



Research Article

DENTINAL CRACKS- A REVIEW

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ABSTRACT

The definition of pain is described as "an unpleasant sensory and emotional feeling that is expressed in terms of such injury or associated with actual or potential tissue injury. "Cariou cavities, broken teeth, and exposed tooth roots are the most common causes of toothaches". Understanding how natural tooth structures are able to withstand mechanical stresses during masticatory activity can be aided by looking at the constitution of stress distribution throughout the intact tooth. Correct diagnosis depends on identifying fractures and cracks in teeth during clinical examination, especially if pulpal involvement is present. In clinical practice, cracked tooth condition presents a significant diagnostic problem. The unusual clinical features of this ailment and lack of awareness of it make accurate diagnosis and adequate therapy difficult. In a dental clinic, tooth fractures (crown or root fractures) are frequently seen emergencies. These could be clinically difficult cases to treat since full dental rehabilitation usually necessitates an interdisciplinary or multidisciplinary approach to therapy.

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INTRODUCTION

The failure of restorations and cyclic loads during mastication indicate how important it is to understand fatigue in dental materials. However, there are frequently clinical difficulties in detecting such failures. After periodontal disease and dental caries, problems associated with broken teeth are the third most common cause of tooth loss.

Two of the most annoying aspects of endodontic and restorative dentistry can be fractures and cracked roots. As a result, the diagnosis may be challenging because the symptoms can be ambiguous or precise. The degree of the fracture or crack determines how it should be treated clinically. The primary objective is to prevent possible cracks or fractures, and early diagnosis is crucial.^[1]

TERMINOLOGY

Craze lines

These are vertical, superficial lines that often develop in tooth enamel as a person ages. They are also known as superficial cracks or hairline cracks. Translucent craze lines may be possible. They might also seem brown, yellow, or grey. In posterior teeth, craze lines typically extend along the buccal and lingual surfaces and/or cross over marginal ridges. In the anterior teeth, long vertical craze lines are more prevalent.^[2]

FRACTURED CUSP

A fractured cusp can be either complete or incomplete, starting from the tooth's crown and extending sub-gingivally,

typically in both buccolingual and mesiodistal directions. One or both cusps are typically involved in the fracture, which then extends down a buccal or lingual groove, crosses the marginal ridge, and ends in the cervical region, either a bit subgingival or parallel to the gingival margin.

CRACKED TOOTH

An incomplete fracture that started from the crown and extended sub-gingivally and mesiodistally is referred to as a **cracked tooth**. Additionally, it may pass through one or both proximal surfaces and marginal ridges.^[2] These kinds of cracks often cause damage to the delicate pulp, necessitating root canal therapy. Tooth extraction is also necessary occasionally.

SPLIT TOOTH

An untreated cracked tooth is typically the cause of a split tooth. It is distinguished by a crack consisting of separate pieces. It is symptomatic of a crack that splits the tooth into two distinct segments and typically extends through both marginal ridges in a mesio-distal manner.

VERTICAL ROOT FRACTURE

A complete or partial vertical root fracture originates from the root at any position and is typically directed buccolingually thus referred to as a "true" vertical root fracture. The crack is usually complete, although it might not be complete and only damage one surface. The complete root or only a section of it

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may be affected by the crack. However, they might not get noticed and exhibit little manifestations.^[3]

