of incidence in relation to the type of affected teeth (Fig. 3A). With the exception of mandibular molars, ‘completely separated’ type occurred more frequently than ‘partially separated’ and was especially pronounced in maxillary anterior teeth. Examination for mesio-distal site revealed that the majority of cemental splits are on the proximal side of root surfaces so early recognition in radiographs is possible if some separation of cementum has occurred[16, 31]. According to the results, CETs were mainly observed on the distal surface of roots except for mandibular molars (Fig.3B), in consistent to the results of Leknes et al.[1] Meanwhile, according to Leknes et al.[1] and Haney et al.[4], cementum deposition increases when functional force is applied to the tooth and the thickness of cementum increases significantly in the area of where CET is found. Dastmalchi et al.[32] investigated the average thickness of premolars and molars and reported significantly thicker cementum on the distal surface compared to the mesial surface (135 and 216 μm respectively) and explained that this was caused by functional stimulation brought on by mesial drifting[4]. One fact that cannot be overlooked is that the results were opposite in mandibular molars (statistically significant). Further research is necessary for this finding. We did not record the length and thickness of CET. A report described that the thickness of cementum augments throughout life, so this thickened cementum in older individuals is more susceptible to break as compared to adolescents[19]. In one finite element analysis[33] using lower premolar model with and without CDJ and cementum (a thickness of 0.2 mm, and 0.15 mm) in tooth supporting structure, the stress levels was 30~50% higher in the PDL structure without CDJ and cementum than that with CDJ and cementum. Because CDJ and cementum functions as a cushion pad with decreasing the stress in the PDL and alveolar bone under loading, CDJ and cementum stress could be damaging themselves during cushioning function. Recent FE stress study of ours (not published) showed that with weakened periodontal support, the peak stress magnitude increased to more than 3 ~5 times at root dentin surface adjacent to remaining bone crest under paraxial loadings.

The cementum detachment occurs frequently in the mid-cervical or in the apical root and its diagnosis can be established by clinical signs and symptoms, radiographic findings and surgical examination[1,4]. For apico-coronal site, Ishikawa et al.[2] reported that CETs were found mainly on the cervical third. In contrast, Lin et al.[16] suggested that they were found more frequently in the middle third and apical third. They described that continuous excessive strain (such as attrition) could lead to cementum displacement on the thicker place (such as the apical third) or on the tensional part (such as the middle third) of an anterior single rooted tooth. As considering the unnecessary tensional forces on the posterior teeth, such as vertical or lateral force, numbers of roots, integrity of dentition, also add to this action. Generally, the location of CETs occurs across two areas rather than being localized in a third area of the root. For this reason, in this study, the apico-coronal location of where CET occurs was categorized into “extent C” (“localized in the cervical area), “extent CM+M” (localized in the middle area and extended from the cervical), and “extent CMA+MA+A“ (localized in the apical area, extended from the middle or the cervical area). Results showed that the most common apico-coronal location of the fragment was at the middle area or extending from the cervical to the middle, and in the case of mandibular anterior teeth, CET occurring at or extending to the apical area was more frequently observed, compared to other regions. This is in agreement with Lin et al.[16], who proposed that with continuous excessive stress, such as attrition, CET occurs more frequently in the middle area, as the area of tension, or in the apical, which has thicker cementum. Furthermore, the fact that fragments extending to the apical area being about 40% more prevalent in the mandibular anterior teeth is interesting. This apical CET in the mandibular anteriors leads to periapical bone loss which in turn can be misdiagnosed as a simple periapical lesion.

Most literatures reported that, when separated cementum fragment is exposed to the intraoral environment, such as within the sulcus or periodontal pocket, acute swelling, exudation, and pain may occur, and in the case where there was pre-existing periodontal disease, alveolar bone loss or periodontal pocket formation can be accelerated[2, 4, 21]. On the other hand, regardless of whether or not the fragment is exposed to the intraoral environment, there are instances when CET is asymptomatic. In this study, among the 82 CET teeth investigated, 33 cases (40.2%) were asymptomatic, 21 cases (25.6%) had deep PD, 7 cases (8.5%) showed swelling, 2 cases (2.4%) had pain, abscess/pus was observed in 12 cases (14.6%), and fistula was observed in 2 cases (8.5%). As for the probing depth (PD) related to clinical symptoms, when the CET was observed only by radiographic screening and asymptomatic, the mean PD was 3.73 mm. For the teeth showing deep PD, the PD was 8.05 mm, 6.40 mm for swelling, 10mm for pain, 6.22 mm for abscess/pus, and 5.83 mm when fistula was observed. Significantly deeper PD was observed in symptomatic teeth. From this finding, it can be deduced that various symptoms may appear when CET occurs in patients with pre-existing periodontitis and CET can be asymptomatic for patients without periodontitis for the time-being. In other word, the site of deep probing depth is related to CET. In classifying the extent of the cemental tear, cervical 1/3, middle 1/3 and apical 1/3 was given, and generally the middle 1/3 was met to the condition accompanying the crestal bone loss.

