International Journal Dental and Medical Sciences Research
Volume 6, Issue 5, Sep - Oct 2024 pp 144-156 www.ijdmsrjournal.com
ISSN: 2582-6018

Mastering the Art of Diagnosing Cracked Teeth: Surmounting the Hurdles

Richa Wadhawan[1], Karishma Gautam[2], Siddhi Savla[3], Ezaz Ahmed[4], Rosy Borah[5], Nishu Sharma [6]

1. *Professor, Oral Medicine, Diagnosis & Radiology, PDM Dental College & Research Institute, Bahadurgarh, Haryana*
2. *Private Practitioner, The Family Dentist, Greater Noida, Uttar Pradesh*
3. *Dental Surgeon, DY Patil University School Of Dentistry, Navi Mumbai, Maharashtra*
4. *Dental Surgeon, A.B. Dental & Aesthetic Clinic, Nagaon, Assam*
5. *Dental Surgeon, Perfect 32 Dental Care Implant & Orthodontic Centre, Dibrugarh, Assam*
6. *Dental Surgeon, Institute Of Dental Education & Advance Studies, Gwalior, Madhya Pradesh*

Submitted: 10-09-2024 Accepted: 20-09-2024

ABSTRACT: Cracked tooth syndrome represents a significant diagnostic challenge in dentistry due to its subtle and nonspecific symptoms. Cracks often initiate in posterior teeth, particularly mandibular molars, and can progress over time, leading to complications such as pulpitis or tooth fracture. The etiology of cracked teeth is multi factorial, with factors including occlusal stress, age, and previous dental treatments contributing to their development. Early diagnosis is critical to preserve tooth structure and prevent further complications. Clinical examination methods, including magnification, staining, transillumination, and the bite test, are essential for identifying cracks that may not be visible initially. Radiographic imaging, while helpful, often falls short in early detection. Advanced techniques such as cone beam computed tomography (CBCT) can provide additional insights but have limitations. Effective management of cracked teeth typically involves a combination of conservative restorative approaches and, when necessary, endodontic treatment. Continued research into the diagnostic techniques and treatment options for cracked teeth is vital for improving patient outcomes and preserving dental health, as highlighted in this review.

Keywords: Cracked Tooth Syndrome, Diagnostic Challenge, Fractured tooth, Craze lines, Transillumination, Bite Test, Radiographic Imaging, Conservative & Endodontic Management

I. INTRODUCTION:

Teeth play a crucial role in mechanically processing food, facilitating speech, and enhancing both aesthetics and overall well-being. The tooth crown consists of hard enamel and dentine, which comprises three essential components that significantly influence its physical properties.[1] Inorganic material, primarily hydroxyl apatite, constitutes 60% of dentine, providing vital stiffness and compressive strength.[2] Organic material, mainly collagen, accounts for 30%, offering durability that enables the tooth to absorb strain and resist fractures.[3] Finally, water makes up 10% of dentine, contributing to its viscoelasticity and allowing it to absorb and distribute stress effectively.[4]

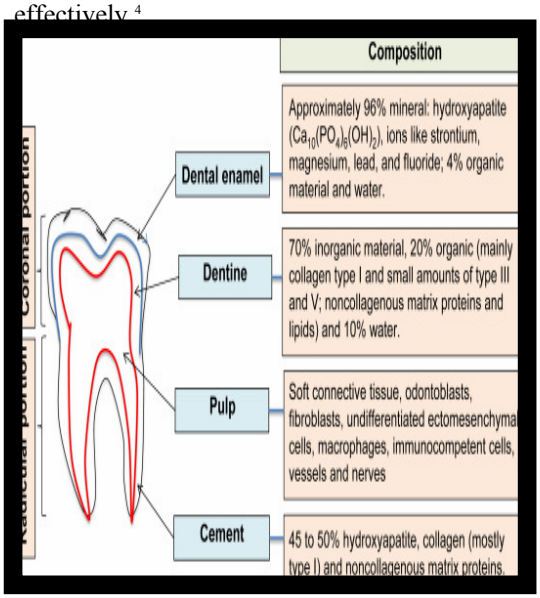

Figure 1: Dental structure and composition

Courtesy:
https://www.sciencedirect.com/topics/engineering/oral-environment

The amount of dentine in a tooth significantly affects its susceptibility to fractures.[5] The integrity of the interaxial dentine (**Figure 2**), which links the

International Journal Dental and Medical Sciences Research
Volume 6, Issue 5, Sep - Oct 2024 pp 144-156 www.ijdmsrjournal.com
ISSN: 2582-6018

tooth's axial walls and encases the central pulp space, is crucial for maintaining strength and resilience.[6]

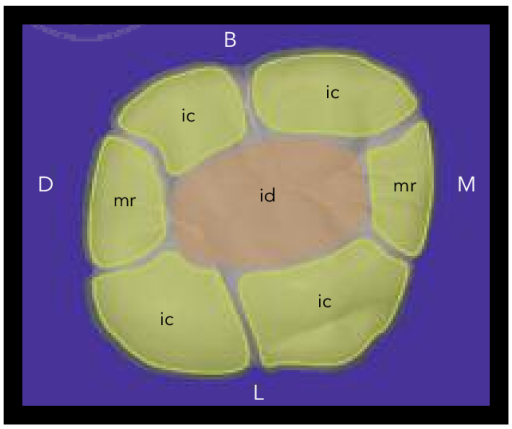

Figure 2: Interaxial dentine

Courtesy: Re D, Fichera G, Devoto W. Cavity configurations for indirect partial coverage adhesive-cemented restorations. Quintessence Dent Technol. 2006; 29: 55-67.

Furthermore, crack propagation patterns can vary considerably due to the tooth's intricate anatomy and layered structure, which directly influences how stress is distributed.[7] Patients with fractured teeth often report vague or inconsistent symptoms, particularly when the pulp is involved, leading to varying degrees of pain.[8] Symptoms in non-vital and root-filled teeth can differ markedly.[9] This review explores specifically on tooth fractures in teeth that have not undergone endodontic treatment, emphasizing the challenges and complexities associated with diagnosing and managing these conditions. Understanding these factors is essential for effective treatment and the restoration of dental health. Diagnosing a cracked tooth poses a challenge, as evaluating the severity of a crack and determining the appropriate treatment can be complex. Cracked teeth often exhibit ambiguous or intricate symptoms.[10] Cameron referred to the combination of a cracked tooth and its related signs and symptoms as "cracked tooth syndrome."[11] However, the term "syndrome" typically denotes a collection of factors that collectively confirm a specific condition, which may not apply to cracked teeth; thus, the term is now seldom used.[12] Prognosis is generally uncertain and depends on the extent of the crack. These cracks are primarily longitudinal, often originating from the tooth's crown.[13] Cracks and fractures can also occur at the root, leading to vertical root fractures (VRF) (**Figure 3**) , which pose severe complications following root canal treatment.[14]

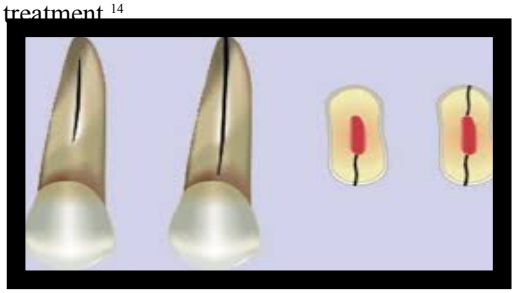

Figure 3: Vertical root fractures

Bhanderi S. Facts about cracks in teeth. Prim Dent J. 2021; 10 (1):20-27.

