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Research article

Clinical, radiographic features and prognosis of cemental tear: A retrospective study of 63 teeth☆

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ABSTRACT

Cemental tears are often misdiagnosed due to their scarcity. In this study, we reported the second largest cohort of cemental tears thus far. By reviewing the radiographic data and medical records of 63 cemental tear teeth, we found that periapical periodontitis was the most frequent diagnosis, followed by cracked tooth/root fracture and periodontitis. Most of the cemental tear teeth that did not have root canal treatment had vital pulp. The apical third of the root was the most prominent site of cemental tears. Cemental tears occurred more frequently in the palatal root of the maxillary molars and in the mesial root of the two-root mandibular molars. Uncontrollable bone loss and tooth mobility were the two main reasons for the extraction of teeth with cemental tears. We suggest that cemental tears should be included in the differential diagnosis of periapical periodontitis, cracked tooth, vertical root fracture and periodontitis, especially for teeth with periapical radiolucency and vital pulp. We believe our study could provide more insights into cemental tears, which will aid clinicians in the early diagnosis and proper treatment of cemental tears.

1. Introduction

Cemental tears, characterized by the partial or complete detachment of cementum from the cemento-dentinal junction or within the body of cementum on the tooth root [1,2] are often misdiagnosed as vertical root fractures, endodontic-periodontal lesions, or failed periodontal or endodontic treatment [3,4].

Due to the scarcity of their incidence, it is difficult to address questions related to cemental tears, including questions about their prevalence, etiology, treatment choices, and prognosis [5]. The diagnosis of cemental tears is challenging even for skilled dentists. Clinical signs such as rapidly progressing periodontal attachment loss, isolated deep periodontal pockets, persistent abscesses or sinus tracts, and negative response to periodontal or endodontic treatment should alert clinicians to consider cemental tears as a potential diagnosis [1,6]. Radiographically, cemental tears may present as radiopacities surrounded by radiolucency in areas of periodontal destruction, often involving the periapical region.

Here, we present the second largest cohort of cemental tears thus far. In this study, we aim to provide detailed clinical and radiographic descriptions to assist in the early diagnosis and treatment of these lesions.

☆ All authors gave their final approval and agreed to be accountable for all aspects of the work.

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Abbreviations

CBCT	cone beam computerized tomography
RCT	root canal treatment (RCT)
micro-CT	micro-computerized tomography

2. Methods and materials

2.1. Data acquisition

All 56821 cone beam computerized tomography (CBCT) scans taken in Nanjing Stomatological Hospital, Nanjing University from 1st January 2019 to 31st December 2021 were searched for cemental tears. The medical records for patients with teeth diagnosed with cemental tears were reviewed, and the chief complaint, primary clinical examination, and treatment information were extracted. Follow-up data were either extracted from the follow-up database for preserved cemental tears after treatment in our hospital or through phone calls for preserved cemental tears without treatment in our hospital. All patients were followed up again through phone calls in September 2022. Patients who complained of discomfort upon phone call follow-up were asked to return for further examination.

2.2. Ethics and consent

This study, approved by the Research Ethics Committee of Nanjing Stomatological Hospital, Medical School of Nanjing University (approval number: NJSH-2023NL-008), adheres to all regulations. Written informed consent was obtained from all patients who returned for clinical follow-up. Verbal informed consent, containing identical content to written consent as well as the consent to record the verbal consent, was recorded for those who did not return.