As for the predisposing factors related to traumatic occlusion, status of crown/abutment for CET teeth and status of crown/abutment/denture for opposing teeth was also investigated, because prosthesis may increase the traumatic occlusal loading of affected tooth. The results showed that in both CET affected teeth and its antagonist, natural crown was the most prevalent at 63.4% and 61.0%, respectively, which was not significantly different. Whether the presence of prosthesis increases the risk of cemental tear remains unknown[23]. Furthermore, vitality or previous endodontic treatment of the teeth related to the presence and the extent of CET fragment was checked. Positive pulp vitality was common for when fragment was localized in the cervical area or the middle area, while negative pulp vitality was common for when the fragment was extended to the root apex. Possible explanations are that root canal treatment is unrelated to cemental tear or that root canal treatment prone the teeth to vertical root fracture easier than the induction of cemental tear[17, 23]. This needs more evaluation. In addition, cemental tear and pulpal-originated lesion have slightly different pattern of swelling and bone destruction. Swelling of pulpal origin is often traced to the root apex, or to the furcation area of molars[34]. In contrast, the swelling of cemental tear is traced to the root surface, depending on the apico-coronal location of the fragment.

As mentioned above, one of the ways to check for CET is to observe a radiopaque foreign body in a radiograph. All of the CET teeth used in this study had radiographic images which allowed us to study the radiographic analysis regarding tooth type of CET tooth such as PDL widening and periapical/periodontal bone loss. Regardless of tooth type, PDL widening was found for most teeth (76.8%), and especially in every case for premolars. This corresponds with the previous reports that most CETs were related to occlusal trauma[1, 4, 21]. We also investigated the apical bone loss and the periodontal angular bone loss in relation to tooth type. There were more cases of apical bone loss being observed in premolars (3 vs. 7 teeth) while the opposite was found in mandibular molars (9 vs. 4 teeth), and this difference was not significant. Moreover, angular bone loss was observed in 64.6% of cases regardless of tooth type and in only 25% of mandibular anterior CET teeth. As for periodontal bone support surrounding CET teeth, 13.4% of affected tooth had periodontal bone support above 75%, 35.4% had between 50~75%, 30.5% had between 25~50% and 20.7% had less than 25%, respectively regardless of tooth type. CET was not prevalent in the teeth with bone support > 75% and this suggested that weakened periodontal support could result in increased stress distribution at root surface adjacent to reduced bone crest under paraxial loadings as recent FE stress study of ours.

It is important to make an early and accurate diagnosis and to establish evidence-based guidelines for treatment outcome predictors of cemental tears as previously mentioned. The limitation of this study is that we did not record the number of the remaining teeth in each patient, and could not relate the tooth status in aged group. In addition, we studied by collecting the cemental tear data, not the management and the resultant prognosis of the tooth. In one multicenter study[6, 7)], the presence of cemental tears was further confirmed by nonsurgical and surgical removal of fractured fragments and histopathologic examination. Unfortunately, our study did not include the histopathologic information or surgical confirmation. On preoperative radiograph, the detached cementum visible as a radiopaque piece in the proximal surfaces of the root within the periodontal ligament. However, in buccal or lingual surfaces, this image can be covered by the tooth root, making the radiographic diagnosis difficult and need to be confirmed under surgical inspection. Trauma history was not taken even though the trauma could be one of the important predisposing factors. For accurate diagnosis, traumatic history and traumatic occlusion needs to be checked. However, this is the first systematic and comprehensive research in Korea that evaluated the association of CET to teeth and periodontal condition. After the future study has gotten the long-term prognosis data for these teeth after management, we could associate the classification system to the management method related to the treatment outcome and prognosis.

In conclusion, CETs were more prevalent in incisors, in males, in aged ≥50 years, in single or multiple, and in cervical and middle more than apical third of roots. CETs were associated with deep pocket >6mm, abscess and fistula. The apical CETs were associated with periapical lesion and loss of pulp vitality. CETs in aged group should be considered as a differential diagnostic entity in isolated sites with rapid periodontal breakdown, even though it is not common. Further research will find that the probable cause of multiple tears is the structural weakness of the cementum in individual preposition. Dental clinicians should know the predisposing factors and appropriately assess the radiographs and pulp vitality of teeth.