Over time, these cracks may extend either along the tooth's long axis or vertically at an angle. It is important to note that a crack or fracture is a finding rather than a definitive diagnosis, as it may or may not correlate with pathology, which requires further investigation.[15] Detecting a crack is an essential part of the clinical examination, as cracks and fractures can provide a pathway for bacterial invasion, potentially resulting in pulpal disease.[16] A crack is characterized as a surface discontinuity that may evolve into a fracture, leading to the actual separation of tooth fragments.[17] As patients age and maintain their natural teeth for longer periods, the prevalence of cracks may increase.[18] The American Association of Endodontics (AAE) classifies the types of cracks in teeth into several categories: craze lines (**Figure 4**) , which are superficial surface fractures; fractured cusps, involving a portion of the tooth's cusp breaking off; cracked teeth, characterized by a crack extending from the chewing surface towards the root; split teeth (**Figure 5**), which involve a complete division of the tooth into distinct segments; and VRF (**Figure 6**), occurring within the root itself. Each type presents unique challenges for diagnosis and treatment, emphasizing the need for careful evaluation in clinical practice.[19]

Figure 4: Craze lines in maxillary anterior teeth

International Journal Dental and Medical Sciences Research
Volume 6, Issue 5, Sep - Oct 2024 pp 144-156 www.ijdmsrjournal.com
ISSN: 2582-6018

Courtesy: https://suredental.com.au/what-are-the-lines-on-the-front-of-my-teeth/

Figure 5: Split tooth

Courtesy: https://rosefamilydentistrync.com/how-to-treat-a-cracked-tooth-in-graham-nc/

Figure 6: Types of cracked tooth

Courtesy: https://www.prakashdentalcare.in/2020/01/types-of-cracked-tooth/

Prevalence of tooth fracture: The prevalence of cracked teeth is around 80% in patients over 40 years of age.[20] The incidence of incomplete tooth fracture with vital pulps is 9.7%.[21] The average biting loads in humans range from 45.7 kg (males) to 36.4 kg (females), and the force ratio between molars, premolars, and incisors is 4:2:1, respectively.[22] Abnormal forces on teeth occurs in dental trauma, normal occlusal function, or due to parafunctional habits where these loads can be higher.[23] The effects of dental trauma and different levels of tooth fracture are well-documented.[24] Considering the effect of occlusal forces on tooth structure reveals how they can lead to fractures. Understanding these forces is essential for effective management and prevention strategies.[25] By analyzing the impact of biting pressure, grinding, and other mechanical stresses, dental professionals can develop tailored approaches to mitigate the risk of fractures and enhance overall dental health.[26] Mandibular second molars are the most commonly affected teeth, followed by mandibular first molars, maxillary premolars; maxillary teeth and mandibular premolars are the least affected.[27] The disto lingual cusp of mandibular molars is the most susceptible cusp for fracture.[28] Mandibular molars are more commonly affected than their maxillary counterparts, which may be explained in terms of a combination of their crown anatomy, inter cuspal contacts, and their proximity to the fulcrum of jaw rotation at the temporo mandibular joint, thus being subject to greater masticatory forces: the 'nutcracker effect.'[29] While it might seem that maxillary molars would be just as prone to fractures due to their distal position, their crown anatomy is actually quite different.[30] The oblique and transverse ridges of maxillary molars, which link the disto buccal and mesio buccal cusps to the mesio lingual cusp, make them more resistant to fracture compared to their mandibular counterparts.[31] They also have a large palatal cusp that often 'plunges' in between the buccal and lingual cusps of the opposing lower molar to create a wedging effect that separates these cusps.[32]

Aetiology: Cracked teeth can stem from a variety of causes, with trauma or injury being one of the most prevalent.[33] Bruxism, or nighttime teeth grinding, applies significant pressure on teeth, leading to cracks; studies have established a strong link between this habit and tooth fractures.[34] Misaligned teeth can exacerbate existing cracks by creating uneven pressure, while habits such as nail-biting or chewing on hard objects further stress the anterior teeth.[35] Sudden temperature changes in oral cavity can compromise tooth structure, and periodontal diseases like gingivitis or periodontitis can weaken teeth, making them more vulnerable to cracks.[36] Additionally, missing teeth or gaps can lead to increased pressure on remaining teeth, raising the risk of damage.[37] A calcium deficiency can cause brittleness, while aging is a critical factor, with nearly 80% of individuals over 40 experiencing cracked teeth.[38] When occlusal forces are applied to teeth, they affect specific areas of the tooth structure, creating a stress plane that can lead to cracks if the force exceeds the dentine's fracture

International Journal Dental and Medical Sciences Research
Volume 6, Issue 5, Sep - Oct 2024 pp 144-156 www.ijdmsrjournal.com
ISSN: 2582-6018

resistance. Restorative procedures can increase the risk of fracture by up to 29 times compared to healthy teeth.[39] Coronal fractures often occur from sudden bites on hard objects, creating localized stress that can lead to what's known as a "masticatory accident (**Figure 7**) "[40]

Figure 7: Intra oral periapical radiograph depicting coronal fracture of maxillary premolar

Courtesy:
https://oralradiology.wordpress.com/2011/06/10/this-week-in-the-clinic-coronal-fracture/

Over time, the cumulative effects of normal and parafunctional chewing can break down chemical and physical bonds along stress planes in the enamel and dentine, resulting in fractures.[41] This is particularly concerning as parafunctional habits are on the rise, especially among younger individuals, likely influenced by lifestyle and occupational stressors. The growing prevalence of cracked teeth underscores the need for awareness and preventive measures to protect dental health. This review will focus on cracks and fractures of teeth that are not related to trauma and their associated etiologies.[42]

