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Review Article

Cemental tear: To know what we have neglected in dental practice



Po-Yuan Jeng^a, Arlinda Luzi Luzi^{a,**}, Rocio Marco Pitarch^{a,***},
Mei-Chi Chang^{b,c,f}, Yu-Hsueh Wu^d, Jjiang-Huei Jeng^{e,*}

^a Department of Dentistry, Universidad CEU Cardenal Herrera, Valencia, Spain

^b Chang Gung University of Science and Technology, Kwei-Shan, Taoyuan City, Taiwan

^c Department of Dentistry, Chang Gung Memorial Hospital, Taipei, Taiwan

^d Department of Dentistry, Far Eastern Memorial Hospital, New Taipei City, Taiwan

^e School of Dentistry, National Taiwan University Medical College and Department of Dentistry, National Taiwan University Hospital, Taipei, Taiwan

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Cemental tear is a special kind of root surface fracture, contributing to periodontal and periapical breakdown. However, it is a challenge for doctors to diagnose, resulting in delayed or improper treatment. We reviewed the predisposing factors, location, radiographic/clinical characteristics, diagnosis and treatments of cemental tears. From the literature, patients with cemental tear were mainly males, over 60 year-old. Possible predisposing factors include gender, age, tooth type, traumatic occlusal force and vital teeth. Cemental tears were common in upper and lower anterior teeth, single or multiple, and can be present in cervical, middle and apical third of roots. Morphology of cemental tears can be either piece-shaped or U-shaped. Clinically, cemental tear shows a unitary periodontal pocket and signs/symptoms mimicking localized periodontitis, apical periodontitis and vertical root fractures. Treatment of cemental tears include scaling, root planning, root canal treatment, periodontal/periapical surgery, guided tissue regeneration, bone grafting, and intentional replantation. Recurrence of cemental tear is possible especially when the fracture involves root apex. Extraction is recommended for teeth with poor prognosis. In conclusion, cemental tears can involve both periodontal and

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* Corresponding author. School of Dentistry, National Taiwan University Medical College and Department of Dentistry, National Taiwan University Hospital, No 1, Chang-Te Street, Taipei, Taiwan.

** Corresponding author. Department of Dentistry, Universidad CEU Cardenal Herrera, Pou de condesa road, Number 5, 46115, Alfara del Patriarca, Valencia, Spain.

*** Corresponding author. Department of Dentistry, Universidad CEU Cardenal Herrera, Pou de condesa road, Number 5, 46115, Alfara del Patriarca, Valencia, Spain.

E-mail addresses: arlinda.luzi@uchceu.es (A.L. Luzi), rocio.marco@uchceu.es (R.M. Pitarch), jhjeng@ntu.edu.tw (J.-H. Jeng).

^f Equal contribution to first author.

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periapical area. Dentists should understand the predisposing factors and clinical features of cemental tears for early diagnosis/treatment to prevent bone loss/tooth extraction.

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Introduction

Cemental tear is a special type surface root fracture involving cementum and sometimes the root dentin (Fig. 1A–F).^{1,2} It leads to appearance of a deep pocket, retaining plaque and calculus, and eventually causing periodontitis.^{2–5} Cases of cemental tear are rarely reported in the literature because the presence of this disease is often neglected, misdiagnosed and under-reported. Dentists may treat these clinical cases as pure periodontal and periapical lesions due to misdiagnosis of cemental tears. In some cases, the presence of cemental tear was realized after the extraction of non-healing teeth.^{1,2,6} Some failed cases with unknown reason, are due to the presence of cemental tear.

Cemental tear may present difficulty in clinical diagnosis. It may involve periodontal and periapical tissue breakdown, soft tissue swelling, pain and sinus tract with exudation (Fig. 1A–F). Case reports showed that clinicians treated the teeth with cemental tears by non-surgical periodontal treatment, root canal treatment or/and non-surgical retreatment alone are often not effective to eradicate this disease.^{3,7–9} If dentists could have diagnosed the cemental tear properly, unnecessary treatment and further bone loss could be avoided. The clinicians as well as their patients could have spent less money, time and effort in resolving the situation.

The clinical features, diagnostic skills and differential diagnosis of cemental tears should be summarized and emphasized. However, limited information was recorded in the published literature. Cemental tear is often not mentioned or deeply discussed in the periodontal or endodontic textbooks. The aim of this study is to review the predisposing factors, location, clinical features, diagnosis, morphology, histology and management of cementum tears.

