

[DOI] 10.12016/j.issn.2096-1456.2024.02.011

· 综述 ·

牙骨质撕裂临床诊治的研究进展

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【摘要】 牙骨质撕裂是指牙骨质沿牙骨质-牙本质界(dentino-cemental junction, CDJ)或牙骨质生长线完全或不完全脱离牙根表面,也可以波及部分牙本质。牙骨质撕裂的病因尚不够明确,文献回顾发现其易感因素包括牙齿类型、性别、年龄、牙周病、牙周或根管治疗史、牙外伤史、咬合创伤史或过度的咬合力。牙骨质碎片可以是片状或U形,易致牙周和根尖周组织破坏。临床上,牙骨质撕裂多表现为孤立性牙周袋,其症状类似于牙周炎、根尖周炎和牙根纵裂。影像学检查对于牙骨质撕裂的临床诊断具有重要意义,常表现为沿牙根表面纵向分布的薄“针刺状”阻射性团块。必要时需借助探查性手术,术中牙骨质碎片及根面牙骨质线可以辅助诊断。组织病理学检查是诊断牙骨质撕裂的金标准。根据牙骨质撕裂正确诊断时间及临床或放射学表现不同,治疗方法不同。随着再生性生物材料的发展及意向性再植术的成熟,越来越多患牙得以长期存留。本综述系统性描述牙骨质撕裂的生物学基础和易感因素、临床特征、影像学和组织病理学表现以及临床管理和预后,为明确诊断并制定个性化治疗计划提供依据。

【关键词】 牙骨质撕裂; 牙骨质; 生长线; 牙骨质-牙本质界; 牙周牙髓联合病变; 牙周翻瓣术; 引导性组织再生术; 意向性再植

【中图分类号】 R78 **【文献标志码】** A **【文章编号】** 2096-1456(2024)02-0155-06

【引用著录格式】 熊斌, 罗海芸, 麻丹丹. 牙骨质撕裂临床诊治的研究进展[J]. 口腔疾病防治, 2024, 32(2): 155-160. doi:10.12016/j.issn.2096-1456.2024.02.011.



微信公众号

Research progress on cemental tears in terms of clinical diagnosis and treatment XIONG Bin, LUO Haiyun, MA Dandan. Department of Endodontology, Stomatological Hospital, School of Stomatology, Southern Medical University, Guangzhou 510280, China

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【Abstract】 A cemental tear is defined as an incomplete or complete detachment of the cementum along the dentino-cemental junction (CDJ) or the incremental line within the body of the cementum, which can also involve part of the root dentine adjacent to the cementum. The pathogenesis of cemental tears is not fully elucidated. From the literature review, possible predisposing factors were identified, including tooth type, sex, age, periodontitis, previous periodontal treatment or root canal treatment, history of dental trauma, and occlusal trauma or excessive occlusal force. The morphology of cemental tears can be either piece-shaped or U-shaped, which usually contributes to periodontal and periapical breakdown. Clinically, cemental tears have a unitary periodontal pocket and present with symptoms mimicking localized periodontitis, apical periodontitis, and vertical root fractures. Imaging examination is of great significance for the clinical diagnosis of cemental tears, which often manifest as thin 'prickle-like' radiopaque masses located longitudinally adjacent to the affected root surface. Exploratory surgery is needed in some cases. Although intraoperative cemental fragments and cemental lines on the root surface can assist in the diagnostic process, histopathology examination is the gold standard for the diagnosis of cemental tears. The treatment methods vary depending on the timing of the correct diagnosis and the clinical or radiological manifestations. With the development of regenerative biomaterials and the development of intentional replantation, an increasing number of affected teeth can survive for a long time. The aim of this review is to systematically describe the biological basis and predisposing factors, clinical features, radiographic and histological

【收稿日期】 2023-04-25; **【修回日期】** 2023-06-13

【基金项目】 广东省自然科学基金面上项目(2021A1515012475);南方医科大学口腔医院临床研究启动计划(KQIIT2021002)

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characteristics, diagnosis and clinical management of cemental tears, and treatment outcomes to help make a clear diagnosis and develop a personalized treatment plan.

