Clinical Fracture Site, Morphologic and Histopathologic Characteristics of Cemental Tear: Role in Endodontic Lesions

Hsueh-Jen Lin, DDS, MS, Shu-Hui Chang, PhD,† Mei-Chi Chang, MS, PhD,‡ Yi-Ling Tsai, DDS, MS,§ Chun-Pin Chiang, DDS, PhD,§ Chiu-Po Chan, DDS,‖ and Jiiang-Huei Jeng, DDS, PhD§*

Abstract

Introduction: Clinical research regarding the clinical and histopathologic characteristics of cemental tear is limited in the endodontic literature. The objective of this study was to evaluate the morphology, apicocoronal location, and the histologic characteristics of cemental tear. **Methods:** The material was collected during 1987–2009 and consisted of 54 teeth that were presented with cemental tears by histologic examination. To investigate the atypical prospects among the groups of each variable, a series of the Poisson χ^2 goodness-of-fit tests were conducted to test for a fit of a discrete, uniform distribution. **Results:** Cemental tear occurred mainly in incisors (74.1%), proximal root surfaces (79.6%), male patients (74.1%), and patients older than 60 years (72.3%). They were noted often in the middle third of root (45.3%), but 41.5% of cemental tears were noted over the apical region. The morphology of cemental tear was either small/thin piece-shaped (77.4% cases) involving 1 root surface or U-shaped (22.6%) involving >1 root surface. The size of cemental tear had an average length of 3.8 mm, width of 2.2 mm, and thickness of 0.9 mm. The separations of cemental tears occurred at cementodentinal junction (77.6%) relative to cementum (22.4%). The adhered soft tissue was either granulation tissue (92.3%) or cyst (7.7%). **Conclusions:** Cemental tear mainly occurs in incisors of male and older persons. It is also popularly noted in the apical region mimicking an endodontic lesion and some with cystic change. Clinically, endodontists should know this disease entity, make accurate early diagnosis, and totally remove the cemental tear during apical surgery to improve the prognosis. *(J Endod 2012;38:1058–1062)*

Key Words

Apical lesion, cemental tear, cementodentinal junction, fracture, histopathological examination

Cemental tear is a special type of root surface fracture that is rarely reported in the periodontal and endodontic literatures (1–6). It is a diagnostic challenge to clinicians because of its varied presentations, and it looks like a solely periodontal or periapical infection (5). The mechanism by which cemental tear develops is currently not fully known and has been attributed to several etiologic factors including age, traumatic occlusion, traumatic event (7, 8), or attrition (6). After more than 20 years of collecting data, Lin et al (6) indicated that the presence of post and core as well as the history of traumatic injury showed little association to cemental tears. They also demonstrated that gender, age, tooth type, and attrition were the predominant predisposing factors of teeth with cemental tears. In addition, tissue swelling, localized deep pocket, pulp vitality, periodontal/periapical bony destruction, and radiographic imaging were the major clinical characteristics of teeth with cemental tears (6). Although information about the incidence of cemental tear in a population is still not available, recently published data indicate that this disease entity is more common than we had believed, particularly in older individuals (1, 2, 7, 8). Failure to locate cemental tear and treatment earlier will result in severe localized periodontal and periapical bony destruction and affect the prognosis of teeth. Therefore, accurate assessment of cemental tears in morphology, histology, and radiographs has great clinical significance.

Clinical studies empirically documenting the size of cemental tear were scant. Previous reports revealed that the size of the fragments emerged as the following results: range of 2–10 mm in length, range of 1–6 mm in width (1, 4, 5, 9–12), and range of 0.5–0.6 mm in thickness (1, 4, 7). In those cases that have been published, the shape of the most fracture fragments was small/thin piece-like or sheet-like involving 1 root surface. However, the presence of a concave surface fragment in left mandibular second premolar was first mentioned in the literature by Haney et al (1) in 1992 and later named as U-shaped fragment offending >1 root surface (4). For the mesiodistal location, Tulkki et al (5) pointed out that the radiopaque "foreign body" was noted on the distal root surface of periapical radiographs (1, 9). Camargo et al (13) found that the sheet-like cemental fragments appeared simultaneously on the buccal, distal, and palatal aspects of the root during surgical exploration. Moreover, Stewart and McClanahan (4) have shown that the fragment perfectly matched an area denuded of cementum on the distolingual root surfaces of extracted tooth. Ishikawa et al (2) studied the apicocoronal location of cemental tear by using radiographic images. They presented 5 cases of cervical and 1 apical cemental tear and suggested that the process of aging and continuous occlusal strain might result in tearing of cervical cementum. Müller (3) reported a tiny, chip-like radiopaque particle, but it was in