Epidemiology and predisposing factors of cemental tears

The prevalence, incidence, etiology and mechanisms of cemental tear in general population is unknown. The reported cases were mainly males, and it is more common in patients over 60 year-old. However, several factors are suspected to be the predisposing factors as summarized in Table 1, including age, gender, tooth type, trauma from occlusion and vitality of teeth.^{1,5,10–12}

Age

Age is considered to be a predisposing factor for cemental tear (Fig. 1C–F), indicating the changes in cementum/

dentin during aging. Most cases report were in patients over 50 year-old. According to the study of Lin et al. (2011), among 71 patients, 10 (14.1%) were over 80 year-old, 29 (40.9%) were 70–80, 13 (18.3%) were 60–70 years old, and 19 were below 60.¹ A possible explanation is the cementum changes through aging.^{2,5,10} Throughout life, the thickness of cementum in elders and teenagers differ 3 to 5 times, depending on the root portion and tooth type.^{13–15} In elder 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.

Gender

Regarding sex, cemental tear occurred more frequently in male patients. In the study of Lin et al. (2011), among 71 patients with cemental tears, 55 (77.5%) were male, while 16 were female. The relationship between sex and cemental tear showed a statistically significant difference (P -value < 0.001).¹ Up to now, there was no obvious explanation for this relation. Probably, males have stronger occlusal forces than females or there are intrinsic differences of cementum between genders. But more cases should be collected for further analysis.

Dental trauma

Although most cases are over 50 year-old, a 22 year-old male patient with cemental tear on the central incisor was reported.⁶ Apparently, there could be other predisposing factors. The anamnesis of the patient included a history of trauma during wrestling with a sibling. Also, a case of cemental tear on a central incisor, which the patient was hit by a baseball 20 years ago.⁹ In the study of Lin et al., only 6 patients recalled a history of traumatic injury.¹ Traumatic event such as acute injury is often described as a factor of cemental tear.^{1,2,5,10,11} 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.¹⁶ Cementum is more susceptible to separate from the dentin under excessive force. However, in the study of Lin et al., most patients (57/63) patients had no memory of