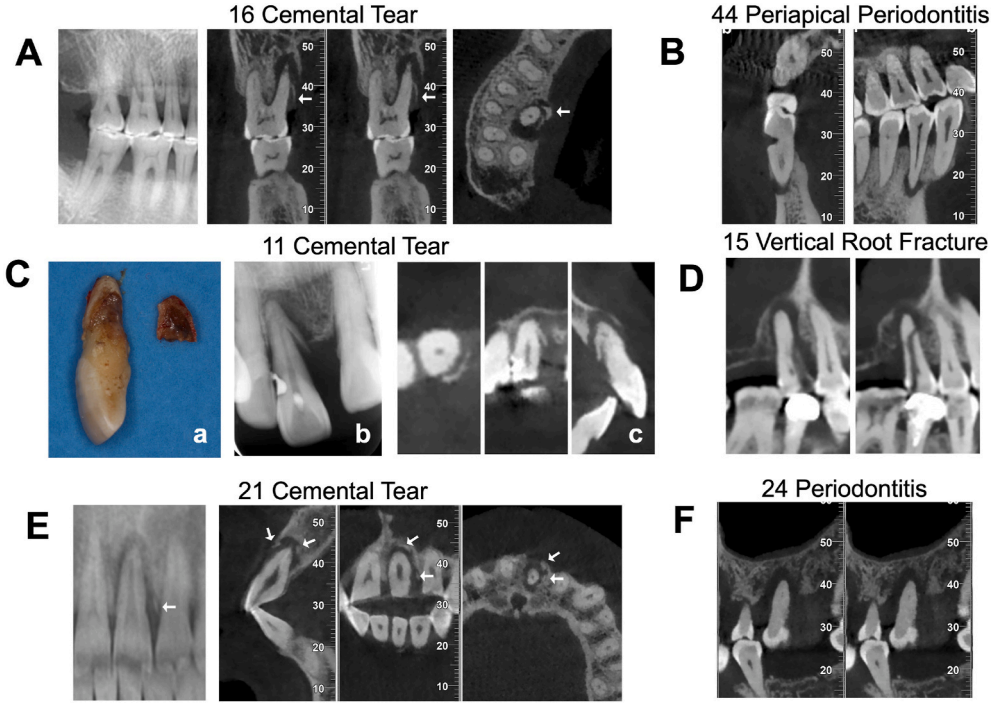

Fig. 1. Representative images depict cemental tear, periapical periodontitis, vertical root fracture, and periodontitis. A: Cemental tear on the palatal root of tooth 16, showing periapical radiolucency with no coronal lesion. B: Tooth 44 with periapical radiolucency and wedge-shaped lesion involving the pulp chamber. C: a. Extracted tooth 11 with detached cementum; b. Plain X-ray of tooth 11 displaying a crack between cementum and dentin; c. CBCT of tooth 11 revealing a crack between cementum and dentin (detached cementum). D: Tooth 15 with vertical root fracture, displaying a crack inside dentin. E: Tooth 21 showing detached cementum on the buccal and distal sides of the root (right, white arrows) with surrounding radiolucency. Only cementum on the distal side of the root is visible on the 2D image (left, white arrow). F: Tooth 21 with periodontitis exhibiting radiolucency around the root. CBCT: cone beam computerized tomography.

2.3. Patients and cemental tear teeth

Sixty-three teeth from 61 patients were diagnosed with cemental tears and included in our study. A 'prickle-like' (i.e., a fine, sharp, and vertical fragment) radiopaque mass adjacent to the affected root surface was diagnosed as a cemental tear [1,7–9], with partial or complete detachment of the cementum from the root (Fig. 1 A, C, E, white arrows). The average age was 61.54 ± 15.12, with 36 patients over 60 years old (59.02 %, Fig. 2A). The incidence of cemental tears was higher in males (33/61, 54.1 %) than in females (28/61, 45.9 %) in our patient group (Fig. 2B). The average follow-up time was 25.16 ± 11.88 months. Detailed information is shown in Fig. 2 and listed in Table 1.