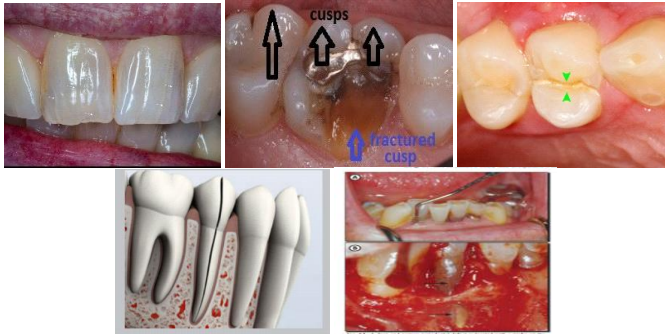


Figure 1

INCIDENCE

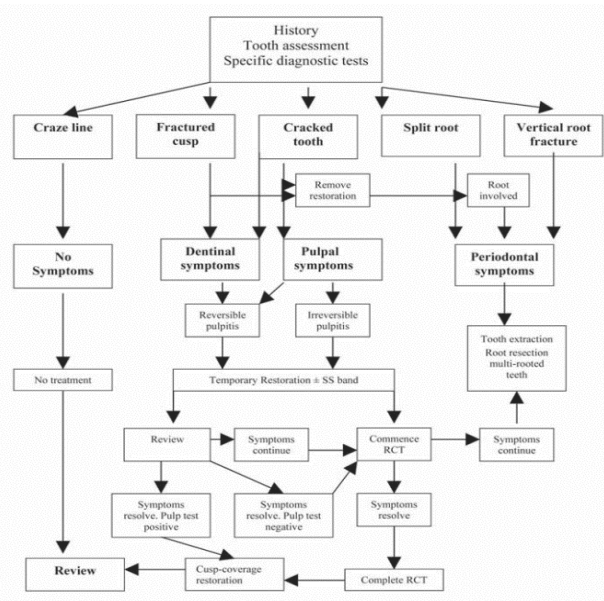
According to Cameron ^[4], patients over 40 years accounted for 80% of the 102 cases of tooth fractures. According to other publications ^[5], intra-coronal restorations are frequently linked to the incidence and prevalence of cracked teeth, with mandibular molars experiencing the highest frequency of this condition. The mandibular premolars are the least prone to fracture than the maxillary molars and premolars, which have comparable rates of damage. The mandibular molar cusp that is most prone to fracture is the distolingual cusp. Compared to functional cusps, non-functional cusps might be more prone to fracture. Therefore, the majority of people who have fractured teeth are adults.

CLASSIFICATION

The American Association of Endodontists provides a brief description in a publication titled "*Cracking the Cracked Tooth Code.*" (Table 1)

DIAGNOSIS OF PAIN IN CRACKED TOOTH

Treatment flow chart for cracked teeth classified by AAE in summary form.^[6]



CRAZE LINES

Superficial, thin lines visible up on the tooth enamel's surface. They do not damage the inside of the tooth or go beyond the gum line. Everyday wear and tear from biting, grinding, and

chewing is what causes them. These microscopic fissures may get deeper and more noticeable over time.^[8]

<i>CRAZE LINES</i>	v/s	<i>CRACKED TEETH</i>
Thin & shallow		Deeper & broad
Affect outer enamel		Affects the complete tooth



Figure 2

<i>ETIOLOGY</i>	<i>SYMPTOMS</i>
1. Large fillings that strain your teeth as they don't give your tooth sufficient support.	1. Heat and cold sensitivity is one of the signs & symptoms of craze lines.
2. They occur as you bite or chew on something hard, like chicken bones, fruit stones or ice. The hard biting pressure is what causes them to form.	2. Discomfort on biting or chewing, particularly after the bite is released.
3. Quick variations in mouth temperature, usually brought on by meals and beverages this is due to the rapid expansion and contraction of our teeth termed as Percolation.	3. Gums around teeth that are swollen.
4. Age: People over the age of 50 are more likely to experience teeth cracking.	

Different diagnostic methods include

S.no.	Methods	
1	Indentation test	You can accomplish this by pressing a pointed object against the tooth's surface. The tooth most likely incorporates craze lines if it indents readily.
2	Trans Illumination test	In works on, fiber optic laser which is applied on to the tooth after it is allowed to air dry. It gets reflected back when there are craze lines, but doesn't reflect when the tooth is cracked.
3	Dye penetration test	It involves applying a unique dye to the tooth's crazes and cracks, allowing the dye to seep through; called as Methylene Blue dye , penetrates craze lines & visually adheres on cracks.

Table 1 Classification of Cracked teeth

CLASSIFICATION	ORIGINATE	DIRECTION	SYMPTOMS	PULP STATUS	PROGNOSIS
<i>Craze Line</i>	Crown	Variable	None	Vital	Excellent
<i>Fractured Cusp</i>	Crown	M-D and/or F-L	Mild & generally, only to biting and cold	Usually Vital	Good
<i>Cracked Tooth</i>	Crown± Root	M-D often Central	Acute pain on biting Occasionally sharp pain to cold	Variable	Questionable: Dependent on depth & extent of the crack
<i>Split Tooth</i>	Crown+ Root	M-D	Marked pain on chewing	Often root filled	Poor unless crack terminates just sub-gingivally
<i>Vertical Root Fracture</i>	Roots	F-L	Vague pain Mimics periodontal disease	Mainly root filled	Poor: Root resection in multi-rooted tooth