From the *Dental Department, Show Chwan Memorial Hospital, Changhua; †Biostatistics Laboratory, College of Public Health, National Taiwan University, Taipei; ‡Biomedical Science Team, Chang Gung University of Science and Technology, Taoyuan; §Graduate Institute of Clinical Dentistry, College of Medicine, National Taiwan University and National Taiwan University Hospital, Taipei; and ‖Department of Periodontics, Chang Gung Memorial Hospital and Chang Gung University, Taipei, Taiwan.

Hsueh-Jen Lin and Shu-Hui Chang contributed equally to this work.

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Address requests for reprints to Professor Jiiang-Huei Jeng, Department of Dentistry and School of Dentistry, National Taiwan University Hospital and National Taiwan University Medical College, No. 1, Chang Te Street, Taipei, Taiwan; or Dr Chiu-Po Chan, Department of Dentistry, Chang Gung Memorial Hospital, Taipei, Taiwan. E-mail address: jhjeng@ntu.edu.tw or carol@adm.cgmh.org.tw

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the middle portion of the mesial aspect of the root surface. However, because of the limited number of sample size, the characteristics of fracture sites and the morphology and histology of cemental tears are not clearly clarified.

Because the apicocoronal location of fracture sites, the size, morphology, and involved root surfaces, and the histologic split sites of cemental tear might potentially affect its clinical diagnosis, accessibility of lesion, and the treatment outcomes, we therefore designed this retrospective study to evaluate the fractured sites and the morphologic and histologic characteristics of cemental tear. The results of this study might highlight our understanding of the pathogenesis of cemental tear and improve its clinical diagnosis and treatment.

Materials and Methods

Collection of Teeth

The material was collected during 1987–2009 and consisted originally of 71 teeth (54 incisors, 9 premolars, and 8 molars) as described before (6). The age, gender, and tooth type were recorded. The diagnosis of cemental tear was confirmed on inspection of extracted teeth, during periapical surgery, or during periodontal surgery. To be included in the study, the tooth had to be presented with a cemental tear by histologic examination. Seventeen specimens did not fulfill these criteria and were excluded. This project was approved by the ethics committee, Chang Gung Memorial Hospital.

Surgical Examination

The length, width, thickness (mm), shape (piece-shape or U-shape), mesiodistal location (buccal/labial, palatal/lingual, proximal), and apicocoronal location of separated root fragment were determined by direct inspection during treatment and by measurement of removed cemental fragment.

Histologic Examination

After measuring the size of cemental tear, the specimens were immediately fixed in 10% buffered formalin and decalcified before processing. Serial paraffin-embedded horizontal sections were stained with hematoxylin-eosin, followed by observation with light microscopy. Meanwhile, soft-tissue adherence (granulation tissue or cyst) and histologic split site were also observed. The innermost layer intensely stained by hematoxylin was observed under microscope as the interfacial layer of cementum-dentin interface. Because a true cementodentinal junction is never broken by routine histologic processing (14), this structure is considered as the cementodentinal junction (7, 14).

TABLE 1. Univariate Analysis of Clinical Parameters (n = 54)

Variables	Analyzed samples, N (%)	χ^2 test statistic*	Degree of freedom	*P* value
Demography				
Gender	54	12.52	1	.0004†
Female	14 (25.9)			
Male	40 (74.1)			
Age (y)	54	53.963	4	<.0001†
<50	9 (16.7)			
50–60	6 (11.1)			
60–70	11 (20.4)			
70–80	21 (38.9)			
>80	7 (13.0)			
Tooth type	54	35.963	2	<.0001†
Incisors	40 (74.1)			
Premolars	8 (14.8)			
Molars	6 (11.1)			
Surgical examination				
Length	52	19.692	2	<.0001†
$0 \leq x < 3$ mm	16 (30.8)			
$3 \leq x < 6$ mm	31 (59.6)			
$x \geq 6$ mm	5 (9.6)			
Width	52	19.229	2	<.0001†
<2 mm	21 (40.4)			
2–4 mm	28 (53.8)			
>4 mm	3 (5.8)			
Thickness	52	19.231	3	.0002†
0–0.5 mm	8 (15.4)			
0.5–1.0 mm	18 (34.6)			
1.0–1.5 mm	23 (44.2)			
>1.5 mm	3 (5.8)			
Mesiodistal location	54	43.889	2	<.0001†
Proximal	43 (79.6)			
Buccal	4 (7.4)			
Palatal	7 (13.0)			
Apicocoronal location	53	9.755	2	.0076†
Cervical 1/3	7 (13.2)			
Middle 1/3	24 (45.3)			
Apical 1/3	22 (41.5)			
Shape	53	15.868	1	<.0001†
Piece-shaped	41 (77.4)			
U-shaped	12 (22.6)			

*Goodness-of-fit test.