II. DISCUSSION:

A cracked tooth can inflict sharp pain while chewing or sudden sensitivity to hot and cold, often leading to intermittent discomfort that complicates diagnosis, especially for subtle cracks. Prompt dental consultation is crucial; untreated cracks can escalate, resulting in severe pain and complications.[43] Some cracks are asymptomatic, allowing them to go unnoticed, while others may present with swollen gingiva or heightened sensitivity.[44] Factors like hard biting, teeth grinding, physical trauma, and large fillings contribute to this common issue.[45] Diagnosing cracked tooth syndrome is particularly challenging for dental practitioners due to its varied presentations and subtle symptoms.[46] Employing comprehensive diagnostic methods—such as thorough dental history assessments, magnified examinations, dental dye, and targeted X-rays—can enhance early detection and treatment outcomes. Recognizing the multi factorial nature of cracked teeth is vital for effective management, ultimately ensuring better care for affected patients and preventing further complications.[47]

Craze Lines: These typically affect only the enamel. They may appear on occlusal surfaces or the buccal and lingual sides. These lines are asymptomatic and usually do not necessitate treatment unless aesthetic issues arise. Transillumination can aid in differentiating a craze line from a cracked tooth; if the line obstructs light, it is likely a crack, while if the light travels through the entire crown; it is likely a craze line (**Figure 8**).[48]

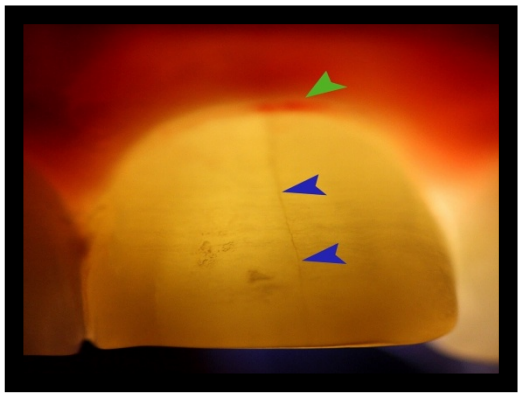

Figure 8: Craze lines seen through transillumination
Courtesy:https://commons.wikimedia.org/wiki/File:Transillumination_of_tooth_marked.jpg

Fractured Cusp: A fractured cusp occurs when a cusp detaches from the tooth due to a complete or incomplete break (**Figure 9**).[49]

International Journal Dental and Medical Sciences Research
Volume 6, Issue 5, Sep - Oct 2024 pp 144-156 www.ijdmsrjournal.com
ISSN: 2582-6018

Figure 9: Fracture of palatal cusp of maxillary premolar
Courtesy: González-López S, González-Villafranca MP, Bolaños-Carmona MV. A new approach to endodontic treatment and operative procedure in nonendodontically treated posterior crown root fractures. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2009; 108(5):e106-10.

These fractures can occur with or without facial trauma and typically begin at the occlusal surface, extending toward the cervical region of the tooth or root.[50] They are often linked to large restorations or significant decay, and patients may experience pain when releasing bite pressure or during percussion.[51] Pulp involvement can vary; fractures above the gingival line generally have a better prognosis than those below it.[52] Treatment is typically straightforward if the tooth can be repaired, but root canal therapy may be necessary if the pulp is compromised.[53] Research by Bader et al. on cusp fractures found that most cases resulted in dentin exposure, with only a few leading to pulp exposure, and many affected teeth had prior restorations.[54] Their survey indicated that lingual cusps in mandibular molars were more prone to fracture than buccal cusps, while buccal cusps in maxillary premolars were more frequently fractured.[55] In maxillary molars, the mesiobuccal and distolingual cusps were the most commonly fractured. They also noted that subgingival fracture extensions were rare and that most impacted teeth remained vital.[56]

Cracked Tooth: A cracked tooth typically presents as an incomplete fracture starting at the crown and extending downward.[57] These cracks are often seen in mandibular molars, usually centrally located, and can cross one or both marginal ridges, potentially reaching the proximal surfaces.[58] While these fractures predominantly run mesio distally, research by Seo et al. indicates that they can also occur in the bucco lingual direction.[59] Roh and Lee found that mesio distal cracks are the most frequent, although bucco-lingual variations can also occur.[60] Such cracks may exist in both intact and restored teeth, often visible in un restored areas and the cavity floor after restoration removal.[61] Detection can be improved with staining and transillumination, though early diagnosis can be challenging.[62] Patients frequently experience pain while chewing, and according to Seo et al., the bite test is the most dependable method for identifying a cracked tooth.[63] If the fracture reaches the pulp, it can lead to pulpal complications and associated symptoms, with a deep, narrow pocket sometimes observed.[64] Conservative treatment with resin restorations is possible if there are no signs of irreversible pulpitis, though regular follow-ups are crucial.[65] For deeper cracks involving the pulp, root canal therapy may be required. Additionally, cracks can extend to the pulpal floor or into the root. A cracked tooth may evolve into a split tooth if the crack deepens and widens, separating fragments; such teeth typically have a poor prognosis and may necessitate extraction.[66]

Predisposing Factors: Cracks are more frequently observed in posterior teeth and tend to increase with age.[67] Kang et al. noted that mandibular molars are especially prone to cracks, a finding supported by Hiatt, likely due to their proximity to the temporo mandibular joint, which subjects them to greater masticatory stress.[68] The anatomical structure of molars also plays a role; an ideal cusp-fossa relationship can create compressive stresses on the cusp and tensile stresses in the fossa, potentially leading to cracks in the fossa, which may be weaker due to calcification zone coalescence.[69] Additionally, the lingual cusps of maxillary teeth may exert excess force on mandibular teeth, contributing to their failure.[70] An oblique ridge in maxillary teeth may enhance their fracture resistance.[71] However, Roh and Lee found that cracks are more prevalent in maxillary molars, noting that lingually tilted mandibular molars in the Korean population may cause buccal cusps to function as plungers against maxillary molars.[72] Age is a significant factor, with Kang et al. reporting a higher incidence of cracked teeth in individuals over 50.[73] Seo et al. found that most patients with cracks were aged 40 to 50, while very few aged 60 to 70 had cracked teeth, possibly due to earlier treatment or fewer remaining teeth.[74] Ratcliff et al. similarly noted that most cracked posterior teeth were seen in individuals aged 40 to

International Journal Dental and Medical Sciences Research
Volume 6, Issue 5, Sep - Oct 2024 pp 144-156 www.ijdmsrjournal.com
ISSN: 2582-6018