【Key words】 cemental tears; cementum; incremental line; dentino-cemental junction; periodontal-endodontic combined lesions; periodontal flap operation; guided tissue regeneration; intentional replantation

J Prev Treat Stomatol Dis, 2024, 32(2): 155-160.

【Competing interests】 The authors declare no competing interests.

This study was supported by the grants from Natural Science Foundation of Guangdong Province (No. 2021A1515012475); Clinical Research Initiation Plan of Stomatological Hospital of Southern Medical University (No. KQJIT2021002).

牙骨质撕裂是一种特殊类型的牙根表面骨折,指牙骨质沿牙骨质-牙本质界(dentino-cemental junction, CDJ)或牙骨质生长线部分或完全脱离^[1-3],可累积部分牙本质形成牙骨质-牙本质裂^[4-6]。目前普遍认为因牙骨质及CDJ固有结构的薄弱而产生的内部因素和与应力相关的外部因素是导致牙骨质撕裂发生和发展的重要机制^[7]。在2018年牙周病新分类中,牙骨质撕裂被归为牙齿局部相关因素^[8];其临床表现类似于原发性牙髓病、牙周病、牙周-牙髓联合病变及牙根纵裂^[9-10],常导致快速进展的牙周或根尖周组织破坏^[11-12]。影像学检查对于早诊断、早治疗、预防严重的牙周损伤和延长患牙存留时间具有重要的临床意义^[13-15]。然而,典型的影像学表现可能较临床症状延迟出现^[4],常导致误诊和误治^[16-17]。彻底清除牙骨质碎片和感染物质是治疗成功的关键,临床上常与引导组织再生手术(guided tissue regeneration, GTR)相结合^[18-20]。

由于目前尚无牙骨质撕裂诊治的专家共识,本文将从以下7个方面进行回顾:①生物学基础和易感因素;②临床特征;③影像学表现;④组织病理学表现;⑤临床诊断;⑥临床管理;⑦预后,以期为临床医生全面认识并正确诊治牙骨质撕裂提供帮助。

1 生物学基础和易感因素

1.1 生物学基础

1.1.1 CDJ纤维机械性连接薄弱 CDJ主要由含有粘蛋白的蛋白聚糖和稀疏分布的胶原纤维组成。部分牙骨质胶原纤维在CDJ与牙本质纤维交织互连,但纤维含量明显少于牙本质和牙骨质^[21-22],在咬合应力下容易继发牙骨质沿CDJ分离。

1.1.2 继发性牙骨质的结构不均一性 随着年龄的增加,牙骨质间歇性分层增厚,形成密度和纤维含量不同的同心环(生长层),类似于树木年

轮^[23]。牙骨质层钙化不全和生长线纤维含量或排列取向减少的部位在过度咬合压力下可能发生牙骨质撕裂^[17]。

1.1.3 与疾病相关的牙骨质结构变化和成牙骨质细胞功能受损 因牙周病暴露在口腔环境中的牙骨质矿物质含量增加,导致牙骨质的结构改变和脆性增加,在外力作用下可能诱发牙骨质撕裂^[2]。牙骨质的原始表层在根面平整去除后可重建高矿化区,但牙骨质结构可能因缺乏典型的胶原纤维带形成而变的更加脆弱。无细胞牙骨质的沉积是一个缓慢连续的过程,而细胞牙骨质能更快、更具修复性地形成^[22]。低磷酸酯酶症因成牙骨质细胞功能受损,导致牙骨质形成和矿化障碍^[24],在正常的咬合应力下容易诱发牙骨质分离甚至牙齿脱落。另外,在成牙骨质细胞功能受损的特定全身系统性疾病中发生的多颗牙齿的牙骨质撕裂,如再生障碍性贫血所致的营养不良,被推测与疾病活跃期形成的细胞牙骨质结构薄弱有关,使增厚的继发性牙骨质沿着层状结构形成裂纹^[3,7]。

1.1.4 牙本质强度降低 在衰老过程中,牙本质逐渐硬化。老年人的牙本质表现出更高的弹性模量及更低的复数模量和弯曲强度,使其抵抗根面牙本质断裂的能力降低^[25-26]。另外,研究发现根管治疗后的牙本质表现出更高的胶原交联率和更低的咬合效率^[25],在外力作用下容易诱发牙本质断裂,这也解释了牙骨质-牙本质裂的组织学发现。