†Statistically significant difference.

Statistical Analysis

Descriptive and univariate analyses were performed by using SPSS 15.0 software for Windows (SPSS Inc, Chicago, IL). To investigate the atypical prospects among the groups of each variable (gender, age, tooth type, length, width, thickness, shape, mesiodistal location, apicocoronal location, soft-tissue adherence, and histologic split site), a series of the Poisson χ^2 goodness-of-fit tests were conducted to test for a fit of a discrete, uniform distribution.

Results

Collection of Teeth

Among the 71 teeth, 54 (40 incisors, 8 premolars, and 6 molars) were presented with cemental tear by histologic examination. The descriptive analysis of these teeth demonstrated that 74.1% of the tears (40 of 54) were found in male patients, and 25.9% (14 of 54) were in female patients ($P < .05$). The average age of patients with cemental tears was 66.1 ± 12.4 years.

Surgical Examination

Table 1 describes the number and frequency distribution of variables of gender, age, tooth type, length, width, thickness, shape, mesiodistal location, apicocoronal location, soft-tissue adherence, and histologic split site. The assessment of these cemental fragments indicated that the metrological values were as follows: (1) length ranging from 1.5–8.0 mm with an average of 3.8 mm (standard deviation [SD], 1.6 mm); (2) width ranging from 1.0–5.0 mm with an average of 2.2 mm (SD, 0.8 mm); and (3) thickness ranging from 0.3–3.0 mm with an average of 0.9 mm (SD, 0.6 mm). Most cemental tears occurred in the proximal root surfaces (79.6%). The location of cemental tear might be noted in the cervical, middle, or apical third of root surface (Fig. 1). Although cemental tears were present mainly in the middle third of root (45.3%), 41.5% of cemental tears were noted over the apical region. Morphology of cemental tear was piece-shaped in 77.4% cases and U-shaped in 22.6% cases (Table 1; Fig. 1*E*).

Histologic Examination

All the biopsy specimens showed the presence of cementum. The innermost fracture near the cementodentinal junction was visible in 38 samples (77.6%), suggesting not an artifact caused by periodontal treatment. Among the 54 teeth, the histologic split sites in 5 specimens (3 male, 2 female) were not obviously identified by the pathologists and were excluded (Table 2). Histologic examination of the specimens at low magnification revealed that fragments were composed mainly of mineralized cementum, unmineralized periodontal tissue, and adherent soft tissue. Higher magnification revealed that the torn fragment consisted of remnants of the periodontal ligament, including fibers and vital connective tissue cells, as well as cementum. The cementum exhibited a normal lamellated appearance, some with