TREATMENT: To some extent, these minimal cracks on teeth are not serious, but how they are treated relies on a variety of circumstances, such as where the crack is, and whether or not it extends beyond the gum line. Drilling away the craze lines is the only method to correct them and remove them. Following are some common choices for recovering the tooth:

S.No.	Ways	
1.	Dental bonding	Placing composite bonding to restore the drilled-away craze line is the most conservative way.
2.	Crowns	A crown might be a preferable choice if we have several craze lines, such as from a huge dental filling. The rationale is that dental crowns will completely enclose the tooth.
3.	Veneers	Dental veneers would be a more aesthetically pleasing alternative to bonding that are limited to the front teeth. Because they are composed of porcelain and are more color stable.
4.	Root Canal	In order to remove the necrosed pulp and restore the integrity of the tooth, a root canal procedure is recommended if the crack extends to the pulp.

CRACKED AND FRACTURED CUSPS

A crack that allows for minuscule flexure during mastication between a cusp and the rest of the tooth structure is what defines a Cracked cusp. Usually, the pulp is not involved in this crack. The crack may progress and cause the cusp to fracture.^[8]

ETIOLOGY

- Teeth grinding, also known as Bruxism:** If we grind our teeth at night, the cusps begin to break off followed by the enamel becomes impacted.
- Carbonated or Sugary Food:** They should be consumed in moderation. When sugar and plaque on teeth interact, an acidic reaction is produced that is harmful for the surface of our teeth.
- Over-Fluoride:** When using fluoride toothpaste or treatment to remove plaque from teeth, it is common for certain cusps to be lost in the process.
- Extensive Intra-coronal restorations:** They could increase the risk of cusp fractures and cracks.

CLINICAL MANIFESTATIONS

EARLY	LATE
<ol style="list-style-type: none"> When a tooth has a broken cusp, it usually hurts sharply during chewing. May only be responsive to certain loads. The tooth is vital, and while its reaction to a cold stimulus may be normal at first, over time may have localized or referred pulpitis.^[9] Large occlusal restorations are frequently linked to cracked cusps^[9], which may weaken and undermine the cusp. However, teeth with smaller restorations or teeth that are intact may also have broken cusps.^[11] 	<ol style="list-style-type: none"> A cracked cusp could develop over time as a result of a crack advancing. The fractured piece will easily separate from the tooth if the fracture line is coronal to the periodontal ligament. Nonetheless, gingival fibers or the periodontal ligament will frequently hold onto the broken cusp if the fracture line stretches sub-gingivally. A more intense and localized form of discomfort may frequently develop after prolonged chewing as a result of the fragmented piece moving within the coronal PDL.

DIAGNOSIS		
S.NO	METHODS	
1	Biting Test	A biting test using a Tooth Slooth or a comparable tool should be used to identify the afflicted tooth. The apparatus consists of a narrow pyramid with a flattened top that is applied to a specific cusp and a larger section that is applied to many opposing teeth as the patient occludes. When these forces are applied, a sharp pain may be felt when the pressure is withdrawn. ^[10]
2	Trans-illumination test	The removal of any massive restorations from the tooth may make it easier to employ this diagnostic equipment effectively. The light source should be modest but powerful, and it should be administered to the tooth at the suspected cusp fracture site.
3	General observation	The broken cusp will either be lost or moving when an explorer is inserted into the fracture line.

TREATMENT

CRACKED CUSP	FRACTURED CUSP
<ol style="list-style-type: none"> 1. The recommended course of treatment is to shield the impacted cusp from occlusal forces in order to minimize discomfort. 2. It is advised to use a full-coverage crown or onlay^[8], while bonded composite restorations have also been suggested. 3. The tooth may not be able to be restored if the fracture plane extends apically into the root.^[8] 4. Elective root canal therapy may be required for prosthetic purposes if extracting the fractured cusp and repair leaves little crown. 5. In order to remove the tooth from active occlusion, occlusal reduction of the tooth should be done as soon as feasible. 	<ol style="list-style-type: none"> 1. A conservative restoration using bonded composite resin to cover the exposed dentin may be recommended if the lost portion is small. 2. An onlay or a complete crown may be required when a bigger fragment has broken and needs to be removed. 3. It is challenging to determine which way a fractured cusp is going when it is discovered in teeth that are still in their original position or that have not had a significant repair. Therefore, patient should be informed of the possible decline in prognosis.