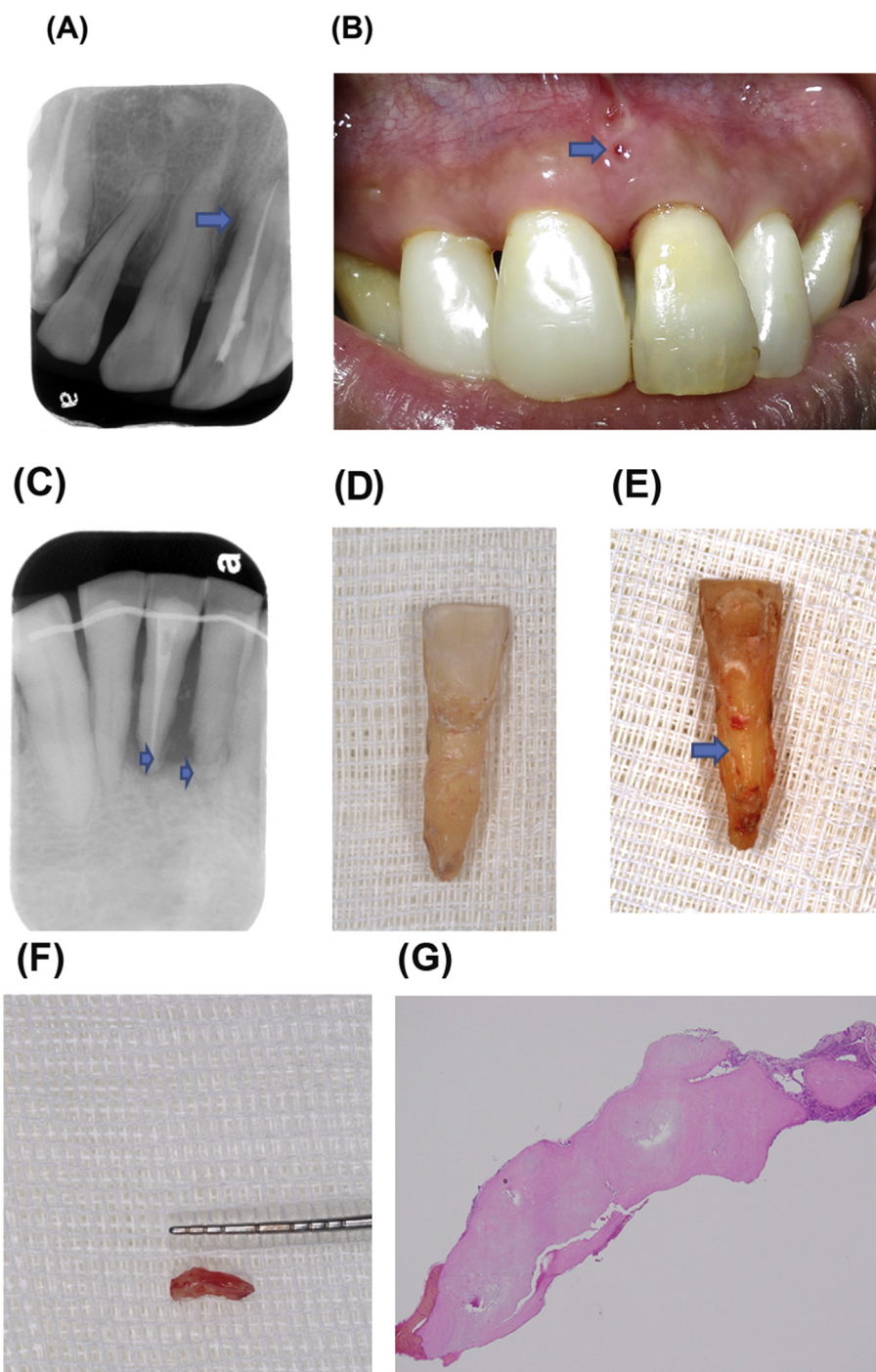


Figure 1 (A) A 55 years-old female referred to Endodontic Clinics for evaluation of endodontic retreatment for #21 on 2016. Clinical examination found periodontal abscess around #21, with deep pocket and sinus tract. Radiographic examination showed prior endodontic treatment of #21, periodontal bony destruction, and a piece-shape cemental tear located around the base of bony destruction, (B) After scaling and subgingival curettage, swelling subsided. But deep pocket, bony destruction, and a small sinus tract are still present. No endodontic retreatment was given for this case. (C) A 79 year-old male was referred from local dental clinic due to persistent abscess of #31 after root canal treatment on Nov. 2016. The patient had no dental trauma history, and an abscess and deep pocket over lingual side was noted. Temporary splinting was given. Radiographic examination showed the presence of periodontal and apical bone loss with cemental tear over #31, 32 (arrows) as well as cone beam CT (data not shown). After non-surgical periodontal treatment, abscess subsided, (D) Recurrent abscess was noted over #31 on May 2017. So extraction of #31 was performed. The buccal side picture of extracted #31 was shown. (E) The lingual side picture of extracted #31 revealed a concave defect with well-demarcated margin (arrow) showing the site of cemental tears. (F) The removed cemental tear fragment. (G) Histopathological examination showed the presence of mainly cellular cementum and diagnosis of cemental tear.

Table 1 Possible predisposing factors of cemental tears.

Age – Mainly in elder person ^{1,2,4,5,10,22}
Gender – Mainly in male ¹
Trauma from occlusion ^{11,12,17,22}
Tooth vitality: Mainly in vital (non-endodontically-treated) teeth ^{1,2,11}
Tooth position: Mainly in upper and lower anterior teeth ^{1,2,4,11,22}

dental trauma, implying that traumatic injury is not the main cause of cemental tear.^{1,2}

Trauma from occlusion

Another predisposing factor is trauma from occlusion,^{11,12,17} including para-functional habits (e.g. bruxism), inadequate/severe occlusal loading and excessive tensional force. 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,¹ suggesting that single root and anterior teeth with occlusal (protrusive or lateral) forces are the possible predisposing factor of cemental tears.