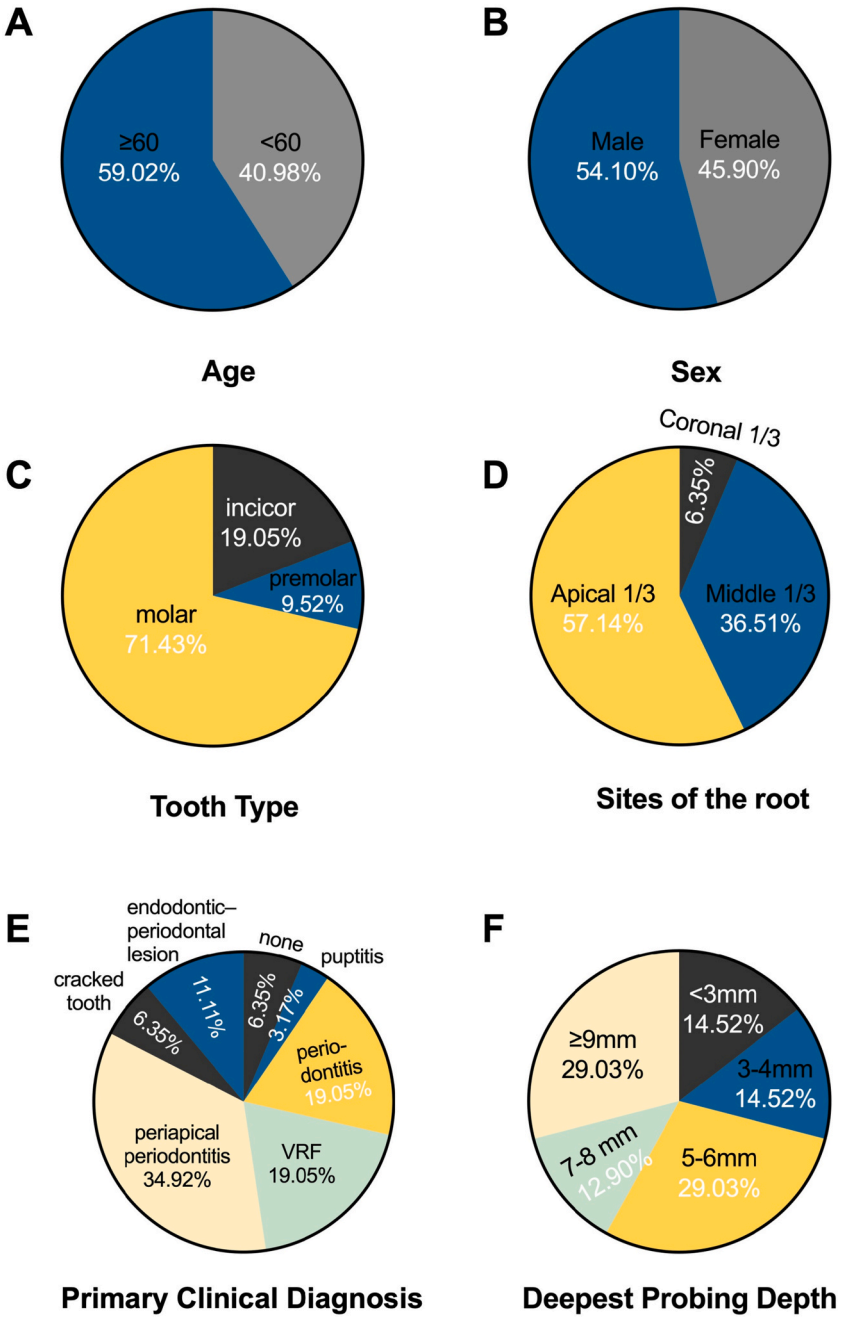

Fig. 2. Pie charts of cemental tear cases.
Pie charts depict various clinical factors in cemental tear cases, including age, sex, tooth type, root sites, primary clinical diagnosis, and deepest probing depth
VRF: vertical root fracture.

Table 1
Clinical features of cemental tears.

ID	Age	Sex	Tooth	Primary Clinical diagnosis	Previous RCT	Pulp vitality	Sinus tract	Tooth Mobility	Antagonist	Deepest probing depth (mm)	Treatment	Prognosis
1	39	M	36	periapical periodontitis	Yes	No	Yes	II	tooth	7	Extraction	Extracted
2	52	F	26	vertical root fracture	Yes	No	No	–	tooth	5	None	P with D
3	53	M	27	periodontitis	No	Yes	No	I	tooth	5	Nonsurgical periodontal treatment	P without D
4	74	M	31	periapical periodontitis	No	Yes	No	II	tooth	6	Apical surgery	P with D
			41	periapical periodontitis	Yes	No	No	II	tooth	6	Apical surgery	P with D
5	57	F	46	periapical periodontitis	Yes	No	Yes	III	tooth	8	Extraction	Extracted
6	60	M	16	vertical root fracture	No	Yes	No	–	tooth (RCT)	5	Extraction	Extracted
7	55	F	24	periapical periodontitis	Yes	No	No	–	tooth	5	Apical surgery	P without D
8	74	M	46	vertical root fracture	No	Yes	No	II	tooth	>10	Extraction	Extracted
9	71	F	26	vertical root fracture	Yes	No	No	I	tooth	>10	None	P with D
10	90	F	15	periodontitis	Yes	No	No	II	bridge	9	Nonsurgical periodontal treatment, extraction	Extracted
11	71	F	26	periapical periodontitis	No	Yes	No	II	tooth	8	Extraction	Extracted
12	86	M	26	pulpitis	No	Yes	No	I	tooth	5	None	P with D
13	73	F	42	endodontic–periodontal lesion	No	Yes	No	III	crown	10	Extraction	Extracted
14	47	M	21	endodontic–periodontal lesion	No	No	Yes	–	tooth	2	Surgical periodontal treatment	P without D
15	49	F	37	periapical periodontitis	Yes	No	No	–	tooth	2	Apical surgery	P without D
16	50	M	26	periodontitis	No	Yes	No	I	tooth (elongated)	>10	Nonsurgical periodontal treatment	Extracted
17	58	M	33	vertical root fracture	No	Yes	No	II	tooth	6	Extraction	Extracted
18	55	F	11	periapical periodontitis	No	Yes	No	I	Tooth (RCT)	5	Apical surgery	P without D
19	83	M	25	vertical root fracture, periodontitis	Yes	No	No	I	tooth	5	Nonsurgical periodontal treatment	P with D
20	79	M	46	cracked tooth, periodontitis	Yes	No	Yes	I	implant	9	Nonsurgical periodontal treatment	P with D
21	83	F	46	vertical root fracture	No	Yes	No	II	tooth	8	None	P with D
22	57	M	36	cracked tooth	No	Yes	No	I	missing	8	Extraction	Extracted
23	68	F	46	endodontic–periodontal lesion	Yes	No	No	–	tooth	2	Surgical periodontal treatment	P with D
24	67	M	26	periapical periodontitis	Yes	No	Yes	II	implant	10	Extraction	Extracted
25	52	M	26	periapical periodontitis	Yes	No	No	I	tooth (periodontitis)	5	Extraction	Extracted
26	40	M	47	vertical root fracture	No	Yes	No	I	tooth	7	Extraction	Extracted
27	28	F	23	periapical periodontitis	Yes	No	No	–	tooth	3	Apical surgery	P with D
28	72	F	36	periodontitis	No	Yes	No	II	tooth	10	Extraction	Extracted
29	70	M	47	periodontitis	Yes	No	No	II	tooth	10	Extraction	Extracted
30	63	F	25	(none)	No	No	Yes	I	crown	9	Extraction	Extracted
31	46	M	23	periapical periodontitis	No	Yes	No	–	implant	3	None	P without D
32	75	F	26	(none)	No	Yes	No	–	tooth	3	None	P without D
33	73	F	26	periodontitis	No	Yes	No	III	tooth (periodontitis)	10	Extraction	Extracted