CRACKED AND SPLIT TEETH

According to American Association of Endodontics-The term **"SPLIT TOOTH"** is defined as a complete fracture initiated from the crown and extending sub-gingivally, usually directed mesio-distally extending through the proximal surfaces and via both marginal ridges.



FIG. 2. A. Tooth Slooth device. A. The Tooth Slooth device. B. Application for a bite test: the tip of the pyramid is touching the tested cusp while the wide base is supported by multiple contacts.

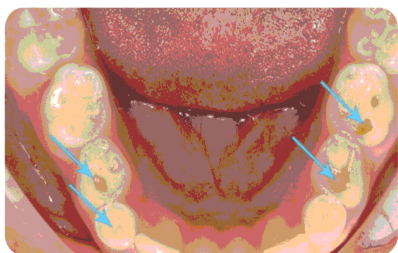


Figure 3

ETIOLOGY	PATIENT HISTORY
<ol style="list-style-type: none"> 1. Teeth cracks are the result of masticatory pressure. 2. Cracked teeth are also often caused by occlusal pre-maturities and bruxism, or clenching of the teeth. The maxillary premolars and mandibular second molars are the teeth that are most likely to break. 3. A tooth crack or fracture can also occasionally result from traumatic injuries, such as a hard upward hit to the jaw (such as in an automobile or sports accident). 4. Unexpectedly biting on a hard object (like a cherry pit or an un-popped corn kernel in popcorn) could also be the cause. When fully applied abruptly, the first molars' occlusal 	<ol style="list-style-type: none"> 1. The patient's history may resemble that of a patient with a broken cusp in that it involves intense pain during chewing and inability of the dentist to identify. 2. Finding the troublesome tooth's location can often be difficult for the practitioner. In due course, the patient may remark that, although previous symptoms decreased and now extremely sensitive to cold stimuli. 3. These findings are consistent with pulpitis or pulp necrosis, which may eventually manifest in the tooth that is afflicted.^[11]

forces can reach 90 kg, which could harm the tooth's structure.

DIAGNOSIS

1. When treating a tooth with symmetrical cracks, the Tooth Slooth apparatus may or may not yield a more obvious outcome.
2. It is possible to replicate the pain by asking the patient to chew on a cotton roll.
3. Furthermore, for the purpose of seeing the crack, dyes like methylene blue or tincture of iodine can be placed to the dentin or the exterior of the crown.
4. If the suspected tooth has no restorations, transillumination can also be used to provide light, which could lead to an incredibly simple diagnosis.
1. 5. Although an objective diagnosis might not always be attainable, the patient should be informed that the patient's chances of receiving endodontic or restorative care may be reduced.

CLINICAL MANIFESTATIONS

EARLY

1. A crack in the clinical crown is the first sign of a broken tooth, and it may progressively spread apically. Fractures separate the crown in buccal and lingual pieces.
2. The teeth may be vital and uncomfortable to masticate in the early stages due to intense pain.
3. Any maxillary or mandibular tooth on the same side of the mouth may be the source of the localized or a referral pain.^[9]
4. At this stage, the impacted tooth may or may not be percussion sensitive, and pulp testing results may be normal or suggestive of heightened sensitivity to cold stimuli.

LATE

1. The pulp may become involved in the later stages of a cracked tooth, and finally the pulp may lose its vitality or the fracture may spread apically.
2. Centrally placed cracks- those that reach from marginal ridge through the central fossa-are more likely to involve the pulp than cracks that are more buccal or lingual in location.^[9]
3. Consequently, bacterial infiltration through the cracks may impair pulp vitality, which may eventually be lost.
4. A diffuse radiolucency encircling the root may finally emerge from the radiography presentation at this advanced stage. Narrow, isolated deep periodontal pockets may exist at this advanced stage.

TREATMENT: CRACKED TOOTH

1. If a patient has a suspected or confirmed cracked tooth, they should be cautioned that their prognosis is poor and occasionally uncertain. The main objectives of treating cracked teeth are to stop the crack from getting worse and to make biting more comfortable. By applying a temporary crown or an orthodontic band around the tooth.
2. Endodontic therapy may be taken into consideration before the permanent crown is placed.
3. The advantages of having a permanent crown placed after a root canal procedure include early protection against occlusal stresses that could cause a fractured tooth to

spread and split, as well as the elimination of the uncomfortable symptoms.