Prosthesis

Prosthesis may increase the occlusal loading of abutment teeth. It also affect the periodontal status and the long-term prognosis of the teeth, especially when high occlusal loadings are present.^{18,19} Also, according to several studies, the stress of fixed bridge is concentrated at the cervical area of the tooth, as well as the connector.^{20,21} A case of cemental tear on an abutment of a three-unit fixed bridge (from tooth #3.5 to #3.7) was reported.²² The tear was located extending from the cervical third to the middle third of tooth #35 (lower left second premolar). Another two cases of cemental tear on an abutment tooth were also reported.^{12,23} Posterior teeth carry more occlusal load than anterior teeth. If the hypothesis that high occlusal loading contributes to cemental tear, there should be a higher incidence of cemental tear in the posterior teeth. Lin et al. collected 16 cases of cemental tear with prosthesis, but the locations of the cemental tear were not available in the article.¹ Whether the presence of prosthesis increases the risk of cemental tear remains unknown.

Root canal treatment

Other possible predisposing factors are previous periodontal treatment and endodontic treatment. But cemental tears are found mainly in non-endodontically-treated (vital pulp) teeth.^{1,2} This is very different from vertical root fracture (VRF), which presents mainly in endodontically-treated teeth,²⁴ suggesting the mechanisms of root fracture in cemental tears and VRF can be different. Possible explanations are that root canal treatment is unrelated to cemental tear or that root canal treatment prone the teeth to VRF easier than the induction of cemental tear.

Clinical characteristics of cemental tears

Location of cemental tear

For tooth type, anterior teeth (incisors) were the most commonly affected by cemental tear.^{1,2} Leknes et al. reported 22 teeth with cemental tear, in which 18 (81%) were anterior teeth and 4 were premolars.⁴ Ishiwaka et al. (1996) also obtained similar results.²² In addition, the frequencies of cemental tear in maxillary or mandibular teeth are nearly the same. Among the 71 cases, 36 were maxillary teeth while 35 were mandibular teeth.¹

Cemental tear can appear in the coronal, middle and apical portion of the root. Cemental tears are more common in the middle (45.3%) and apical third (41.5%) of the root. The signs and symptoms of cemental tears were mimicking solely periodontitis or apical periodontitis.² Interestingly, available case or case series reports rarely referred cemental tear in the apical third area.^{4–12,22,23,25–28} This difference is probably because most of the early cases were reported by periodontists but not endodontists. A special U-shaped type cemental tear in the apical area of affected teeth with concomitant apical periodontitis symptoms and signs were reported,^{1,2,12} indicating cemental tear is also an endodontic entity. About 77.4% cemental tears are piece-shaped, whereas 22.6% are U-shaped, mainly in the apical area.²

As for the mesio-distal location, cemental tears are the most frequently located on the proximal surfaces (79.6%),² because of their easily detected by radiographic examination. In addition, most cases present one cemental tear per individual.¹³ But two or more cemental tears can be also noted in the same patients.^{11,22,25,27}

Clinical features of cemental tears

Generally, the clinical features are summarized in Table 2. The most common clinical characteristic of cemental tear is an increase in periodontal probing depth, bleeding upon probing, gingival swelling and suppuration, periodontal or apical abscess and bony destruction, tooth mobility, unresponsive to root canal treatment, can affect multiple teeth and possible recurrence (Fig. 1A and B).^{1,11,12,17,29} Most cemental tears have periodontal pocket deeper than 6 mm. The site of deep probing is related to the location of cemental tear. The swelling can be painless or painful.¹ Interestingly, most of the cemental tears were found in vital teeth without prior endodontic treatment.^{1,2} In addition, greater gingival recession and attachment loss were seen on the root surface with cemental tears than intact cemental surfaces.^{4,10} On palpation and percussion, mobility and fremitus may be noticed. However, the presence of cemental tears (especially U-shaped) often lead to periodontal and periapical tissue breakdown. But the symptom and signs are still present even after non-surgical periodontal and root canal treatment. Recent studies have shown the apical involvement of cemental tears and concomitant apical periodontitis.^{1–3}

More specifically, a radiopaque, thin, vertical, intra-bony body, parallel to the root surface is often noted on radiographs (Fig. 1), whereas displacement of the fractured

Table 2 Clinical features of cemental tears.

General features	<ol style="list-style-type: none"> 1. Deep, unilateral periodontal pocket. 2. Pulp response is often vital. But non-vital is also possible due to misdiagnosis. 3. Periodontal or apical bony destruction, with possible tooth mobility. 4. Unresponsive to endodontic treatment. 5. Gingival swelling, sinus tract and exudation. 6. Pain. 7. Can affect multiple teeth. 8. Possible recurrence.
More specific features	<ol style="list-style-type: none"> 1. A fractured cemental fragment can be noted from periapical radiographs. 2. Histopathological examination of cemental tears fractured at cemento-dentinal junction. 3. Total removal of fractured cemental tear is crucial for treatment success.

fragment is also possible. In most cases, loss of surrounding bone with evident periodontal and apical lesions is noticed.^{1,4,10} If cemental tear is not successfully treated, more bony destruction will lead to extraction of the tooth eventually.