References

1. Leknes KN, Lie T, Selvig KA: Cemental tear: A risk factor in periodontal attachment loss. J Periodontol 67: 583-8, 1996.
2. Ishikawa I, Oda S, Hayashi J, Arakawa S:. Cervical cemental tears in older patients with adult periodontitis. Case reports. J Periodontol 67(1):15-20, 1996.
3. Carranza FA: The cementum. Glickman's Clinical Periodontology. 7th ed ed. Philadelphia: WB Saunders . p. 60-1, 1990
4. Haney JM, Leknes KN, Lie T, Selvig KA, Wikesjö UME. Cemental tear related to rapid periodontal breakdown: a case report. J Periodontol 63(3):220-4, 1992.
5. Figg WA: A Tear in the Cementum. J Dent Res 8(6):623-33, 1928.
6. Lin H-J, Chan C-P, Yang C-Y, Wu C-T, Tsai Y-L, Huang C-C, Yang K-D, Lin C-C, Chang S-H, Jeng J-H: Cemental tear: Clinical characteristics and its predisposing factors. J Endod 37(5):611-8, 2011. doi: 10.1016/j.joen.2011.02.017
7. Lin H-J, Chang M-C, Chang S-H, Wu C-T, Tsai Y-L, Huang C-C, Chang S-F, Cheng Y-W, Chan C-P, Jeng J-H: Treatment Outcome of the Teeth with Cemental Tears. J Endod 40:1315-20, 2014. doi:10.1016/j.joen.2014.05.012

8. Camargo PM, Pirih FQM, Wolinsky LE, Lekovic V, Kamrath H, White SN: Clinical repair of an osseous defect associated with a cemental tear: a case report. Int J Periodont Restor Dent 23:79-85, 2003.
9. Chou J: Cementodentinal Tear: A Case Report With 7-Year Follow-Up. J Periodontol 75(12):1708-13, 2004. doi:10.1902/jop.2004.75.12.1708
10. Tulkki MJ, Baisden ML, McClanahan SB: Cemental Tear: A Case Report of a Rare Root Fracture. J Endod 32:1005-7, 2006. doi:10.1016/j.joen.2006.02.032
11. Lyons CT, Peacock MK, Cuenin MF, Swiec GD, Dickey DJ: Severe localized periodontal destruction associated with cervical cemental separation. Gen Dent 53(3):212-4, 2005.
12. Stewart ML, McClanahan SB: Cemental tear: a case report. Int Endodontic J 39:81-6, 2006. doi.org/10.1111/j.1365-2591.2005.01034.x
13. Tai T-F, Chiang C-P, Lin C-P, Lin C-C , Jeng J-H: Persistent endodontic lesion due to complex cementodentinal tears in a maxillary central incisor—a case report. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 103:e55-e60, 2007. doi:10.1016/j.tripleo.2006.12.011
14. Leknes KN: The influence of anatomic and iatrogenic root surface characteristics on bacterial colonization and periodontal destruction: a review. J Periodontol 68(6):507-16, 1997.
15. Lin H-J, Chan C-P, Wu C-T, Jeng J-H: Cemental tear on a mandibular second molar: a case report. Odontol 98(2):173-6, 2010. doi:10.1007/s10266-010-0121-8
16. Lin HJ, Chang S-H, Chang M-C, Tsai Y-L, Chiang C-P, Chan C-P, Jeng J-H: Clinical fracture site, morphologic and histopathologic characteristics of cemental tear: role in endodontic lesions. J Endod 38(8):1058-62, 2012. doi:10.1016/j.joen.2012.04.011
17. Cohen S, Berman LH, Blanco L, Bakland L, Kim JS: A Demographic Analysis of Vertical Root Fractures. J Endod 32:1160 -3, 2006. doi: 10.1016/j.joen.2006.07.008
18. Moskow BS: Origin, histogenesis and fate of calcified bodies in the periodontal ligament. J Periodontol 42(3):131-134, 1971.
19. Grant DA, Bernick S. The periodontium of ageing humans. J Periodontal Res 43:660-7,1972.
20. Noma N, Kakigawa H, Kozono Y, Yokota M: Cementum crack formation by repeated loading in vitro. J Periodontol 78:764-9, 2007. doi: 10.1902/jop.2007.060328
21. Marquam BJ: Atypical localized deep pocket due to a cemental tear: case report. J Contemp Dent Pract (3):052-64, 2003.
22. Kaur S, Kumar S, Mishra R, Gera A, Gupta H: Cemental Tear: An Un-usual Case Report. Ind J Dental Sci 4:84-6, 2012.
23. Jeng P-Y, Luzi AL, Pitarch RM, Chang M-C, Wu Y-H, Jeng J-H: Cemental tear: To know what we have neglected in dental practice. J Formosan Med Assoc 117:261-7, 2018. doi:10.1016/ j.jfma.2017.09.001
24. Yamamoto T, Hasegawa T, Yamamoto T, Hongo H, Amizuka N: Histology of human cementum: its structure, function and development. Jpn Dent Sci Rev 52:63-74, 2016. doi:10.1016 / j.jdsr.2016.04.002
25. An GK: Normal aging of teeth. Geriatr Ag 2009(12):513-7, 2009.
26. Pinchi V, Forestieri AL, Calvitti M: Thickness of the dental (radicular) cementum: a parameter for estimating age. J Forensic Odonto-Stomatol 25:1-6, 2007.
27. Watanabe C, Watanabe Y, Miyauchi M, Minoru F, Watanabe Y: Multiple cemental tears. Oral Surgery, Oral Med Oral Pathol Oral Radiol 114(3): 365-72, 2012. doi:10.1016/j.oooo.2012.01.003
28. Asghar S: Cemental Tear; Predisposing Factors, Clinical Signs Symptoms, Diagnosis and its Management. JBUMDC 2(2):4-7, 2012.
29. Yamamoto T, Domon T, Takahashi S, Islam MN, Suzuki R, Wakita M: The structure and function of the cemento-dentinal junction in human teeth. J Periodont Res 34:261-8, 1999.
30. Fiorellini JP, Stathopoulou PG: Anatomy of the periodontium. In: Newman MG, Takei HH, Klokkevold PR, Carranza FA, editors. Carranza's clinical periodontology. 12th ed ed: Elsevier; 2015. p. 9-39.
31. Holton W L, Hancock E B , Pelleu G B Jr: Prevalence