1.2 易感因素

牙骨质撕裂的易感因素包括牙齿类型、性别、年龄、根管治疗史、牙周病及牙周治疗史、牙外伤及异常咬合史^[7,16,27]。全身性疾病与牙骨质撕裂的关系鲜有文献提及。在缺乏体外研究证据的情况下,很难建立咬合创伤和牙髓病与牙骨质撕裂的相关性。咬合创伤可以是促进牙周炎发展的主要因素,也可以是牙周支持组织减少、牙齿松动移位

的继发效应^[28-29]。在研究咬合创伤与牙骨质撕裂的关系时,几乎难以消除牙周病这一干扰因子。

2 临床特征

2.1 患病特点

目前关于牙骨质撕裂患病率的研究证据有限。有学者对4 629颗恒牙根尖片进行回顾性研究发现,牙骨质撕裂的患病率为0.89%^[12];而CBCT研究将其检出率提高到1.9%^[13]。然而,这两项研究仅将影像学上分离于根面的薄片状阻射影定义为牙骨质撕裂,缺乏临床检查和病理学诊断;其实际患病率可能高于目前的研究结果。牙骨质撕裂在前牙,特别是切牙多见;好发于男性和60岁以上的老年人^[7,16]。

2.2 发生部位

牙骨质撕裂多发生于CDJ^[11,17],可位于牙颈部、根中部或根尖部^[9-11]。60岁以上的患者中,3.9%的牙骨质碎片位于根尖部,而60岁以下的患者为36.8%^[14]。牙骨质撕裂常表现为孤立根面的突起或异物;部分可波及多个根面形成U形碎片^[7,11]。Lin等^[11]对54例牙骨质撕裂的研究发现,77.4%为薄片状,22.6%为U形碎片。进一步研究表明51.9%的片状牙骨质位于根中1/3,而66.7%的U形碎片涉及根尖1/3^[14](图1)。牙骨质撕裂好发于邻面^[11,13]。碎片宽1~6.5 mm,长2~10 mm,表面积可达根面的20%,厚度≤2 mm,性别上未发现明显差异^[7,11,14]。

2.3 临床表现

牙骨质撕裂最常见的临床特征有以下几种:

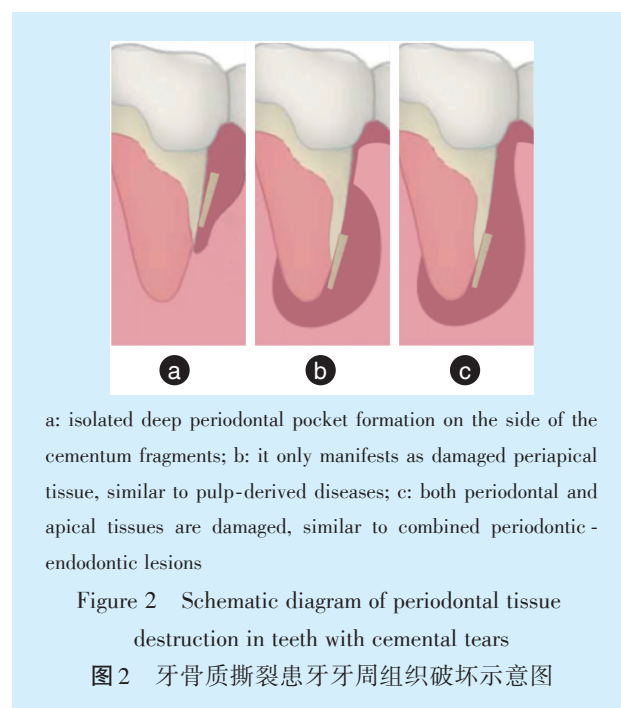
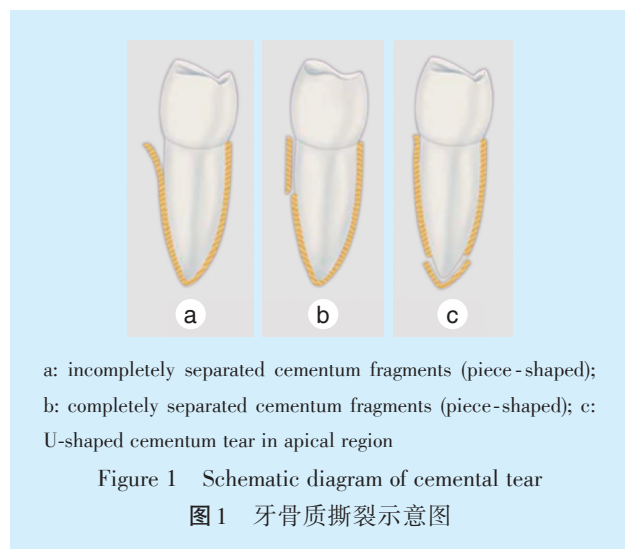
①牙周病样改变,牙龈探诊出血、局部孤立深牙周