(*continued on next page*)

Table 1 (*continued*)

ID	Age	Sex	Tooth	Primary Clinical diagnosis	Previous RCT	Pulp vitality	Sinus tract	Tooth Mobility	Antagonist	Deepest probing depth (mm)	Treatment	Prognosis
34	70	M	16	endodontic–periodontal lesion	No	Yes	No	I	tooth	10	Nonsurgical periodontal treatment, extraction	Extracted
35	68	M	36	periodontitis	No	Yes	No	II	tooth (elongated)	10	Nonsurgical periodontal treatment	P with D
36	64	M	11	periapical periodontitis	No	Yes	No	I	tooth	3	None	P without D
37	26	F	37	periapical periodontitis	Yes	No	No	–	tooth	3	Apical surgery	P with D
38	61	M	27	periapical periodontitis	Yes	No	No	–	tooth (tilted)	6	Apical surgery	P without D
39	69	F	47	periapical periodontitis	Yes	No	No	I	tooth (tilted)	5	Apical surgery	P with D
40	53	M	17	periapical periodontitis	No	Yes	No	II	crown	>10	Extraction	Extracted
41	56	M	16	vertical root fracture	Yes	No	No	–	tooth	2	None	P without D
42	69	F	35	pulptitis, cracked tooth	No	Yes	No	–	tooth	4	None	P without D
43	72	M	36	periapical periodontitis, periodontitis, tooth fracture	No	Yes	No	I	crown	5	Surgical periodontal treatment	P with D
44	65	M	37	periodontitis	Yes	No	No	–	tooth	2	Nonsurgical periodontal treatment	P with D
45	54	F	26	vertical root fracture	Yes	No	No	–	tooth	5	None	P with D
46	28	M	36	periodontitis	No	Yes	No	II	tooth	>10	Extraction	Extracted
47	60	F	11	periodontitis	Yes	No	No	–	tooth	2	Nonsurgical periodontal treatment	P with D
48	61	M	47	vertical root fracture	Yes	No	Yes	III	tooth	>10	Extraction	Extracted
49	72	F	26	periapical periodontitis	No	Yes	No	I	tooth (filling)	6	None	P with D
50	81	M	46	cracked tooth, periodontitis	Yes	No	Yes	II	tooth	8	Nonsurgical periodontal treatment, extraction	Extracted
51	76	M	17	periapical periodontitis	No	Yes	No	I	tooth	6	None	P with D
52	31	F	26	periapical periodontitis	No	Yes	No	–	tooth	2	None	P without D
53	67	F	26	periodontitis	Yes	No	No	–	tooth	3	Nonsurgical periodontal treatment	P with D
54	65	M	16	endodontic–periodontal lesion	No	Yes	No	I	implant	5	Nonsurgical periodontal treatment	P with D
55	56	F	26	cracked tooth	No	Yes	No	–	tooth	2	None	P without D
56	37	M	34	periapical periodontitis	Yes	No	Yes	II	tooth	3	Apical surgery, extraction	Extracted
57	79	F	26	endodontic–periodontal lesion	No	Yes	No	III	missing	8	Extraction	Extracted
58	38	M	16	(none)	Yes	No	No	I	tooth	4	None	P without D
59	76	F	11	11 vertical root fracture	No	Yes	No	III	tooth (cemental tear)	9	Extraction	Extracted
			41	(none)	No	Yes	No	III	tooth (cemental tear)	>10	Extraction	Extracted
60	63	M	37	periodontitis	Yes	No	No	I	tooth	5	Nonsurgical periodontal treatment	P with D
61	40	F	36	endodontic–periodontal lesion	No	Yes	No	–	tooth	2	Nonsurgical periodontal treatment	P with D

F: female; M: male; RCT: root canal treatment; P with D: preserved with discomfort; P without D: preserved without discomfort.