49, indicating that excursive interferences and parafunctional habits may heighten the risk of cracks in posterior teeth.[75] Roh and Lee also indicated that the prevalence of cracks rises after age 40.[76] Gender has been evaluated as a predisposing factor, with no specific preference observed; however, Kang et al. reported higher rates of cracks in 61% males.[77] In early stages, cracked teeth exhibit nonspecific symptoms, like pain during biting or mastication, and initial cracks may not be visible even with staining.[78] Diagnosis improves with techniques such as magnification, staining, trans illumination, and the bite test.[79] If a tooth is restored, all restorations may need removal for accurate diagnosis.[80] Magnification tools and methylene blue dye can help locate cracks, while trans illumination shows changes in light intensity at fracture sites.[81] The bite test effectively reproduces symptoms.[82] Radiographs are less useful for coronal cracks but may reveal vertical bone loss or fragment separation in advanced cases.[83] Research indicates cracked teeth are common in both intact and restored teeth, with varying susceptibility based on restoration type. Treatment typically involves removing cracked sections and restoring the tooth, with options dependent on the depth of the crack.[84]

VRF differ from coronal cracks by originating in the root and typically extending in a bucco lingual direction.[85] Prevalence studies suggest that VRF is more common in endodontically treated teeth, particularly molars.[86] Factors such as prior root canal treatments can increase the risk of VRF.[87] Older patients (>40 years) with overfilled root canals are also at higher risk, and roots that are flattened mesiodistally have been found to be particularly prone to VRF.[88]

Age and VRF: Aging may alter the mechanical behavior and properties of dentin. As individuals age, there is an increase in the thickness of both coronal and radicular dentin. The dentinal tubules undergo significant changes, with mineral deposition leading to reduced tubule diameters and a phenomenon known as sclerotic dentin, which can make dentin appear more transparent.[86] Thomas et al. reported that sclerotic dentin is especially pronounced in teeth that have undergone endodontic treatment, regardless of the patient's age.[87] Dentin also tends to become more brittle with age, with older dentin exhibiting reduced flexural strength and energy required for fracture.[88] Kinney et al. found that sclerotic dentin has lower fracture toughness, and changes in collagen cross-linking may also contribute to the alterations in mechanical properties. These age-related changes must be considered during endodontic treatment for older individuals.[89]

Clinical Signs and Symptoms: Early diagnosis of VRF is essential to preserve surrounding bone, which may facilitate future restoration.[90] VRF can occur during procedures such as obturation or post placement, but symptoms may manifest years after the endodontic treatment is completed.[91] Indicators of VRF include deep, narrow periodontal pockets and a "halo" radiolucency, which differs from the broad-based pockets typically seen in periodontal disease. This breakdown of periodontal tissue can result from necrotic debris and bacteria accumulating within the fracture. [92]

Diagnosis: Radiographs and CBCT are important tools in diagnosing VRF.[93] For a VRF to be visible on an X-ray, the primary beam must be oriented within 4° of the fracture plane.[94] In advanced stages, where fragment separation occurs, radiographs will typically reveal the fracture.[95] A common radiographic finding in VRF is a "halo"-shaped radiolucency seen on the lateral aspect of the root, extending apically.[96] CBCT offers three-dimensional imaging, allowing for better visualization of complex anatomical structures. It has become the imaging method of choice for challenging diagnostic scenarios.[97] While CBCT can be useful in assessing endodontically treated teeth for VRF, interpreting these images can be difficult due to the presence of obturating materials. Both digital radiography and CBCT have limitations in early VRF diagnosis (**Figure 10**).

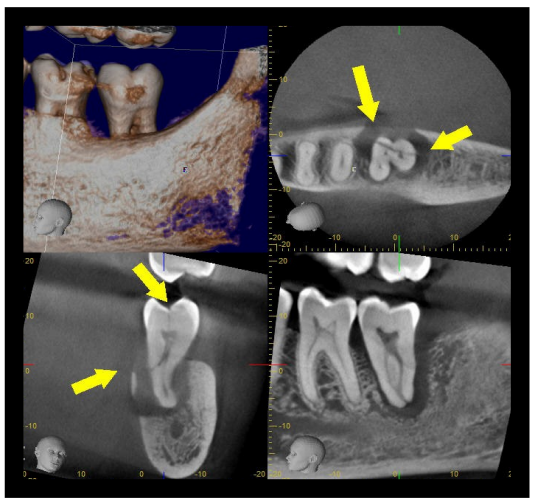

Figure 10: CBCT depicting vertical root fracture

Courtesy: Venkatesh A, Subbiya A, Suresh M, Prakash V. Diagnosis of Vertical Root Fracture:

International Journal Dental and Medical Sciences Research
Volume 6, Issue 5, Sep - Oct 2024 pp 144-156 www.ijdmsrjournal.com
ISSN: 2582-6018

A Review. Indian J Public Health Res Dev. 2019; 10(12):2149-52.

However, CBCT may aid in identifying subtle changes in periradicular bone before the fracture is visibly detectable and can show bone destruction before it involves the cortical plate. For VRF to be visible on CBCT, the fracture width must be at least double the voxel size of the imaging machine. Maximum widths of natural fractures have been reported between 60 and 770 µm. A recent review concluded that there is insufficient evidence to confirm CBCT's reliability in detecting VRF in endodontically treated teeth.[98] The definitive method for identifying a VRF remains direct visualization of the fracture line on the root surface following surgical exploration or using a dental operating microscope for intracanal visualization. The treatment for VRF is extraction of the tooth or root. As VRF can result in loss of bone around the cracked root, early diagnosis and treatment can help in conservation of bone which will help in future restoration of that area.[99]

Management: Home remedies like warm rinses, over-the-counter pain medications, and cold compresses may provide temporary relief. Cracks are more common in individuals over 40, particularly women, and vary in severity from minor craze lines needing no treatment to significant cracks like split teeth or vertical root fractures, which may require extraction.[100] Treatment options depend on the crack's location and severity, ranging from monitoring minor cracks to crowns or root canal therapy for severe cases (**Figure 11**).[101]

Figure 11: Root canal treatment of fractured maxillary lateral incisor

Courtesy: Baba NZ, Goodacre CJ. Restoration of endodontically treated teeth: contemporary concepts and future perspectives. Endod Topics. 2014; 31:68-83.

Untreated cracks can lead to infections, evidenced by increased pain, swollen gingiva, and sensitivity, necessitating drainage and antibiotics.[102] While not all cracked teeth can be prevented, strategies such as avoiding hard foods, addressing grinding habits, and using mouth guards during sports can help mitigate risk.[103] Cracked teeth can be treated in various ways, depending on factors such as the location, symptoms, size, and extent of the crack. In some cases, an emergency dentist may be necessary.[104] Common treatments include bonding, where a durable, tooth-colored resin is applied and hardened with a special tool; crowns, which are ceramic or porcelain devices placed over damaged teeth; and veneers, which involve applying thin layers of plastic or porcelain to the tooth surface, albeit at a higher cost than bonding (**Figure 12**).[105]

Figure 12: Dental veneers in management of fracture of maxillary anterior teeth

Courtesy: Castelnuovo J, Tjan AHL, Phillips K, Nicholls JI, Kois JC. Fracture load and mode of failure of ceramic veneers with different preparations. J Prosthet Dent. 2000; 83(2):171-80.