and Distribution of Attached Cementicles on Human Root Surfaces. J Periodontol 57: 321-4, 1986.

32. Dastmalchi R, Poison A, Bouwsma O, Proskin H: Cementum thickness and mesial drift. J Clin Periodontol 17:709-13, 1990.
33. Ren LM, Wang WX, Takao Y, Chen ZX: Effects of cementum–dentine junction and cementum on the mechanical response of tooth supporting structure. J Dent 38:882-91, 2010. doi: 10.1016/ j.jdent.2010.07.013
34. Parolia A, Gait TC, Porto ICCM, Mala K: Endo-perio lesion: a dilemma from 19th until 21st century. J Interdiscip Dent 3:2-11, 2013. doi: 10.4103/2229-5194.120514

한글초록

백악질 열리의 임상 및 방사선적 특징과 위험요인의 분석

김소진[1], 강병철[2], 김선헌[3], 정현주[1]

전남대학교 치의학전문대학원 치주과학교실[1], 영상치의학과교실[2], 구강해부학교실[3]
전남대학교 치의학연구소

치근면이 구조적 기능적으로 온전해야 장기적으로 치주조직건강을 유지할 수 있다. 백악질 열리(cemental tear)는 처치 전 진단방사선 사진에서 탐지될 수 있으며 그 경우 치아주위 조직 파괴가 동반될 가능성이 높다. 분리된 치근면 열리의 길이와 치경-근단측 위치가 치료 결과 및 예후에 유의하게 관련될 수 있다.

이번 연구에서는 백악질 열리의 소인과 해당치아의 치주적 양상에 관해 방사선학적 임상적으로 평가하고 관련 위험인자를 확인하였다. 전남대학교 치과병원에서 2009~2017년도에 촬영된 환자(≥ 40세)의 구내 방사선 사진에서 백악질 열리(치근면 표면에서 부분이나 완전 분리된 방사선 불투과성 파편의 존재)를 확진한 후 치경-근단측 위치를 기록하고, 환자 연령, 치과병력, 해당부위의 치주상태와 근단상태, 치관 및 대합치를 후향적으로 평가하였다. 방사선적으로 변연 치주조직 골 소실, 치주인대 확장, 근단주위 골소실 및 근관처치 여부를 평가하고 임상적으로 치은종창 등 치주증상, 치주낭 깊이를 기록하였다. 성별, 연령군, 치아군에 따른 분포와 관찰된 요인들의 관계를 교차 검정을 이용하여 분석하였다. 백악질 열리는 50세 이상 연령층, 남성, 전치부에서 빈번하였으며, 치경부가 근단부보다 7배 높게 나타났다. 임상적 소견으로 치은종창 및 농루(34%), 깊은 치주낭(≥ 6mm)(80%)을 나타내었고, 치경부 열리는 치주인대강 확대와 수직골흡수 ($p < 0.005$)와, 근단부 열리는 근단병소 및 근관처치($p < 0.001$)와 관련되었다.

이상의 결과로부터 백악질 열리는 치주병소와 근단병소와 유사하여 진단에 어려움을 동반할 수 있다. 백악질 열리는 노인환자에서 국소적 급성 치주조직파괴를 동반한 경우 감별진단에 고려되어야 한다. 향후 연구를 통해 복수의 백악질 열리를 동반하는 경우 개인적 소인으로서 백악질의 구조적 위약성에 대한 구명이 필요하다.

주제어: 백악질 열리, 구내 방사선사진, 선행요인, 치주상태