2.4. Statistical analysis

The correlation between different clinical factors (age, sex, location, previous root canal treatment (RCT), pulp vitality, sinus tract, tooth mobility) and prognosis was analyzed by chi-square test and logistic regression analysis. Data analysis and figure drafting were completed with GraphPad Prism 9 (version 9.4.1, GraphPad Software) and SPSS® v19 (SPSS, Chicago, IL, USA).

3. Results

3.1. Primary clinical diagnosis

Primary clinical diagnosis upon the first clinical visit for teeth with cemental tears was recorded. Among the 63 teeth of 61 patients, 4 teeth did not have any clinical symptoms and were diagnosed through CBCT that was aiming for other teeth. Periapical periodontitis was the most frequent diagnosis, with 22 teeth diagnosed, among which one was also diagnosed with periodontitis and tooth fracture. With 16 diagnoses, the second most prominent diagnosis was cracked tooth or root fracture (11 vertical root fracture, 2 cracked tooth, 1 vertical root fracture with periodontitis, 1 cracked tooth with periodontitis, 1 cracked tooth with pulpitis). Other diagnoses included periodontitis (12), endodontic–periodontal lesions (7), and pulpitis (2) (Table 1, Fig. 2E).

3.2. Clinical examinations

Among the 63 teeth, 28 underwent RCT before diagnosed with cemental tear. Thirty-four out of the remaining 35 teeth that did not have RCT had vital pulp, and the other 1 lost pulp vitality and had a sinus tract. Among the 63 teeth, a total of 9 teeth came with sinus tracts.

For tooth mobilities, 19 teeth did not show clinical mobility, 20 were I-degree loosened, 20 teeth with no bolitily, and 16 teeth with II-degree mobility, were II-degree loosened, and 7 were III-degree loosened.

Among the 49 teeth that had attachment loss, 36 had the deepest probing depth at the same site as the cement tear. The deepest probing side and the site of the cemental tear were not matched in 2 teeth, but attachment loss was also observed in the site of the cemental tear. The other 10 had no attachment loss at the site of the cemental tear; among these cases, the cemental tear occurred in the root apex. Among the here were 15 teeth that did not have attachment loss. We might miss one data while using the Exel, 1 had no obvious bone loss in CBCT, and 14 had bone loss at the same site of cemental tear in CBCT (3 had cemental tear in the middle 1/3 of the root, and 11 had cemental tear in the root apex). These results indicated that cemental tears in sites other than the root apex could be a significant factor that causes attachment loss. Data of deepest probing depth has been listed in Fig. 2F and Table 1.

For antagonists, the majority were original teeth (52 teeth), among which 41 were healthy teeth without clinical symptoms, 2 had RCT, 1 had filling, 2 were elongated, 2 were tilted, 2 had periodontitis, and 2 had cemental tears (teeth 11 and 41 of the same patient). One tooth had a bridge as an antagonist, 5 antagonists were crowns, 1 was missing, and 4 were dental implants (Table 1).

3.3. Sites of cemental tear

For various tooth types, the incidence of cemental tears varied, with molars exhibiting the highest frequency (71.43 %), followed by incisors (19.05 %) and premolars (9.52 %, Fig. 2C).

Among the 24 maxillary molars included in our cohort, the palatal root emerged as the primary site for cemental tears (17/24, 70.83 %). Among the 21 mandibular molars, a greater prevalence of cemental tears was observed in the mesial root of two-rooted mandibular molars (13 out of 21, 61.90 %). Regarding incisors, cemental tears were more prevalent in the middle third of the root in maxillary incisors (5 out of 7, 71.43 %), and in the apical third of the root in mandibular incisors (4 out of 5, 80.00 %, Table 2). Similarly, among premolars, cemental tears were more frequent in the apical third of the root (4 out of 6, 66.67 %, Table 2). Further detailed information is provided in Table 2.

Table 2
Site of cemental tear in different tooth type.

Maxillary				Mandibular				Total
		Part of the Root				Part of the Root		
Incisor	7	Coronal Third	0	Incisor	5	Coronal Third	0	0
		Middle Third	5			Middle Third	1	6
		Apical Third	2			Apical Third	4	6
Premolar	4	Coronal Third	0	Premolar	2	Coronal Third	0	0
		Middle Third	1			Middle Third	1	2
		Apical Third	3			Apical Third	1	4
Molar	24	Coronal Third	3	Molar	21	Coronal Third	1	4
		Middle Third	8			Middle Third	7	15
		Apical Third	13			Apical Third	13	26

3.4. Representative radiographic figures

Cemental tear typically presents as a 'prickle-like' radiopaque mass, characterized by a fine, sharp, and vertical fragment adjacent to the affected root surface [1,7–9], often exhibiting partial or complete detachment of the cementum from the root (Fig. 1 A, C, E, white arrows).

Given that periapical periodontitis, vertical root fracture, and periodontitis are the three primary clinical diagnoses associated with cemental tear (Fig. 2E), we present representative radiographic figures for cemental tear, periapical periodontitis, vertical root fracture, and periodontitis.