袋、牙槽骨破坏及牙齿松动;②牙髓病样损伤,根尖周骨质破坏、牙槽黏膜肿胀、脓肿或窦道形成,但牙髓有活力且根管治疗疗效不佳;③类牙周牙髓联合病变样病损;④具有复发倾向^[6,9,15](图2)。研究发现65%的患牙牙髓活力呈阳性,并出现脓肿和肿胀(66%)及孤立深牙周袋>6 mm(73%)症状^[16]。深牙周袋与患病部位有关^[10];临床上有时可探及根面粗糙或明显的阻碍感。牙髓活力通常不受牙骨质撕裂的影响^[1,10,17],但当病损长期暴露于牙周袋内,致病菌可通过牙本质小管或侧副根管进入牙髓,导致慢性牙髓坏死^[9];涉及根尖的牙骨质撕裂常与根尖周炎并存。疼痛症状可能与疾病的进展阶段有关:半分离式牙骨质碎片在牙周组织内停留,仅造成轻微不适;当碎片与牙根完全分离,牙周组织快速破坏使症状变得明显^[7];脱落的牙骨质碎片一旦暴露于口腔环境可能出现急性牙周炎症状。

3 影像学表现

3.1 X线片

牙骨质撕裂的典型影像学表现为沿牙根表面纵向分布的薄“针刺状”阻射性团块^[3],可附着或分离于根面,周围通常伴有D形、角形、J形或局限于根尖周的骨吸收透射影像,硬骨板常被破坏^[17]。牙骨质碎片可以飘移到周围组织或松质骨间隙内,甚至与牙槽骨融合^[2]。临床上需要与骨硬板和牙槽骨区分开来。



3.2 CBCT

传统的X线片无法检测到颊舌侧的牙骨质碎片^[12, 17],也难以在早期阶段检测到尚未分离的牙骨质碎片^[15],当怀疑牙骨质撕裂时,需结合灵敏度更高的小视野CBCT。除了能检测到颊舌侧病变并提供准确的病损位置外,CBCT还可以帮助判断牙骨质分离形式,如根面不规则厚度可能提示既往牙骨质脱落史;牙骨质碎片与根面之间的间隙大小表明牙骨质的分离程度^[5, 30]。临床上还可通过CBCT提高对牙周组织破坏范围的判断,以优化治疗方案。然而,部分隐秘性牙骨质碎片仍需要术中探查并结合牙科显微镜才能彻底清除^[1, 9, 31]。

4 组织病理学表现

牙骨质碎片由无细胞牙骨质和/或细胞牙骨质组成,部分可观察到明显的生长线^[5]。偶尔会有一些牙本质和/或牙周膜附着在牙骨质碎片上;牙周膜中可见炎症细胞浸润。碎片多粘附在肉芽组织、炎性纤维组织或纤维瘢痕组织上^[3, 7];部分可嵌入纤维组织内,表明牙骨质撕裂更早发生,结缔组织随后迁移到牙骨质碎片与根面间隙内^[17]。患牙根面有时可见到不完全分离牙骨质及修复性牙骨质形成^[5, 17]。近年来,有学者在牙骨质碎片上检测到革兰阳性菌和过碘酸希夫阳性菌^[20]。细菌的增殖存活可能使牙骨质发生不可逆损伤,影响预后^[22]。