For extensive cracks that expose and infect the pulp, a root canal may be appropriate, as it removes the damaged pulp and helps maintain the tooth's integrity.[106] Composite resin (**Figure 13**) can effectively hide fractures and restore aesthetics, especially for minor issues like craze lines or hairline fractures. Extraction (**Figure 14**) becomes the last resort when the crack is so severe that repair is impossible, as attempting to restore it could harm the nerves and roots (**Figure 15**).

International Journal Dental and Medical Sciences Research
Volume 6, Issue 5, Sep - Oct 2024 pp 144-156 www.ijdmsrjournal.com
ISSN: 2582-6018

Figure 13: Composite build up of fractured maxillary anterior tooth
Courtesy:
https://sparkledentalcare.co.in/Broken-teeth-repair-specialist-in-mumbai

Figure 14: Extraction of fractured tooth
Courtesy: https://www.glowdental.co.nz/dental-conditions/cracked-tooth-syndrome/

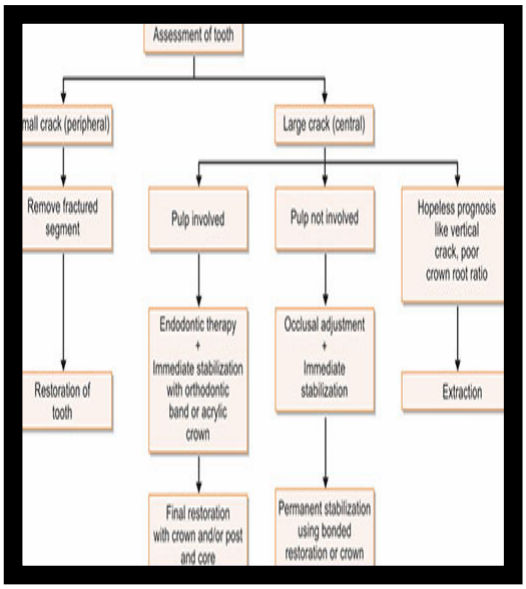

Figure 15: Flow chart of management of crack tooth
Courtesy:
https://www.jaypeedigital.com/book/9789350909522/chapter/ch32

Additionally, treatments like whitening toothpaste, professional whitening, high-quality fluoride toothpaste, and maintaining good oral hygiene can also contribute to overall dental health.[105] To prevent cracked teeth, many causes can be addressed with some simple tips. First, it's crucial to stop clenching and grinding teeth, which are among the most common culprits. Dentists often recommend using a nightguard (**Figure 16**) or making lifestyle changes, such as reducing stress, to combat bruxism.[106]

Figure 16: Night guard
Courtesy:
https://prestigedentalpasadena.com/benefits-of-nightguards.aspx

International Journal Dental and Medical Sciences Research
Volume 6, Issue 5, Sep - Oct 2024 pp 144-156 www.ijdmsrjournal.com
ISSN: 2582-6018

Correcting misalignment is also important, as uneven bites can create pressure that leads to cracks; orthodontic devices can help address these issues.[107] Quitting smoking is essential, as tobacco products can weaken teeth, making them more susceptible to damage. Maintaining proper oral hygiene is vital for preserving the strength and integrity of teeth, helping to prevent cracks and fractures. Additionally, it's wise to break bad habits like nail-biting or chewing on hard objects, as these can exert pressure on teeth and lead to fractures.[108] To avoid sudden temperature changes that can crack teeth, steer clear of extremely hot or cold foods. Lastly, a calcium-rich diet can help counteract the effects of aging on body, promoting stronger bones and healthier teeth. By incorporating these practices, can significantly reduce the risk of cracked teeth.[109]

Future Prospects: Diagnosing cracked teeth presents several challenges, but advancements in technology and techniques are paving the way for improved outcomes. Enhanced imaging modalities, such as CBCT, offer clearer visualization of cracks for earlier and more accurate diagnosis. The integration of artificial intelligence in dental diagnostics may assist in identifying subtle patterns in radiographs, increasing detection rates of cracks that might otherwise go unnoticed.[110] Innovations in restorative biomaterials could improve bonding and reinforcement of cracked teeth, enhancing their longevity and reducing the risk of complications. Standardizing comprehensive examination protocols, including magnification and staining techniques, can further enhance crack detection and ensure consistency across practices. Additionally, increasing patient awareness regarding the signs and symptoms of cracked teeth can lead to earlier dental visits, improving management outcomes. Encouraging interdisciplinary collaboration between general dentists and specialists will also promote knowledge sharing and improve treatment strategies. By embracing these advancements, the dental community can better address the challenges of diagnosing cracked teeth, ultimately enhancing patient care and outcomes.[111]

III. CONCLUSION:

Cracks and fractures in teeth often go unnoticed, particularly in their early stages, underscoring the critical need for heightened awareness among dental professionals. Recognizing craze lines and cracks is not just a routine task; it's a vital part of a thorough intraoral examination, especially when patients report discomfort during mastication. To address this challenge effectively, a nuanced approach is essential for identifying, classifying, and managing cracked teeth. Diagnosing cracked teeth is a complex endeavor that requires a multifaceted strategy. By dismantling barriers such as inadequate imaging techniques, inconsistent diagnostic protocols, and low patient awareness, dental professionals can significantly enhance their diagnostic accuracy. Embracing advanced technologies like CBCT and artificial intelligence allows for clearer insights into tooth structures, while standardized protocols foster reliable assessments across practices. Moreover, empowering patients through education and promoting interdisciplinary collaboration will enable both practitioners and patients to recognize early signs of cracks, facilitating timely and effective interventions. As we continue to innovate and refine our diagnostic methods, the dental community will be better equipped to confront the intricacies of cracked teeth, ultimately transforming patient care and preserving dental health for future generations.