4. Discoloration along the dentin crack may be seen following the removal of an intra-coronal restoration.
5. The prognosis for the tooth is poor and extraction should be considered if a crack is discovered that extends from the mesial wall, through the pulp chamber floor, and into the distal wall. [8]

SPLIT TEETH

1. The only available treatment option when a tooth is split, either diagonally or over its length, is usually extraction.^[8]
2. Retaining and restoring the tooth, however, might be an option if the fracture line is such that the split results in large and small parts and if the elimination of the tiny fragment maintains adequate restorable tooth structure. ^[8]



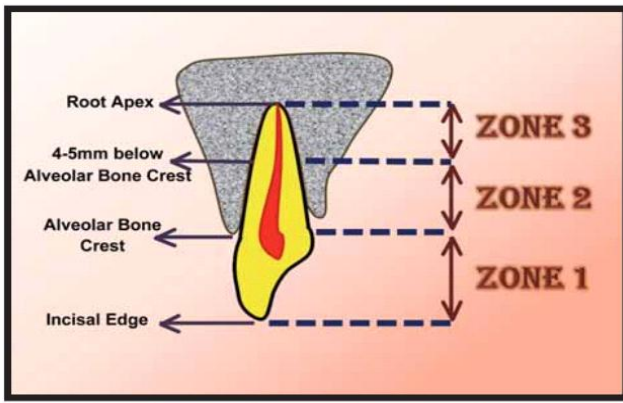
Figure 4

HORIZONTAL ROOT FRACTURE

1. The term "Horizontal root fracture" refers to a fracture line that is oblique or perpendicular to the root's long axis.
2. The most common kind of root fractures are horizontal ones, which result from frontal impacts and mostly affect fully erupted teeth with full root formation in the maxillary central incisor region (the anterior maxilla).^[12]
3. According to Caliskan & Pehlivan (1996), the most common fractures occur at the middle third of the root (57%), followed by those at the apical (34%) and cervical (9%).
4. Young people are most likely to experience horizontal/transverse root fractures as a result of direct physical trauma to the anterior region.

CLASSIFICATION:^[13]

Types	Sub-Classification	
Horizontal Root Fracture	Number	<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> Simple </div> <div style="text-align: center;"> Multiple </div> </div>
	Location	<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> Cervical </div> <div style="text-align: center;"> Middle </div> <div style="text-align: center;"> Apical </div> </div>
	Position of Coronal Fragment	<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> Not Displaced </div> <div style="text-align: center;"> Displaced </div> </div>
	Extent	<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> Partial </div> <div style="text-align: center;"> Total </div> </div>



of the root.^[12]

MANAGEMENT: Treatment of root fractures in the apical, middle, and cervical regions.^[13]

Position of Fracture Line	Treatment	
	Apical	Watch and observe
Retain the segment		Pulp Vital
Surgical extraction		Pulp Necrosis
Middle	Reduction and stabilization	
	Healing	70—80% Of intra—alveolar fractures
	Root canal treatment	Pulp Necrosis
Cervical	Poorest Chances of Healing	
	Reduction & stabilization	Coronal segment is present. Fracture below the alveolar bone crest.
	Reattachment	Coronal segment is present. Fracture at or above the alveolar bone crest.
	Post Crowns	Coronal segment is absent (lost). Fracture above the alveolar bone crest.
	Periodontal surgery	Sufficient root length. Fracture below the alveolar bone crest. Aesthetic result is not required.
	Orthodontic extrusion	Sufficient root length. Fracture below the alveolar bone crest. Aesthetic result is required.
	Surgical extrusion	Emergency treatment. Fracture below the alveolar bone crest.
	Extraction	Other conservative treatment not possible. Other conservative treatments failed. Poor prognosis.