Diagnosis and differential diagnosis

Cemental tear requires differential diagnosis with ① Periodontal disease without cemental tear ② Vertical root fracture ③ Endodontic-Periodontal lesion. Especially in case of a unitary pocket, clinicians should diagnose the lesion carefully. Clinically cemental tears usually accompanied by deep pocket, abscess, periodontal and periapical bony destruction, detection fractured fragments on radiographs is important to make differential diagnosis with solely periodontitis, apical periodontitis and vertical root fracture. In general, 80.0% (36/45) of teeth could be correctly diagnosed before treatment through careful examination.^{1,2} While a tentative diagnosis of cemental tear

can be easily observed under periapical radiographs, taking the fractured fragments during scaling/root planning, periodontal and apical surgery for histopathological examination are better for confirmation.

The differential diagnosis between cemental tear and vertical root fracture (VRF) is summarized in Table 3. Both VRF and cemental tear show a deep, isolated periodontal pocket, periodontal/apical bony destruction, and gingival swelling. VRF usually occurs in endodontically treated teeth,^{24,30,31} while cemental tear occurs in both vital teeth and endodontically treated teeth.^{1,2} For diagnosis, patients may be asked about the diet, trauma history, and onset of swelling and pain. VRF is most common in the buccal-lingual direction,^{30,31} while cemental tear is more common in the proximal surfaces. Deep pocket is present on the site of cemental tears, whereas deep pocket may be unilateral or on two opposite sides of the same affected tooth.³⁰ Both cemental tears and VRF show similar radiolucent lesions. Cemental tear may also require one or more radiographs to show a thin fragment on the root surface for confirmation. VRF are not often discernible by periapical radiographs unless displacement of fractured root fragments is present.³¹

In several cases reports, teeth with cemental tears are treated endodontically but in vain, due to misdiagnosis or apical involvement.^{3,6–9,12} When these lesions have reached an advanced stage, these teeth should be extracted. In teeth without previous root canal treatment, the differential diagnosis is easier. Instead, the pulp vitality test provides useful information. Cemental tears mostly do not affect the pulp status, while problems of endodontic origin show pulpal inflammation or necrosis. Palpation, percussion and mobility test do not indicate pulpal or periodontal origin, but may help localizing the tooth with pathology.^{32,33} 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.^{32,33} In contrast, the swelling of cemental tear is traced to the root surface, depending on the apico-coronal location of the fragment. It would be traced close to the apex, if the cemental fragment is at the apical 3rd area. The bone destruction of endodontic origin can be around

Table 3 Differential diagnosis and treatment between cemental tear and vertical root fracture.

	Cemental tear	Vertical root fracture
Tooth type	Mainly in anterior teeth	Mainly in molars
Tooth vitality	Mainly in vital teeth (also some in non-vital teeth).	Usually in endodontically-treated teeth with/without post
Probing	One isolated deep pocket, narrow or wide	One or two isolated, deep pockets on opposite side of a tooth, narrow
Location	More common on proximal surfaces or around root apex	More common in buccal-lingual direction
Radiographic examination	A thin radiopaque fragment along the root surface	Fractured fragments Cannot be detected in radiograph unless displacement is present.
Prosthesis	Without prosthesis in most affected teeth	With/without prosthesis
Treatment	Complete removal of fragment	Tooth extraction
Fracture Pattern	Surface root fracture	Fracture along vertical axis of root

the apex, at the furcation area, or along the root surface.³² Usually it has a broad base, forming a U-shape radiolucency.³³ That of cemental tear/periodontal disease is along the root, with the cervical area wide, forming a V-shape radiolucency. When deciding whether the problem is pulpal origin or not, the possible causes should be carefully evaluated. Possible causes of irreversible pulpitis and pulpal necrosis can be trauma, deep restorations, large caries and cracks.^{33,34}

Differential diagnosis is more challenging when the tooth is endodontically treated. If the cemental fragment is not clearly visible on the radiograph, and vertical bone loss is around the tooth, clinicians may consider as endodontic failure. For example, in the case of Damasceno et al. (2012), pain was present around a tooth with root canal treatment made 12 years ago. The clinician suspected an endodontic failure and performed non-surgical retreatment.⁸ He finally realized the lesion of cemental tear on the radiograph after the treatment, since the pain persisted. In the case of Stewart et al. treated a tooth endodontically three times, but the sinus tract did not resolve. They found out the cemental fragment during an exploratory surgery.⁶ Thus, before considering an endodontic failure, clinicians have to examine the radiographs carefully and look for possible explanations (e.g. poor root canal filling, missed canal, under-filled canal ...) and possible apical surgery for direct inspection.