Financial support and sponsorship Nil
Conflicts of interest There are no conflicts of interest

REFERENCES:

[1]. Coppens CRM, De Moor RJG. Prevalence of vertical root fractures in extracted endodontically treated teeth. Int Endod J. 2003; 36:926.
[2]. Ehrmann BH, Tyas MJ. Cracked tooth syndrome: diagnosis, treatment and correlation between symptoms and post extraction findings. Aust Dent J. 1990; 35(2):105-112.
[3]. Berman LH, Rotstein I. Diagnosis. In: Hargreaves K, Berman L, editors. Cohen's pathways of the pulp. 1st South Asia ed. St. Louis: Elsevier; 2016. p. 2-32.
[4]. Pires FR, Benfato ID, de Oliveira RR, et al. Effect of fiber-reinforced composite post on fracture resistance of endodontically treated teeth. J Prosthet Dent. 2018; 119(5):770-774.
[5]. Alshahrani A, Alshahrani M, Alkhuraisi N, et al. Comparison of fracture resistance between endodontically treated teeth restored with different techniques. J Dent. 2019; 87:89-95.

[6]. Huang C, Wang Z, Huang Y, et al. The effect of ferrule height on the fracture resistance of endodontically treated teeth. J Prosthodont. 2019; 28(1):9-14.
[7]. De Sousa A, et al. Radiographic assessment of root fractures in endodontically treated teeth. Dentomaxillofac Radiol. 2014; 43(7):20140001.
[8]. Pashley DH, Tay FR, Loushine RJ, et al. The effects of endodontic procedures on the properties of dentin. J Endod. 2009; 35(2):210-221.
[9]. Sim IG, Lim TS, Krishnaswamy G, Chen NN. Decision making for retention of endodontically treated posterior cracked teeth: a 5-year follow-up study. J Endod. 2016; 42(2):225-229.
[10]. Hiatt WH. Incomplete crown-root fracture in pulpal-periodontal disease. J Periodontol. 1973; 44(6):369-379.
[11]. Cameron CE. The cracked tooth syndrome: additional findings. J Am Dent Assoc. 1976; 93(5):971-975.
[12]. Pitts DL, Natkin E. Diagnosis and treatment of vertical root fractures. J Endod. 1983; 9(8):338-346.
[13]. Berman LH, Kuttler S. Fracture necrosis: diagnosis, prognosis assessment, and treatment recommendations. J Endod. 2010; 36(3):442-446.
[14]. Cargnelutti G, et al. Analysis of factors associated with the prognosis of endodontically treated teeth with vertical root fractures. J Endod. 2017; 43(5):836-841.
[15]. Morfis AS. Vertical root fractures. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1990; 69 (5):631-635.
[16]. Vire DE. Failure of endodontically treated teeth: classification and evaluation. J Endod. 1991; 17(7):338-342.
[17]. Fuss Z, Lustig J, Tamse A. Prevalence of vertical root fractures in extracted endodontically treated teeth. Int Endod J. 1999; 32(4):283-286.
[18]. Touré B, Faye B, Kane AW, Lo CM, Niang B, Boucher Y. Analysis of reasons for extraction of endodontically treated teeth: a prospective study. J Endod. 2011; 37(11):1512-1515.
[19]. American Association of Endodontists. Cracking the cracked tooth code: detection and treatment of various longitudinal tooth fractures. In: Endodontics: colleagues for excellence. Chicago: American Association of Endodontists; 2008. p. 1-8.
[20]. Borén DL, Jonasson P, Kvist T. Long-term survival of endodontically treated teeth at a public dental specialist clinic. J Endod. 2015; 41(2):176-181.
[21]. Pradeep Kumar AR, Shemesh H, Jothilatha S, Vijayabharathi R, Jayalakshmi S, Kishen A. Diagnosis of vertical root fractures in restored endodontically treated teeth: a time-dependent retrospective cohort study. J Endod. 2016; 42(8):1175-1180.
[22]. Cohen S, Berman LH, Blanco L, Bakland L, Kim JS. A demographic analysis of vertical root fractures. J Endod. 2006; 32 (12):1160-1163.
[23]. Tamse A, Kaffe I, Lustig J, Ganor Y, Fuss Z. Radiographic features of vertically fractured endodontically treated mesial roots of mandibular molars. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2006; 101(6):797-802.
[24]. Arola D, Ivancik J, Majd H, FouadA, Bajaj D, Zhang XY, Eidelman N. Microstructure and mechanical behaviour of radicular and coronal dentin. Endod Topics. 2009; 20(1):30-51.
[25]. Thomas GJ, Whittaker DK, Embery G. A comparative study of translucent apical dentine in vital and non-vital human teeth. Arch Oral Biol. 1994; 39(1):29-34.
[26]. Arola D, Reprogel RK. Effects of aging on the mechanical behavior of human dentin. Biomaterials 2005; 26(18):4051-4061.
[27]. Kinney JH, Nalla RK, Pople JA, Breunig TM, Ritchie RO. Age-related transparent root dentin: mineral concentration, crystallite size, and mechanical properties. Biomaterials. 2005; 26(16):3363-3376.
[28]. Rivera EM, Yamauchi M. Site comparisons of dentine collagen cross-links from extracted human teeth. Arch Oral Biol. 1993; 38(7):541-546.
[29]. Fuss Z, Lustig J, Katz A, Tamse A. An evaluation of endodontically treated vertical root fractured teeth: impact of operative procedures. J Endod. 2001; 27(1):46-48.