Cemental tear in proximity to the apical root may induce periapical radiolucency similar to that caused by periapical periodontitis due to pulp necrosis (Fig. 1A). However, in cases of pure cemental tear without pulp necrosis, neither caries nor cracks conducive to pulp necrosis were observed (Fig. 1A). Clinical examination confirmed the presence of a vital pulp. Conversely, a tooth with periapical periodontitis would lack pulp vitality and typically exhibit caries, wedge-shaped defects, microcracks, abrasion, occlusal trauma, or abnormal central cusp cracks leading to pulp necrosis (Fig. 1B).

A patient initially diagnosed with a vertical root fracture based on plain X-ray displayed a vertical crack along the root and a J-

Table 3
Chi-square analysis of prognostic factors for cemental tear.

	Preserved without discomfort	Preserved with discomfort	Extracted	*Sum*	Chi-square	df	*P* value
Patients	14	22	25	***61***			
Sex							
Female	7	12	9	***28***	1.744	2	0.4182
Male	7	10	16	***33***			
Age							
<60	10	5	10	***25***	8.407	2	**0.0149***
≥60	4	17	15	***36***			
Teeth	14	23	26	***63***			
Tooth Type							
Incisor	4	4	4	***12***	2.534	4	0.6385
Premolar	2	1	3	***6***			
Molar	8	18	19	***45***			
Position							
Maxillary	12	11	12	***35***	6.644	2	**0.0361***
Mandibular	2	12	14	***28***			
Deepest Probing Depth							
<3 mm	5	4	0	***9***	42.42	8	< **0.0001****
3–4 mm	5	3	1	***9***			
5–6 mm	4	12	3	***19***			
7–8 mm	0	1	7	***8***			
≥9 mm	0	3	15	***18***			
Tooth Mobility							
-	10	8	1	***19***	33.21	6	< **0.0001****
I	4	10	6	***20***			
II	0	5	12	***17***			
III	0	0	7	***7***			
Site of cemental tear							
coronal 1/3	0	1	3	***4***	4.959	4	0.2915
middle 1/3	7	10	6	***23***			
apical 1/3	7	12	17	***36***			
Sinus Tract							
No	13	22	19	***54***	5.829	2	0.0542
Yes	1	1	7	***9***			
Pulp Vitality							
Yes	8	9	16	***33***	2.62	2	0.2698
No	6	14	10	***30***			
Antagonist							
Tooth	13	20	19	***52***	7.393	8	0.4949
Bridge	0	0	1	***1***			
Crown	0	1	3	***4***			
Missing	0	0	2	***2***			
Implant	1	2	1	***4***			
Primary clinical diagnosis							
None	2	0	2	***4***	9.145	12	0.6905
Pulptitis	1	1	0	***2***			
Periodontitis	1	5	6	***12***			
Vertical Root Fracture	1	5	6	***12***			
Periapical Periodontitis	7	8	7	***22***			
Cracked Tooth	1	1	2	***4***			
Endodontic–Periodontal Lesion	1	3	3	***7***			

shaped radiolucency around the root (Fig. 1C–b). However, upon CBCT examination, no dentinal crack was observed (Fig. 1C–c). Post-tooth extraction revealed detached cementum from the root, while the dentin remained intact (Fig. 1C–a). In contrast, a vertical root fracture typically manifests with a crack within the dentin (Fig. 1D).

Cemental tear may contribute to localized rapid periodontal breakdown [10], potentially leading to a diagnosis of periodontitis. In contrast to periodontitis, when periodontal breakdown results solely from cemental tear, and the patient maintains good oral hygiene, other teeth apart from the affected ones generally exhibit no discernible bone loss (Fig. 1E). It is noteworthy that detached cementum in the mesial/distal site of the root may be visible in plain X-ray (Fig. 1C–b, 1E-left), but not in the buccal/palatal site of the root (Fig. 1C–c, Fig. 1E-left). In comparison, even with similar peri-root radiolucency, patients with severe periodontitis exhibit varying levels of bone loss in other teeth, and no detached cementum is observed around the root (Fig. 1F).

3.5. Treatment and prognosis

Fifteen teeth did not receive any treatment. Among these teeth, 8 teeth experienced no discomfort before diagnosis and were preserved without discomfort. Seven experienced little discomfort before diagnosis, the patients rejected treatment suggestions, and these teeth were preserved with the same little discomfort as before diagnosis.

Twenty-one teeth were extracted without further treatment. Sixteen teeth were extracted due to obvious tooth mobility, and 5 teeth were extracted due to personal financial reasons.

Ten patients underwent apical surgery. After apical surgery, 1 tooth was extracted due to uncontrollable bone loss, and 4 teeth were preserved without discomfort. Five teeth were preserved with discomfort, but the discomfort eased compared to before surgery.