5 临床诊断

牙骨质撕裂的初步诊断主要依据影像学表现,结合病史以及临床症状和体征。研究表明术前X线片可检出56%的牙骨质撕裂^[16]。如果X线片上观察到牙骨质碎片样阻射影,80%可以得到正确诊断。前牙病变在X线片上更容易被识别^[14]。CBCT可以提高牙骨质撕裂的检出率。在缺乏特征性影像学表现的情况下牙骨质撕裂极易被误诊误治。临床上对于不明原因伴快速进展的孤立性牙周病变或根尖周破坏的活髓牙,以及常规根管治疗无法解决窦道时,应怀疑牙骨质撕裂^[1, 10],必要时进行探查性手术^[1, 32]。术中牙骨质碎片以及根面牙骨质线(根面暴露的牙本质和正常牙骨质的分界线)可以辅助诊断^[5, 32]。组织病理学检查是诊断牙骨质撕裂的金标准^[5, 17]。拔牙过程中无法获得牙骨质碎片的情况下,在排除了根面平整、根面龋等因素后,牙骨质线可以作为重要的诊断依据^[5, 16, 32]。

6 临床管理

牙骨质撕裂的治疗原则是彻底清除牙骨质碎片及牙结石等相关感染,以实现牙周再附着^[10, 14]。目前牙骨质撕裂治疗有非手术和/或手术两种方法^[7]。根据正确诊断牙骨质撕裂的早晚、临床或放射学表现的不同,其治疗方法也不同。如果仅仅是一个影像学发现,没有任何临床症状和体征,没有必要干预^[7, 18]。研究表明,在去除创伤性咬合因素的情况下,未暴露在口腔环境中的牙骨质碎片可能通过形成新的牙骨质将其重新连接到牙齿上,或者在牙齿和牙骨质碎片之间以及碎片和牙槽骨前沿之间形成“双层”牙周膜以完成修复过程^[2]。因此,早期的治疗重点在于检查咬合和定期复查^[28]。临床上首先确定患牙的牙髓状态,活髓牙常规不需要进行根管治疗^[16, 20],除非在治疗过程中会侵犯根尖部神经血管,使牙髓供应受损。如果牙髓坏死或根管治疗后感染持续,应优先根管治疗或再治疗,防止额外的牙周刺激影响预后^[33]。当牙骨质碎片位于根尖1/3且有根尖病变,通常需要进行根尖手术,术前应考虑根管治疗或再治疗^[15-16]。

位于冠方1/3的牙骨质碎片可首先通过根面平整去除^[10, 20, 34];同期对有咬合创伤和松动迹象的患牙进行咬合调整^[28];在1~2个月后重新评估牙周愈合状况。对于位于近根方的牙骨质碎片或非手术治疗无效的患牙,建议采用牙周翻瓣术或结合GTR手术治疗^[1, 4, 10, 18, 20]。术前应仔细评估牙周袋深度、残余骨壁范围和数量以及患牙松动度。窄而深的骨内缺损可通过GTR获得显著疗效;骨缺损越深,预后越佳^[35]。目前重组人成纤维细胞生长因子-2(recombinant human fibroblast growth factor-2, rhFGF-2)和釉质基质衍生物(enamel matrix derivatives, EMD)已成功应用于牙骨质撕裂骨内缺损的治疗,在牙周袋深度减少、附着水平和骨增量水平上获得了显著的疗效^[9, 19, 20]。另外,透明质酸(hyaluronic acid, HA)和可吸收生物膜的联合应用可促进患牙牙周修复和骨重建^[1]。对于高度松动(Miller grade II级或更高)的患牙,术前应行松牙固定,以免牙齿松动对牙周愈合产生负面影响^[28]。

在多根牙中,半切或截根术在合适的情况下也是可行的选择^[36-37]。当手术预后不佳或无法进行手术时,意向性再植为保留天然牙的最后一道防线,尤其是入路具有挑战性 or 牙周手术会对邻近重要解剖结构造成损伤时^[10, 38]。预后无望的患

牙(存在骨丧失 > 75%、牙周探诊深度 > 8 mm、根分叉病变Ⅲ度、松动度Ⅲ度、冠根比不佳等1个以上牙周病损)可考虑拔除^[9, 10, 39],防止牙周组织进一步破坏而影响后期种植修复。如果因患牙结构缺陷而无法防止复发或几个牙齿同时出现牙骨质撕裂,拔牙可能是最终的选择^[3]。除了评估牙周条件外,拔牙决定还基于修复需求、临床医生的理念和以患者为中心的原则^[39]。临床上,女性患者可能更倾向于保留患牙^[14]。