[30]. Walton RE, Michelich RJ, Smith GN. The histopathogenesis of vertical root fractures. J Endod 1984; 10(2):48-56.
[31]. Rud J, Omnell KA. Root fractures due to corrosion: diagnostic aspects. Scand J Dent Res. 1970; 78(5):397-403.
[32]. Nair MK, Levin, MD.; Nair, UP. Radiographic interpretation. In: Hargreaves K, Berman L, editors. Cohen's pathways of the pulp. First South Asia ed. St. Louis: Elsevier; 2016. p. 33-70.
[33]. 33.Khedmat S, Rouhi N, Drage N, Shokouhinejad N, Nekoofar MH. Evaluation of three imaging techniques for the detection of vertical root fractures in the absence and presence of gutta percha root fillings. Int Endod J. 2012; 45(11):1004-1009.
[34]. Chavda R, Mannocci F, Andiappan M, Patel S. Comparing the in vivo diagnostic accuracy of digital periapical radiography with cone-beam computed tomography for the detection of vertical root fracture. J Endod. 2014; 40(10):1524-1529.
[35]. Metzger Z, Berman LH, Tamse A. Cracks and fractures. In: Hargreaves K, Berman L, editors. Cohen's pathways of the pulp. First South Asia ed. St. Louis: Elsevier; 2016. p. 793-817.
[36]. Chang E, Lam E, Shah P, Azarpazhooh A. Cone-beam computed tomography for detecting vertical root fractures in endodontically treated teeth: a systematic review. J Endod. 2015; 42(2):177-185.
[37]. Mounce R. The role of the operator in the management of cracked teeth. J Endod. 2015; 41(9):1579-1585.
[38]. Vasilakos G, Kafantaris N, Karamouzos A, et al. Evaluation of the effectiveness of different restorative materials on the fracture resistance of endodontically treated teeth. J Dent. 2016; 49:30-35.
[39]. Pashley DH, Tay FR, Loushine RJ, et al. The effects of endodontic procedures on the properties of dentin. J Endod. 2009; 35(2):210-221.
[40]. Bittner N, Scherer W, Gernhardt CR. The impact of restorative materials on the fracture resistance of endodontically treated teeth. Dent Mater. 2012; 28(4):459-466.
[41]. Pitel M, Szep S, et al. Fracture resistance of endodontically treated teeth with various restorative techniques. J Prosthodont. 2014; 23(5):372-378.
[42]. Ahlawat J, Kumar S, Kumar V, et al. Incidence and causes of vertical root fractures in endodontically treated teeth: a retrospective study. J Endod. 2017; 43(9):1465-1470.
[43]. Lopes HP, et al. Correlation between the type of tooth and the occurrence of vertical root fractures. J Endod. 2016; 42(11):1611-1616.
[44]. Figueiredo F, Nascimento E, et al. Prevalence of root fractures in endodontically treated teeth. Int Endod J. 2017; 50(3):284-290.
[45]. Wilcox LR, et al. The influence of post design on fracture resistance of endodontically treated teeth: a systematic review. J Prosthodont. 2015; 24(5):358-367.
[46]. De Lima AF, et al. Root canal filling materials and the risk of vertical root fracture: a systematic review. J Endod. 2018; 44(4):657-664.
[47]. Ounsi HF, et al. Diagnosis and management of cracked tooth syndrome: a clinical review. J Dent. 2015; 43(1):1-7.
[48]. Lin W, et al. Analysis of the fracture resistance of endodontically treated teeth with different ferrule designs. J Prosthodont. 2016; 25(3):228-233.
[49]. Gherlone E, et al. Cracked teeth: epidemiology and treatment options. Oral Health Prev Dent. 2013; 11(4):329-335.
[50]. Nair PN, et al. Vertical root fractures: a histological perspective. J Endod. 2003; 29(3):169-174.
[51]. Stankiewicz N, et al. The impact of post space preparation on the structural integrity of endodontically treated teeth. J Prosthodont. 2014; 23(7):513-520.
[52]. Mavridou A, et al. The role of adhesive materials in the reinforcement of endodontically treated teeth. Dent Mater. 2015; 31(9):e233-e239.
[53]. Schmitt VL, et al. In vitro evaluation of the fracture resistance of roots restored with different post systems. J Endod. 2015; 41(7):1114-1119.
[54]. Bader JD, Martin JA, Shugars DA. Incidence rates for complete cusp fracture. Community Dent Oral Epidemiol. 2001; 29(5):346-353.

[55]. Tavares M, et al. Prevalence of cracks in endodontically treated molars. J Endod. 2016; 42(3):429-433.
[56]. Ramezani J, et al. The role of dental ceramics in the reinforcement of cracked teeth. J Dent. 2016; 49:72-78.
[57]. Lee S, et al. Clinical and radiographic features of cracked teeth: a systematic review. J Endod. 2015; 41(10):1586-1594.
[58]. Salas C, et al. Cracked tooth syndrome: a critical review. Dent Clin North Am. 2014; 58(3):501-518.
[59]. Seo DG, Yi YA, Shin SJ, Park JW. Analysis of factors associated with cracked teeth. J Endod. 2012; 38(3):288-92.
[60]. Saatchi M, et al. The role of cone-beam computed tomography in diagnosing cracked teeth. J Endod. 2016; 42(12):1790-1795.
[61]. Valois CR, et al. Cracked tooth syndrome: diagnosis and management. Gen Dent. 2015; 63(1):38-42.
[62]. Reddy S, et al. Assessment of the incidence of vertical root fractures using different imaging techniques. J Endod. 2017; 43(4):634-638.
[63]. Moreira J, et al. Impact of different obturation techniques on the fracture resistance of endodontically treated teeth. J Endod. 2018; 44(8):1222-1227.
[64]. Kato AS, et al. The influence of temporary restorative materials on the fracture strength of endodontically treated teeth. J Endod. 2014; 40(8):1201-1205.
[65]. Ozel S, et al. The effect of dentin bonding agents on the fracture resistance of endodontically treated teeth. J Dent. 2016; 49:72-78.
[66]. Mota de Sousa A, et al. Effectiveness of cone-beam computed tomography in detecting vertical root fractures. J Endod. 2018; 44(1):1-8.
[67]. Leung V, Wang Y, Wong E, et al. Effect of tooth whitening on the fracture resistance of endodontically treated teeth. J Dent. 2019; 87:96-101.
[68]. Kwon YH, Lee JH, Lee SH, et al. Influence of post and core systems on the fracture resistance of endodontically treated teeth: a systematic review. J Prosthet Dent. 2018;120(3):386-394.
[69]. Tjan AHL, Boucher CO. Fracture resistance of endodontically treated teeth restored with different crown materials. J Prosthet Dent. 2018; 119(3):387-394.
[70]. Sadek F, van der Meer W, Kreulen CM, et al. The effect of different luting agents on the fracture resistance of endodontically treated teeth: an in vitro study. Dent Mater. 2018; 34(1):43-48.
[71]. El-Gharbawy HM, Tashkandi E, Ibrahim H. A comparison of fracture resistance of teeth restored with different post systems: an in vitro study. J Endod. 2018; 44(4):676-680.
[72]. Roh BD, Lee YE. Analysis of 154 cases of teeth with cracks. Dent Traumatol. 2006; 22(3):118-123.
[73]. Sweeney WT, Pruitt J, Etienne J, et al. Assessment of root fracture resistance with various restorative techniques. J Dent. 2015; 43(5):561-566.
[74]. Darbar UR, Awan M, McMillan D, et al. The influence of adhesive bonding on the fracture resistance of endodontically treated teeth. Dent Mater. 2019; 35(3):414-421.
[75]. Ratcliff S, Becker IM, Quinn L. Type and incidence of cracks in posterior teeth. J Prosthet Dent. 2001; 86(2):168-172.
[76]. Morita K, Matsuura S, Yamada Y, et al. Role of ferrule design in the fracture resistance of endodontically treated teeth: a systematic review. J Endod. 2019; 45(3):356-364.
[77]. Kang SH, Kim BS, Kim Y. Cracked teeth: distribution, characteristics, and survival after root canal treatment. J Endod. 2016; 42(4):557-562.
[78]. Cekic-Nagas I, Miletic I, Miletic V, et al. Influence of different restorative materials on the fracture resistance of endodontically treated teeth. Dent Mater. 2019; 35(7):1121-1128.
[79]. Tavares M, de Oliveira TR, Freitas A, et al. Fracture resistance of endodontically treated teeth with different core designs. J Endod. 2019; 45(6):760-766.
[80]. Kahnberg KE, Lindh C, Svedberg A, et al. The impact of ferrule on fracture resistance of endodontically treated teeth. J Dent. 2019; 87:56-62.
[81]. Khoshhal M, Moutia A, Ibrahimi A, et al. Comparative study of the effect of