Fourteen teeth underwent nonsurgical periodontal treatments. After treatment, 3 teeth were extracted due to uncontrollable bone loss, and 1 tooth was preserved without discomfort. Nine teeth were preserved with discomfort.

Three patients underwent surgical periodontal treatment. After treatment, 1 tooth was preserved without discomfort, and 2 teeth were preserved with discomfort.

In summary, among the 63 teeth included, 14 teeth were reserved without clinical discomfort, 23 teeth were reserved with clinical discomfort, and 26 teeth were extracted (Table 1).

The main reasons for tooth extraction were uncontrollable bone loss and tooth mobility. Chi-square analysis showed that deep probing depth ($P < 0.0001$) and II-III degree of tooth mobility ($P < 0.0001$) were most significantly correlated with tooth extraction (Table 3). Maxillary teeth showed a better prognosis than mandibular teeth ($P = 0.0361$). In addition, older age ($\geq$60) was also a factor indicating poor prognosis ($P = 0.0149$, Table 3). Logistic regression analysis (Table 4) showed that prognosis was significantly associated with age ($p = 0.011$), deepest probing depth ($p = 0.005$) and tooth mobility ($p = 0.009$). Teeth with deepest probing depth over 6 mm (OR = 45.38, 95%CI: 9.442 to 177.3) , II to III degree mobility (OR = 17.37, 95%CI: 4.842 to 61.53), sinus tract (OR = 6.447, 95%CI: 1.338to 32.14) are of higher risk of extraction (Table 5).

4. Discussion

As a rare and often misdiagnosed condition in the clinic, the prevalence of cemental tears remains unclear [3,9,11]. Internal factors due to the inherent structural weakness of cementum and its interface with dentine and external factors that are associated with stress have been proposed as the two mechanisms responsible for the development and propagation of cemental tears, and avoiding occlusal trauma might help prevent cemental tears [9,12]. Early diagnosis and treatment can improve the prognosis for cemental tears and may help to preserve the affected tooth. Timely diagnosis and treatment of cemental tears to prevent further deterioration of the affected tooth and surrounding periodontal tissue are important.

In this study, we sought to provide detailed clinical and radiographic descriptions of cemental tears to help alert clinicians of cemental tears.

In this study, we recorded the primary diagnosis for cemental tears (which could be misdiagnosed) to alert clinicians in related diagnoses. Cemental tear could result in radiolucency similar to periapical periodontitis, vertical root fracture, and/or periodontitis, often leading to misdiagnoses during initial clinical visits with plain X-ray. However, bone loss purely caused by cemental tear does not

Table 4
Logistic regression analysis of prognostic factors for cemental tear.

	Unstandardized Coefficients		Standardized Coefficients	t	Significance
	B	Std. Error	Beta		
(Constant)	0.839	0.239		3.502	0.001
Age	0.008	0.003	0.253	2.623	0.011*
Sex	−0.028	0.09	−0.028	−0.31	0.757
Position	0.056	0.094	0.056	0.594	0.555
Tooth_Type	−0.014	0.061	−0.022	−0.234	0.816
Deepest_Probing_Depth	−0.073	0.025	−0.426	−2.926	0.005**
Pulp_Vitality	−0.04	0.105	−0.04	−0.38	0.706
Sinus_Tract	−0.171	0.154	−0.123	−1.105	0.274
Mobility	−0.211	0.077	−0.42	−2.733	0.009**

Dependent Variable: Prognosis (preserved vs extracted).

Table 5
Odds ratio of prognostic factors for cemental tear.

	Conserved	Extracted	Odds Ratio	95 % Confidence Interval
Patients	**36**	**25**		
Sex				
Female	19	16	0.6287	0.2152 to 1.904
Male	17	9		
Age				
<60	15	10	1.071	0.4054 to 2.979
≥60	21	15		
Teeth	**37**	**26**		
Tooth Type				
incicor &premolar	11	7	1.148	0.3795 to 3.329
molar	26	19		
Position				
Maxillary	23	12	1.917	0.6612 to 5.078
Mandibular	14	14		
Deepest Probing Depth				
≤6 mm	33	4	**45.38**	9.442 to 177.3
>6 mm	4	22		
Tooth Mobility				
0-I	32	7	**17.37**	4.842 to 61.53
II-III	5	19		
Sinus Tract				
No	35	19	**6.447**	1.338 to 32.14
Yes	2	7		
Pulp Vitality				
Yes	17	16	0.5313	0.1950 to 1.525
No	20	10		

compromise pulp vitality like periapical periodontitis, lacks dentinal cracks like vertical root fracture, and lacks etiological factors associated with periodontitis. In accordance with previous studies, we propose including cemental tears in the differential diagnosis for periapical radiolucency with vital pulp [8], vertical root fracture [3], and localized rapidly progressive periodontitis [6,13].