7 临床预后

研究表明,在接受治疗1年后,93.9%的患牙仍处于功能性保留状态,其中51.5%获得了完全性骨再生^[14],但牙骨质撕裂的远期预后还有待系统性研究。牙骨质撕裂的发生部位是影响牙周愈合的重要因素,根中1/3和颈1/3的治愈率相似,并明显优于根尖1/3,可能是因为近冠方的牙骨质碎片和局部感染较根尖区更容易去除。同时,根尖区的U形病损常累积多个根面,牙周破坏程度较其他部位更大而影响预后^[11, 14]。另外,手术治疗可能促进牙周愈合,研究发现57.7%的牙骨质撕裂经手术治疗愈合,比非手术治疗(28.6%)高^[14]。大面积牙骨质撕裂的患牙也可通过牙周治疗获得长期成功^[4],牙周预后似乎并不受牙骨质碎片面积的影响。病变牙骨质感染的去除是实现牙周修复的条件之一;临床上牙周刮治可去除根面所有牙骨质^[40]。牙根表面微小的非病理性缺损可通过修复性牙骨质愈合,并再现牙骨质的发育过程。在最初的牙周愈合过程中,成牙骨质细胞生成比正常组织快。

8 结论和展望

由于缺乏充分的认识和典型的临床特征,在临床实践中,牙骨质撕裂容易被误诊为原发性牙周病或牙髓病、牙周-牙髓联合病变及牙根纵裂,导致治疗失败甚至拔除。因此,临床上可综合多种检查方法以辅助诊断,如病史询问、临床症状、牙周和牙髓检查、影像学检查及探查性手术。根据病损部位和牙周破坏程度的不同,临床医生对牙骨质撕裂的处理以及患牙预后也各不同。作为口腔专业人员需要对更多病例进行深入研究,并广泛学习牙体牙髓和牙周病理学知识,提高对不同治疗方法的理 解,从而改善患牙预后。

【Author contributions】 Xiong B conceptualized and wrote the article; Luo HY collected the reference and revised the article; Ma DD conceptualized and revised the article. All authors read and approved the fi-

nal manuscript as submitted.

参考文献

- [1] Pilloni A, Nardo F, Rojas MA. Surgical treatment of a cemental tear-associated bony defect using hyaluronic acid and a resorbable collagen membrane: a 2-year follow-up [J]. *Clin Adv Periodontics*, 2019, 9(2): 64-69. doi: 10.1002/cap.10053.
- [2] Moskow BS. *Calculus* attachment in cemental separations [J]. *J Periodontol*, 1969, 40(3): 125-130. doi: 10.1902/jop.1969.40.3.125.
- [3] Watanabe C, Watanabe Y, Miyauchi M, et al. Multiple cemental tears [J]. *Oral Surg Oral Med Oral Pathol Oral Radiol*, 2012, 114(3): 365-372. doi: 10.1016/j.oooo.2012.01.003.
- [4] Chou J, Rawal YB, O'Neil JR, et al. Cementodentinal tear: a case report with 7-year follow-up [J]. *J Periodontol*, 2004, 75(12): 1708-1713. doi: 10.1902/jop.2004.75.12.1708.
- [5] Ong TK, Harun N, Lim TW. Cemental tear on maxillary anterior incisors: a description of clinical, radiographic, and histopathological features of two clinical cases [J]. *Eur Endod J*, 2019, 4(2): 90-95. doi: 10.14744/eej.2019.13007.
- [6] Xiong Z, Gu F, Xiang J, et al. Cementodentinal tear associated with a periodontal- endodontic combined lesion: a case report with a 14-month follow-up [J]. *Int J Periodontics Restorative Dent*, 2022, 42(2): e27-e32. doi: 10.11607/prd.5555.
- [7] Lee AHC, Neelakantan P, Dummer PMH, et al. Cemental tear: literature review, proposed classification and recommendations for treatment [J]. *Int Endod J*, 2021, 54(11): 2044-2073. doi: 10.1111/iej.13611.
- [8] Jepsen S, Caton JG, Albandar JM, et al. Periodontal manifestations of systemic diseases and developmental and acquired conditions: consensus report of workgroup 3 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions [J]. *J Periodontol*, 2018, 89(Suppl 1): S237-S248. doi: 10.1002/JPER.17-0733.
- [9] Pedercini A, Weitz DF, Heyse JD Jr, et al. Cemental tear: an overlooked finding associated with rapid periodontal destruction. A case series [J]. *Aust Dent J*, 2021, 66(Suppl 1): S82-S87. doi: 10.1111/adj.12844.
- [10] Jeng PY, Luzi AL, Pitarch RM, et al. Cemental tear: to know what we have neglected in dental practice [J]. *J Formos Med Assoc*, 2018, 117(4): 261-267. doi: 10.1016/j.jfma.2017.09.001.
- [11] Lin HJ, Chang SH, Chang MC, et al. Clinical fracture site, morphologic and histopathologic characteristics of cemental tear: role in endodontic lesions [J]. *J Endod*, 2012, 38(8): 1058 - 1062. doi: 10.1016/j.joen.2012.04.011.
- [12] Keskin C, Güler DH. A retrospective study of the prevalence of cemental tear in a sample of the adult population applied ondokuz mayis university faculty of dentistry [J]. *Meandros*, 2017, 18(2): 115-119. doi: 10.4274/meandros.39974.
- [13] Özkan G, Dönmez Özkan H. Evaluation of cemental tear frequency using cone-beam computed tomography: a retrospective study [J]. *Meandros*, 2020, 21(2): 128-133. doi: 10.4274/meandros.galenos.2020.46320.
- [14] Lin HJ, Chang MC, Chang SH, et al. Treatment outcome of the