ETIOLOGY	CLINICAL MANIFESTATION
<ol style="list-style-type: none"> Horizontal root fractures are typically seen in anterior teeth that have experienced direct impact. Indirect trauma is typically in posterior teeth. Furthermore, parafunctional habits, traumatic occlusion, significant dental decay, and iatrogenic reasons can infrequently result in root fractures. 	<ol style="list-style-type: none"> While fractures of the apical and cervical thirds of the root occur equally, whereas fractures in the middle third of the root occur more frequently. The apical third of a root's fractures do not exhibit any movement or displacement; middle third fractures are typically extruded and have displacement; and cervical third fractures, extend below the crestal bone, exhibit movement in the crown due to the attachment of PDL. The crown of anterior teeth that have a fracture line above the crestal bone is typically very movable. Clinically, posterior have one hard and one flexible cusp. Primarily tests for pulp vitality and responsiveness may yield negative results because of temporary or chronic trauma-related pulpal damage.
DIAGNOSIS	
<ol style="list-style-type: none"> The central beam must be aimed within a maximum range of 15–20° of the fracture plane in order for these fractures to be seen. Two extra periapical radiographs (one with a positive angulation of 15° to the fracture line and the other with a negative angulation of 15° to the fracture line) should be exposed in addition to the standard periapical radiograph.^[12] Additional recommended protocols for precisely seeing the fracture line are: radiographs taken at 45°, 90°, and 110° angles. Two traditional periapical bisecting-angle exposures and a steep occlusal exposure. Although periapical radiographs provide a better image of cervical-third root fractures, occlusal radiographs may be necessary to reveal fractures in the apical third 	

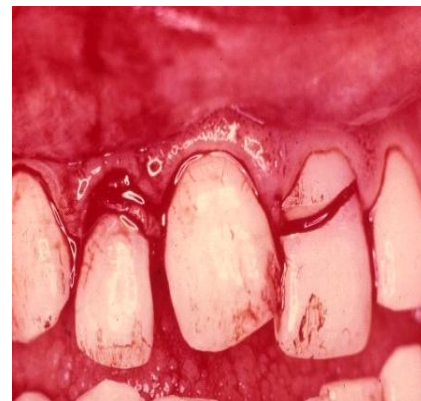


Figure 5

VERTICAL ROOT FRACTURE

A complete or partial fracture including the cementum, dentin, and root canal system of a root that is longitudinally (axially) orientated and typically directed buccolingually is called a **Vertical root fracture (VRF)**. Vertical root fractures can occur gradually and show no outward symptoms, which makes (differential) diagnosis difficult. Early removal of teeth that have complex VRFs, will reduce peri-radicular bone loss and avoid pain or discomfort.

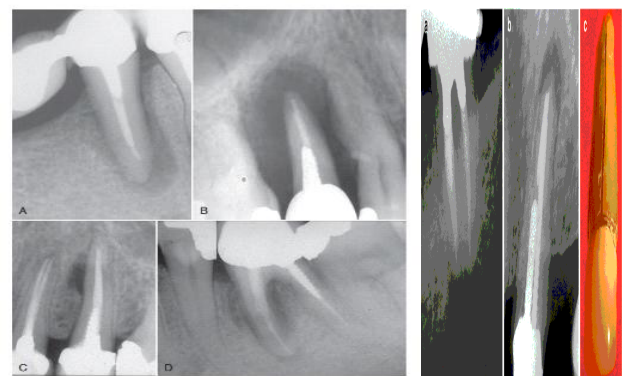


Figure 6

ETIOLOGY: Endodontic therapy is the most frequent dental procedure that causes vertical root fractures. VRFs typically appear long after the procedure has been finished, rather than during the actual obturation of the root canal.^[14] VRFs have a complex aetiology.

FACTORS THAT PREDISPOSE NATURALLY:	IATROGENIC PREDISPOSING VARIABLES:
<p>(A)The shape of the root cross section</p> <p>Teeth that commonly experience VRFs is an oval root cross section, where the buccolingual diameter is more than the mesiodistal; comprising the mandibular incisors, the mesial roots of the mandibular molars, and the maxillary and mandibular premolars.</p> <p>(B) Occlusal factors</p> <p>Examples include high forces, particularly in the case of mandibular second molars, and load concentrations brought on by pre-maturities in maxillary premolars.</p> <p>(C)Pre-existing microcracks:</p> <p>Because of occlusal parafunction or recurrent mastication stresses, preexisting microcracks may form in the radicular dentin.</p>	<p>(A)Root canal treatment</p> <p>Physical properties of the dentin as a material may not be affected by treatment, the cumulative effects of many iatrogenic or natural variables may undermine the radicular dentin as a structure.</p> <p>(B) Rotary instrumentation caused microcracks</p> <p>Microcracks in the residual radicular dentin are consequence of utilizing nickel-titanium rotary and reciprocating files for root canal preparation. Some of the microcracks propagated and became through-and-through fractures due to additional stress given to the roots, either by retreatment or by root obturation with lateral compaction.</p> <p>(C) Uneven thickness of remaining dentin:</p> <p>Excessive instrumentation in the mesial roots of the mandibular molars or first maxillary premolars may also result in uneven dentin thickness. These teeth may have a distal or mesial concavity, respectively, that is not visible on periapical radiographs. These regions, known as "<i>danger zones</i>", may show signs of internal strain that could result in fracture.</p> <p>(D)Techniques for obturation</p> <p>Internal pressure applied with a spreader during obturation procedures, like lateral compaction, can result in stresses^[15] and the propagation of microcracks into fractures across the entire thickness. Thus, the thermo-plasticized method is advantageous.</p> <p>(E)Type of spreader used</p> <p>Using a thicker, more rigid hand spreader made of stainless</p>