Among the 22 teeth misdiagnosed as periapical periodontitis, 10 did not have an RCT history and had vital pulp. This is in accordance with Hiba Qari's research [8], which reported that periapical radiolucency with vital pulp might indicate a great possibility for cemental tears. Indeed, there were 19 teeth with periapical radiolucency with vital pulp in our cohort. Thirty-four out of the 35 teeth that did not have a previous RCT had vital pulp upon primary diagnosis. The only one lost pulp vitality due to dental caries but not cemental tears. No evidence has shown that cemental tears with vital pulp should have RCT.

Nearly half (44.44 %) of the teeth had an RCT history. However, it is difficult to investigate the cause-and-effect relationship between RCTs and cemental tears, as RCTs might be conducted due to previous misdiagnoses [9]. VL Tan et al. reported that RCT did not routinely lead to cemental tears [14]. On the other hand, local, conservative curettage or surgical treatment to remove the detached cementum have been suggested to be more appropriate treatments [8,15].

As for other predisposing factors, consistent with previous studies [9,11], older age was an important factor for cemental tears; there were 36 patients older than 60 years old, and the average age for all patients was over 60 years old (61.54 ± 15.12). Regarding gender, there were more males (54.1 %) than females (45.9 %) in our cohort. In our cohort, there were slightly more maxillary teeth (35/63, 55.6 %) than mandibular teeth (28/63, 44.4 %), and cemental tears seemed to occur more frequently in the molars (45/63, 71.4 %).

In addition to the findings discussed above, we also highlighted some other notable findings from our study. We found that the apical third tended to have the highest incidence of cemental tears, and the coronal third had the lowest incidence of cemental tears (Fig. 2D). This finding might not be good news for cemental tear treatment, as an outcome study reported that the apicocoronal location of the detached cementum affected the prognosis of the treatment [16]. Moreover, among our cohort, we found that the palatal root was the most prominent site for cemental tears of the maxillary molars (17/24, 70.83 %), and cemental tears occurred more frequently in the mesial root of the two-root mandibular molars.

In our cohort, periapical periodontitis was the most prominent clinical diagnosis, followed by vertical root fracture and periodontitis. Uncontrollable tooth mobility and attachment loss are the major reasons for tooth extraction of cemental tears, suggesting that early diagnosis and treatment are critical to avoid rapid periodontal destruction [10].

The major limitation of this study is that cases were extracted based on the CBCT data, which might miss some of the potential cases that did not undergo CBCT scan in our hospital. Regrettably, we could not include teeth with cemental tear fragments too small to be identified with CBCT. Consequently, our findings represent only those cemental tear fragments large enough for CBCT identification.

Moreover, not all patients were requested to return for regular clinical examination. Instead, phone calls served as the initial step for follow-up, with further clinical examination extended only to patients experiencing discomfort. This follow-up method may overlook patients with advancing lesions lacking clinical symptoms.

Another limitation of this study is the inability of our data to provide guidance for the treatment choice of cemental tears. As a retrospective study, we cannot establish a direct causal relationship between treatment and prognosis. Patients made treatment

choices based not only on prognosis but also on the time and financial cost of the suggested treatment before our investigation. For example, 5 patients chose to extract their teeth without any treatment for financial reasons. Four patients refused apical surgery due to possible pulpitis/pulp necrosis after surgery. Among preserved teeth, 22 patients (23 teeth) still experienced different levels of discomfort but chose not to undergo further treatment or tooth extraction. In other words, the dentists did not provide treatment based on the best clinical practice evidence but allowed the patients to make their own decisions. We only recorded the treatment and prognosis, but the treatment choices might not be the best evidence-based medicine. According to the literature, it is unnecessary to perform any active intervention if the cemental tear is merely a radiographical finding without associated clinical signs and symptoms [17]. If intervention is indicated, complete removal of the torn fragment has been claimed to be essential in treating cemental tears. Apical surgery, nonsurgical, and/or surgical periodontal treatments are often recommended depending on the fragment's location [3, 17].

Further research is needed to better comprehend the etiology and treatment options of cemental tears. The underlying mechanisms behind the detachment of cementum from the root surface remain not fully understood. A study on human cadavers found micro cemental tear on 14 out of 24 molars upon micro-computerized tomography (micro-CT) examination [14]. Micro-CT could aid in better identifying micro cemental tear. Randomized clinical trials and prospective studies could provide better evidence for treatment choices. Subsequent research in this area may identify potential preventive measures and enhance treatment approaches for cemental tears.

Data availability

All data used in the generation of the results presented in this manuscript will be made available upon reasonable request from the corresponding author.

CRediT authorship contribution statement

SuFeng Zhao: Writing – original draft, Investigation, Funding acquisition. **ZhengDing Yuan:** Writing – original draft, Investigation, Data curation. **XinYao Zhou:** Software, Investigation, Formal analysis. **XuDong Yang:** Writing – review & editing, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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