- teeth with cemental tears [J]. *J Endod*, 2014, 40(9): 1315-1320. doi: 10.1016/j.joen.2014.05.012.
- [15] Chawla A, Kumar V. Cemental tear: an unusual cause for persisting endodontic periodontal lesion [J]. *Indian J Dent Res*, 2019, 30(1): 140-143. doi: 10.4103/ijdr.IJDR_746_17.
- [16] Lin HJ, Chan CP, Yang CY, et al. Cemental tear: clinical characteristics and its predisposing factors [J]. *J Endod*, 2011, 37(5): 611-618. doi: 10.1016/j.joen.2011.02.017.
- [17] Qari H, Dorn SO, Blum GN, et al. The pararadicular radiolucency with vital pulp: Clinicopathologic features of 21 cemental tears [J]. *Oral Surg Oral Med Oral Pathol Oral Radiol*, 2019, 128(6): 680-689. doi: 10.1016/j.oooo.2019.07.012.
- [18] Park YS, Lee JH, Jeong SN. Treatment of the cemental tear [J]. *Oral Biol Res*, 2018, 42(4): 248-253. doi: 10.21851/obr.42.04.201812.248.
- [19] Nagahara T, Takeda K, Inoue S, et al. Endodontic approach and periodontal regenerative therapy for a mandibular right central incisor affected by a perforation and cemental tear [J]. *Int J Periodontics Restorative Dent*, 2021, 41(5): e205-e212. doi: 10.11607/prd.5466.
- [20] Nagahara T, Takeda K, Inoue S, et al. Successful regenerative response of a severe bone defect in a right lower central incisor affected by a cemental tear [J]. *Clin Case Rep*, 2022, 10(11): e6472. doi: 10.1002/ccr3.6472.
- [21] Yamamoto T, Domon T, Takahashi S, et al. The structure and function of the cemento-dentinal junction in human teeth [J]. *J Periodontol*, 1999, 34(5): 261-268. doi: 10.1111/j.1600-0765.1999.tb02252.x.
- [22] Bosshardt DD, Selvig KA. Dental cementum: the dynamic tissue covering of the root [J]. *Periodontol* 2000, 1997, 13: 41-75. doi: 10.1111/j.1600-0757.1997.tb00095.x.
- [23] Pradeep L, Kokila G, Gopinathan PA, et al. Age estimation with cemental annulation using light, phase contrast and polarized microscopy [J]. *J Microsc Ultrastruct*, 2021, 9(2): 55-60. doi: 10.4103/JMAU.JMAU_3_20.
- [24] Wölfel EM, von Kroge S, Matthies L, et al. Effects of infantile hypophosphatasia on human dental tissue [J]. *Calcif Tissue Int*, 2023, 112(3): 308-319. doi: 10.1007/s00223-022-01041-4.
- [25] Yan W, Montoya C, Øilo M, et al. Contribution of root canal treatment to the fracture resistance of dentin [J]. *J Endod*, 2019, 45(2): 189-193. doi: 10.1016/j.joen.2018.10.004.
- [26] Maeda H. Aging and senescence of dental pulp and hard tissues of the tooth [J]. *Front Cell Dev Biol*, 2020, 8: 605996. doi: 10.3389/fcell.2020.605996.
- [27] Tan VL, Hardiman R, Pilbrow V, et al. Dentinal microcracks and cemental tears related to chemo-mechanical root canal instrumentation: a micro-CT Cadaver Study [J]. *Aust Dent J*, 2022, 67(1): 76-82. doi: 10.1111/adj.12887.