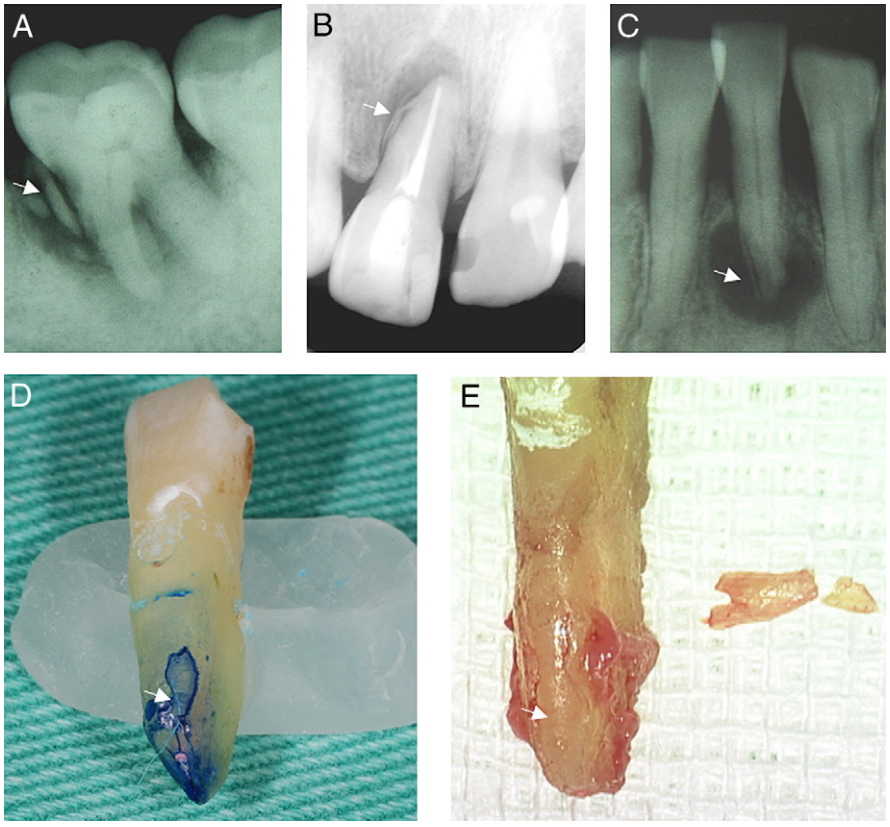

Figure 1. (*A*) Radiograph from 47-year-old female patient showing distinct angular bony defect containing 3 radiopaque cemental tear fragments on mesial-cervical aspect of left mandibular first molar. This is like a periodontal lesion. (*B*) Periapical radiograph of right maxillary central incisor in 45-year-old male patient. A longitudinal radiolucent fracture line on middle portion of distal root surface was noticed mimicking an endodontic lesion. (*C*) A 76-year-old man was referred to our clinic with chief complaint of pain in left mandibular central incisor. Radiographic appearance of left mandibular central incisor showed periapical radiolucency and radiolucent fracture line over the apical region of the root mimicking an endodontic lesion as analyzed by electric pulp test. (*D*) The mandibular central incisor from 58-year-old male patient immediately after extraction and methylene blue staining. A cemental tear on the labial surface to mesial aspect near root apex was noted. (*E*) The extracted tooth with U-shaped cemental tear (*arrow*) from 56-year-old female patient. *Arrows* indicate cemental tears.

TABLE 2. Univariate Analysis of Histopathologic Parameters

Variables	Analyzed samples, N (%)	χ^2 test statistic*	Degree of freedom	*P* value
Histopathologic examination				
Histologic split site	49	14.876	1	.0001†
Cementodentinal junction	38 (77.6)			
In cementum	11 (22.4)			
Soft tissue	52	37.231	1	<.0001†
Granulation tissue	48 (92.3)			
Radicular cyst	4 (7.7)			

*Goodness-of-fit test.
†Statistically significant difference.

cellular elements (cementum lacunae) (Fig. 2*A* and *B*) (14). Only 7.7% of adhered tissue was cyst, and 92.3% was observed to be granulation tissue (Table 2; Fig. 2*B* and *C*).

Discussion

Cemental tear is more common than we have believed, particularly in older individuals (6, 7, 15). However, cemental tear was seldom reported before possibly because of misdiagnosis, leading to the eventual extraction of affected teeth. In this study, cemental tear occurred mainly in male and older patients (age, >60 years). Incisors are the major affected teeth. This finding is generally consistent with our previous study (6). Whether excessive occlusal force of male patients in anterior single-rooted teeth is a predisposing factor of cemental tear should be further addressed by collection of more cases for study. Before and during endodontic treatment, radiographs should be carefully evaluated for the presence of cemental tears, especially for referral cases, and symptomatic teeth that are not responsive to conventional endodontic treatment. Extensive apical surgery might be difficult in some older patients with severe systemic diseases. Instead of extraction, intentional replantation is one alternative choice for that kind of case with success (16).