post space preparation techniques on fracture resistance of endodontically treated teeth. J Prosthodont. 2019; 28(1):36-42.
[82]. Sadeghi M, Sadeghi A, Hossaini M, et al. Comparison of fracture resistance of endodontically treated teeth with different types of posts. J Endod. 2018; 44(1):60-65.
[83]. Al-Quran F, Al-Tamimi A, Al-Shahrani H, et al. Effect of different types of composite materials on the fracture resistance of endodontically treated teeth. J Prosthodont. 2018; 27(2):120-126.
[84]. Khalil H, Vasilakos G, Karamouzos A, et al. Influence of post design on fracture resistance of endodontically treated teeth: a systematic review. J Dent. 2018; 79:83-90.
[85]. Leandro V, Almeida AL, Oliveira R, et al. The effect of coronal restoration on the fracture resistance of endodontically treated molars. J Endod. 2018; 44(7):1027-1032.
[86]. 86. Tang W, Wu Y, Smales RJ. Identifying and reducing risks for potential fractures in endodontically treated teeth. J Endod. 2010; 36(4):609-617.
[87]. Bittner N, Scherer W, Gernhardt CR. The impact of restorative materials on the fracture resistance of endodontically treated teeth. Dent Mater. 2012; 28(4):459-466.
[88]. Behr M, Hahnel S, Rosentritt M, et al. The influence of post design and adhesive cement on fracture resistance of endodontically treated teeth. J Endod. 2019; 45(4):465-470.
[89]. Al-Maweri SA, Al-Hamoudi N, Al-Khatti A, et al. Analysis of the fracture resistance of endodontically treated teeth with different restorative materials: a systematic review. J Endod. 2019; 45(1):17-25.
[90]. Kwon YH, Lee JH, Lee SH, et al. Influence of post and core systems on the fracture resistance of endodontically treated teeth: a systematic review. J Prosthet Dent. 2018; 120(3):386-394.
[91]. Gu Y, Zhang H, Wu X, et al. The effect of dentin bonding agents on the fracture resistance of endodontically treated teeth. J Dent. 2019; 87:40-45.
[92]. Sadiq M, Ali K, Ali A, et al. Comparative evaluation of fracture resistance of endodontically treated teeth restored with fiber-reinforced composite and conventional post systems. J Prosthodont. 2018; 27(6):525-531.
[93]. Thomas GJ, Whittaker DK. A comparative study of translucent apical dentine in vital and non-vital human teeth. Arch Oral Biol. 1994; 39(1):29-34.
[94]. Pineda M, Alzate A, Forero G, et al. The impact of restoration type on fracture resistance of endodontically treated teeth: a systematic review. J Prosthodont. 2018; 27(5):405-411.
[95]. Nair M, Bansal R, Gupta V, et al. A study of fracture resistance of endodontically treated teeth restored with different materials: an in vitro study. J Dent. 2019; 87:23-29.
[96]. Uctasli S, Arslan S, Akin H, et al. The effect of different restorative materials on the fracture resistance of endodontically treated teeth. Dent Mater. 2019; 35(3):421-426.
[97]. Jamal M, Raza H, Hakeem A, et al. Effect of temporary restorative materials on the fracture strength of endodontically treated teeth. J Endod. 2018; 44(7):1045-1049.
[98]. Caruso S, Paduano V, De Angelis F, et al. The role of immediate restoration on the fracture resistance of endodontically treated teeth: a systematic review. J Endod. 2019; 45(2):265-273.
[99]. Bafakeeh O, Al-Sudairy S, Ashmawy A, et al. Assessment of the effect of different filling materials on fracture resistance of endodontically treated teeth. J Prosthodont. 2018; 27(7):648-654.
[100]. Sadeghi M, Miri Z, Kaveh K, et al. The effect of various restorative techniques on the fracture resistance of endodontically treated teeth. J Endod. 2018; 44(2):295-300.
[101]. Camargo L, Almeida C, De Lima AF, et al. The influence of the restorative technique on the fracture resistance of endodontically treated teeth. J Dent. 2019; 87:34-39.
[102]. Al-Bayati B, Al-Ani S, Al-Ghanim A, et al. Comparison of fracture resistance of endodontically treated teeth restored with different materials: an in

vitro study. J Endod. 2018; 44(9):1413-1419.
[103]. Jabbari A, Lamey P, McCarthy R, et al. Assessment of the fracture resistance of endodontically treated teeth restored with different post systems. J Prosthodont. 2019; 28(8):887-892.
[104]. Sawhney A, Kaur G, Dutta S, et al. A comparative evaluation of fracture resistance of endodontically treated teeth with different coronal restorations: an in vitro study. J Dent. 2019; 87:63-68.
[105]. Maghaireh H, Al-Sharabi A, Jarrar A, et al. The influence of post design and material on fracture resistance of endodontically treated teeth: a systematic review. J Endod. 2019; 45(3):356-364.
[106]. Pires FR, Benfato ID, de Oliveira RR, et al. Effect of fiber-reinforced composite post on fracture resistance of endodontically treated teeth. J Prosthet Dent. 2019; 119(5):770-774.
[107]. Arslan H, Aladag A, Yilmaz B, et al. The impact of different core materials on the fracture resistance of endodontically treated teeth. J Endod. 2019; 45(6):826-831.
[108]. Sadeghi M, Jafari F, Yousefi H, et al. The effect of different bonding agents on the fracture resistance of endodontically treated teeth. J Dent. 2019; 87:99-105.
[109]. Mavridou A, et al. The role of adhesive materials in the reinforcement of endodontically treated teeth. Dent Mater. 2015; 31(9):e233-e239.
[110]. Geha H, Bakeman H, Al Khatib M, et al. Influence of ferrule height on the fracture resistance of endodontically treated teeth. J Prosthodont. 2019; 28(7):707-711.
[111]. Lee H, Kim J, Park J, et al. The role of intra-canal post design in the fracture resistance of endodontically treated teeth: a systematic review. J Endod. 2019; 45(11):1434-1440.