- [28] Fan J, Caton JG. Occlusal trauma and excessive occlusal forces: narrative review, case definitions, and diagnostic considerations [J]. *J Clin Periodontol*, 2018, 45(Suppl 20): S199-S206. doi: 10.1111/jcpe.12949.
- [29] Ríos CC, Campiño JI, Posada-López A, et al. Occlusal trauma is associated with periodontitis: a retrospective case-control study [J]. *J Periodontol*, 2021, 92(12): 1788-1794. doi: 10.1002/JPER.20-0598.
- [30] Michelotti G, Sahrman P, Tauböck TT, et al. Cemental Tear (Zementabschabung) [J]. *Swiss Dent J*, 2021, 131(4): 358-359. doi: 10.5167/uzh-211176.
- [31] Abella Sans F, Nathani TI, Carreño MA, et al. Multidisciplinary management of an external cervical resorption and cemental tear [J]. *Giornale Italiano di Endodonzia*, 2021, 35: 10-15. doi: 10.32067/GIE.2021.35.01.14.
- [32] Nik-Azis NM, Mohd N. Management of severe localized periodontal destruction associated with a cemental defect: a case report [J]. *J Dent Indones*, 2022, 29(1): 73-77. doi: 10.14693/jdi.v29i1.1306.
- [33] Siqueira JF, Rôças IN. Present status and future directions: Microbiology of endodontic infections [J]. *Int Endod J*, 2022, 55(Suppl 3): 512-530. doi: 10.1111/iej.13677.
- [34] Borkar SA, de Ataide IN. Management and 5-year follow-up of tooth with bilateral cemental tear and complete pulp canal obliteration [J]. *J Conserv Dent*, 2019, 22(2): 213-214. doi: 10.4103/JCD.JCD_370_18.
- [35] Nibali L, Sultan D, Arena C, et al. Periodontal infrabony defects: systematic review of healing by defect morphology following regenerative surgery [J]. *J Clin Periodontol*, 2021, 48(1): 100-113. doi: 10.1111/jcpe.13381.
- [36] Setzer FC, Shou H, Kulwattanaporn P, et al. Outcome of crown and root resection: a systematic review and meta-analysis of the literature [J]. *J Endod*, 2019, 45(1): 6-19. doi: 10.1016/j.joen.2018.10.003.
- [37] Mokbel N, Kassir AR, Naaman N, et al. Root resection and hemisection revisited. part I: a systematic review [J]. *Int J Periodontics Restorative Dent*, 2019, 39(1): e11-e31. doi: 10.11607/prd.3798.
- [38] Pisano M, Di Spirito F, Martina S, et al. Intentional replantation of single-rooted and multi-rooted teeth: a systematic review [J]. *Healthcare (Basel)*, 2022, 11(1): 11. doi: 10.3390/healthcare11010011.
- [39] Kwok V, Caton JG. Commentary: prognosis revisited: a system for assigning periodontal prognosis [J]. *J Periodontol*, 2007, 78(11): 2063-2071. doi: 10.1902/jop.2007.070210.
- [40] Yan Y, Zhan Y, Wang XE, et al. Clinical evaluation of ultrasonic subgingival debridement versus ultrasonic subgingival scaling combined with manual root planing in the treatment of periodontitis: study protocol for a randomized controlled trial [J]. *Trials*, 2020, 21(1): 113. doi: 10.1186/s13063-019-4031-y.

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