	<p>steel may put more strain on the radicular dentin and raise the risk of root fracture. Thus, a smaller diameter and more flexible spreader should be utilized.</p> <p>(F)Post design:</p> <p>The strain distribution in the root is greatly influenced by post choice, design, and sitting. Posts that are overly thick or lengthy increase the risk of VRFs. Thus, posts ought to be utilized just when they are crucial for core retention.</p>
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CLINICAL MANIFESTATIONS	
EARLY	LATE
<ol style="list-style-type: none"> 1. On the tooth that is influenced, there may be discomfort in the early stages which is frequently dull. 2. As the fracture and ensuing infection worsen, swelling frequently develops, and a sinus tract may be visible in a more coronal location. 3. Radiographic results in the early stages are rare for the following reasons: (a) a root canal filling may make it difficult to detect the fracture; and (b) the overlying root structure may hinder the degradation of bone. 4. It is possible for a deep, narrow, and isolated periodontal pocket to be connected to the root. 	<ol style="list-style-type: none"> 1. It is simpler to find a long-standing VRF. Since the alveolar bone next to the root has already undergone damage, a periapical radiograph is more probable to identify. 2. The J-shaped or halo radiolucency, which combines periapical and peri-radicular radiolucency, is one of the most common symptoms. 3. Furthermore, the originally tight and small pocket along the fracture may widen and become more visible. In long-term cases when there is bone loss, the root segments split, which would clearly show as root fracture on a radiograph.

PATIENT HISTORY
<ol style="list-style-type: none"> 1. The patient may report discomfort or sensitivity around a particular tooth. 2. There could occasionally be swelling and history of multiple radiographic and clinical evaluations with no discernible cause for discomfort is evaluated. 3. It's possible that attempts at surgery or retreatment are made to obtain a correct diagnosis.