To know more about the pathogenesis of cemental tears, we analyzed their length, width, thickness, shape, mesiodistal location, apicocoronal location, and histologic split site. The size of cemental tear has a popular range of length of 3.0–6.0 mm, a width of 2.0–4.0 mm, and a thickness of 1.0–1.5 mm (44.2%, 23 of 52) and 0.5–1.0 mm (34.6%, 18 of 52). Previous reports suggested that the thickness of cementum increases throughout life and has been reported to vary, on the average, from 50 μm in the cervical region up to 600 μm apically (7). One possible explanation is that thickened cementum in older individuals is prone to fracture relative to younger individuals. Interestingly, light microscopic examination of this study revealed that the separations were more often noted along the cementodentinal junction when compared with separations within cementum (77.6%, 38 of 49 versus 22.4%, 11 of 49). However, the histologic material was collected by using very different methods such as tooth extractions, endodontic surgery, and periodontal treatment. The cementum could have been damaged during any of these treatments and possibly affect the validity of the specimens. Although the fractured root fragments were carefully inspected and removed during treatment in this study, more standardized procedures should be developed for future studies on the etiology of cemental tear. Physicochemical changes of the cementodentinal junction during aging have been recognized that might weaken the adhesion of proteoglycans and attachment (15). In addition, the increased fibrosis and the decreased extensibility of collagen make the cementum of older patients susceptible to separation (1, 7, 15). Consequently, fragments that separate along cementodentinal junction should be more frequently observed than those split within cementum.

Analysis for mesiodistal position demonstrates that the majority of cemental tears are on the proximal aspect of root surfaces. This finding implicates the possible early detection under radiographs if some displacement of cemental tears is present. For apicocoronal location, Ishikawa et al (2) indicated that cemental tears were frequently seen in the cervical third. However, we found that cemental tears occurred more often in the middle third (45.3%) and apical third (41.5%) of root surface relative to cervical third. Our data support the idea that for an anterior tooth, continuous excessive stress (such as attrition) could lead to cementum separation on the thicker site (such as the apical third) or on the tensional area (such as the middle third) (3, 6, 10, 15). Moreover, when considering the exerting of excessive tensional forces on the posterior teeth, other factors such as direction of occlusal forces (vertical or lateral force), number of roots, dentition integrity, and distal vertical support might also contribute to these events. It should be noted that in 22 of 53 cemental tears (41.5%), the separated fragments were located in the apical third. Whereas a previous report suggested that cemental tear is associated mainly with periodontal disease (7), our results reveal that cemental tear is not only a periodontal disease entity but also an endodontic disease

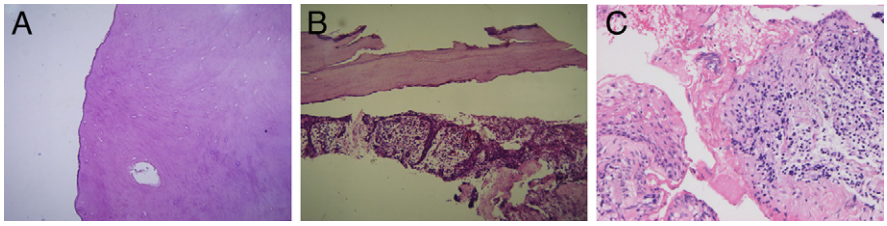

Figure 2. Photomicrographs of cemental tear fragments. (*A*) Cemental tear was removed from 44-year-old male patient in left maxillary lateral incisor. Photomicrograph of section showed cellular cementum. (*B*) After surgical removal of cemental tear from patient in Figure 1*B*, histologic examination of cemental tear removed from distal side of central incisor (Fig. 1*B*) revealed acellular cementum, granulation tissue, and an intensely stained cementodentinal junction layer. (*C*) Photomicrograph of soft tissue adhered to cemental tear in left central incisor of 55-year-old female patient revealed a radicular cyst.

entity. Because total debridement of cemental tear is important for successful treatment, nonsurgical endodontic therapy and even apical surgery should be conducted in some cases.

The analysis of fragment shape revealed that 12 cemental tears (22.6%, 12 of 53) were classified as U-shaped fractures. Clinically, the U-shaped cemental tear might impair the prognosis of treatment outcome possibly because of the greater extent of periodontal destruction and difficulty of total removal of fractured root fragments during periodontal and periapical surgery (10). Although most of the soft tissue adhered on cemental tear was shown to be granulation tissue (92.3%), 4 specimens were reported to be cyst, further supporting the correlation between cemental tear and endodontic lesions.

In conclusion, results in this study highlight the following observations. Cemental tear that occurred in middle third and apical third of root surfaces is significantly predominant. The fracture most likely occurs along the cementodentinal junction. The presence of U-shaped fragments, apical location, and cyst tissue adherence to cemental tear suggest the importance of this disease entity during endodontic practice. Further investigations are required to know more about the pathogenesis and characteristics of cemental tear and their influence on the prognosis of teeth.

Acknowledgments

The authors deny any conflicts of interest related to this study.

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