To sum up, clinicians require a broad knowledge of dental and periodontal pathology, in order to diagnose and treat cemental tears. When a localized bone loss is present, one should take cemental tear into account as a possible cause.

Histological examination of cemental tear

The histological findings included cementum lamellae, cementocytes and adhered PDL fibers. The main structure of the specimens was lamellated appearance interrupted by a few globular structures.^{5,11} The lamellar structure suggested continuous cementum apposition throughout life. In some cases, granulation tissue or radicular cyst may adhere to the specimen.^{2,5} In addition, 77.6% of cemental fragments involved the cemento-dentinal junction, while 22.4% involved only the cementum.²

Treatment of cemental tears

The objective of the treatment is to remove the source of pathology and restore the structure and function of the affected tissue.¹⁰ The total removal of fractured cemental fragments is the most important for successful treatment of cemental tears. The treatment may include three mechanical methods: ① scaling and root planning or periodontal surgery (Fig. 1A and B), ② endodontic treatment + apical surgery, and ③ intentional replantation.³⁵ Sometimes the teeth should be extracted due to unpredictable or poor prognosis (Fig. 1C–1F).

Depending on the location of cemental tear and the severity of periodontal disease, clinicians may have different approaches. The cementum tear is evaluated radiographically before treatment. When the fragment is at the coronal third, it can be removed with non-surgical

treatment (scaling and root planning).^{7,8,22} However, when the fragment is in a deeper area or when non-surgical approach has failed, periodontal flap surgery may be required.^{5,7,8,10,23} If the fragment is at the apical third with accompanied apical periodontitis, one might need to perform endodontic treatment, then ostectomy at the apex level to expose the fragment, and then totally remove the fractured fragments during apical surgery. Before performing any surgical approach, one must attempt with non-surgical approach first.

After removal of the fractured cemental fragment, guided tissue regeneration (GTR) with/without bone grating can be used for repair and reconstruction of the periodontal and apical bony defects.^{3,7–10} Where cemental tears are difficult for complete removal, intentional replantation procedures can be done to save the tooth.³⁵ Some affected teeth should be extracted in advanced cases (late detection, misdiagnosis ...) with severe bone loss,³ to prevent further bony destruction and difficulty for future implant therapy.

Conclusion

Cemental tear has always been a diagnostic challenge for the clinicians. Early diagnosis is possible after understanding its clinical characteristics and predisposing factors and careful observation. In actually, cemental tear is not so rare and may affect the cervical, middle and even apical third of root surfaces mimicking periodontal and periapical lesion alone. Cemental tear mainly occurred in males over 60 year-old, in upper and lower anterior teeth, single or multiple adjacent teeth, and most of the fractured fragments can be carefully examined in periapical radiographs, perhaps also by cone beam computer tomography (CBCT), a new diagnostic tool in modern endodontic treatment. The fractured fragment of cemental tear can be a small/thin piece-shaped or U-shaped fragment especially involving the root apex leading to apical inflammation and even pulp necrosis.

Cemental tear can be detected through a careful examination of fractured fragments on radiographs and during non-surgical/surgical periodontal and apical surgery. Possible predisposing factors of cemental tear include gender, age, tooth type, traumatic occlusion, and mainly in non-endodontically-treated teeth. Clinically, it shows a unitary periodontal pocket and may present signs and symptoms simulating of localized periodontitis or apical periodontitis. It requires differential diagnosis with a solely periodontitis, endodontic lesions, VRF etc. Total debridement of fractured cemental fragment with/without prior root canal treatment is important for clinical success. This can be done by scaling and root planning or surgical debridement with/without GTR and bone graft. However, recurrence of cemental tear is sometimes noted due to further extension of the prior fractured sites. If the prognosis of affected tooth is unpredictable or poor, the teeth may be extracted.

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