DIAGNOSIS & RADIOGRAPHIC FEATURES		VRF POCKETS & CORONALLY PLACED SINUS TRACT	CBCT IN VRF
IMPORTANCE OF EARLY DIAGNOSIS	RADIOGRAPHIC FEATURES		
<p>1. In cases of VRF, an early and accurate diagnosis is essential to prevent further damage to the alveolar bone. Early identification is especially crucial if implants are anticipated to be used in a future restorative operation.</p> <p>2. In 2008^[8], the American Association of Endodontists declared that sinus tract and narrow, isolated periodontal probing defect connected to a root canal treatment-with or without post placement-can be regarded as a hallmark for the existence of a VRF.</p> <p>a) Early diagnosis is challenging when the following two criteria are combined:</p> <p>(a) resemble those of apical periodontitis</p> <p>b) are linked to narrow and tight pockets. Using hard probes, it is challenging to detect X-ray in the early stages of VRF.</p>	<p>1. Slender, radiolucent band across the length of the root.</p> <p>2. Early in VRF, no radiolucent bone lesions may be seen, therefore the clinician must make interpretations based on the varied patterns of peri-radiolar bone deterioration.</p> <p>3. A high likelihood of a VRF was linked to a <i>J-shaped or halo appearance</i>, which is a combination of periapical and peri-radiolar radiolucency.</p> <p>4. The cortical plate of the alveolar bone is destroyed when there is an <i>angular resorption</i> of the crestal bone along the root on one or both sides.</p> <p>5. The radiolucency grows larger than the root's size as the bone loss progresses.</p> <p>6. The radiopaque obturation frequently obscures the view of the hairline radiolucency of the fracture as VRFs are in the buccolingual plane, making clinical diagnosis of an early stage from a periapical radiograph unlikely.</p> <p>7. Root obturation removal and canal retreatment as well as obtaining radiographs in order to identify a hairline radiolucency, which could lead to a more conclusive diagnosis of a VRF.</p>	<p>1. The pockets characterize the initial phases of VRFs. Deep periodontal pockets are therefore usually relatively flexible and wider coronally. These periodontal pocket types usually show up with the deeper portion of the pocket at the mesial or distal aspects. The reason for this is because bacteria enter the fracture and cause the periodontal ligament to undergo a destructive host reaction.</p> <p>2. Usually, the pocket connected to a VRF is small and limited to the area right next to the tooth that is affected. This pocket is frequently found where the tooth's lingual or buccal convexity meets.</p> <p>3. Should use a flexible probe. It is most likely that the root has a VRF when a typical VRF pocket is found on the buccal or lingual side of the root's convex flank.</p> <p>Since the source is not a periapical lesion, sinus tracts linked to a VRF pocket are frequently located in a more coronal position.</p>	<p>1. According to research, it could be able to identify early-stage VRFs using a CBCT scan with the axial view selected. However, the machine's resolution may have a major impact on this kind of detection.</p> <p>2. The identification of early, unseparated VRFs is unreliable at voxel sizes of 0.3 mm; however, the reliability significantly increased when smaller voxel sizes were used.</p> <p>3. In the cancellous bone, the early degradation of the bone along the suspected fracture may be apparent at rather early stages.</p> <p>4. In the near future, CBCT is expected to have higher resolution, which could make it a valuable diagnostic tool for identifying VRFs.</p>

TREATMENT: Vertical root fractures (VRFs) can occur in teeth that have undergone retreatment, but they are rare in those that have never received endodontic treatment. Prevention is the key to managing VRFs. The importance of treating vertical root fractures stems from the fact that pathogens in the root canal and cementum damage on external root surface leading to External inflammatory root resorption.

1. Resection of the root is recommended in multi-rooted teeth when a single root fractures in order to protect the surrounding structures.
2. Resin bonding reconstruction of root-filled teeth with vertical root fractures is new choice.
3. The following factors determine the prognosis of replantation therapy:
 - a) Traumatized fragment extraction.
 - b) A 15-minute extraoral period.
 - c) Short-term calcium hydroxide dressing disinfection.
 - d) Administering tetracycline systemically leads to disinfection and decrease in osteoclast activity.

4. Intentional replantation with rotation and extrusion shows improvement in periodontal pockets and healing of alveolar bone.
5. The following materials are used to reconnect fragments:

a) *Glass Ionomer Cement* b) *Cyanoacrylate*: an attempt has been made to fuse the pieces of anterior teeth. Deep pocketing and resorption were linked to a poor long-term prognosis. c) *Tri-n-butyl borane (TBB)/methyl methacrylate (MMA)/ethyl-trimellitate anhydride (META)*: 4- META/MMA TBB -low toxicity and biocompatibility for PDL are its benefits. d) *Dual cure resin cements*: These have a quick polymerization time, a high bond strength, and strong marginal integrity. e) *Mineral trioxide aggregate (MTA)*: is a root repair-based on calcium silicate that is used extensively in endodontics.

ENAMEL AND DENTINAL CRACKS ^[19]

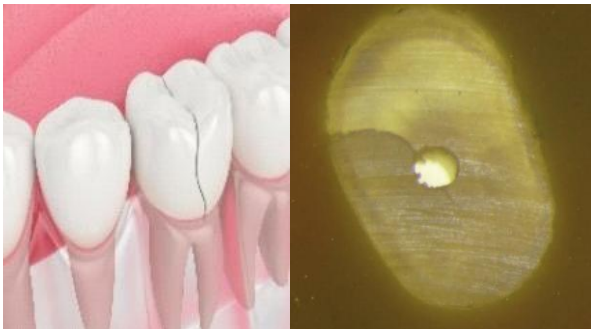


Figure 7

A partial enamel rupture in a living tooth involving dentinal and pulpal involvement is referred to as a fractured tooth. Adults between the age of 30 and 50 have reported an incidence rate of 34–74%, with a feminine predilection. Given that the symptoms of a cracked tooth can vary widely, diagnosing one can be difficult for a medical professional.^[16] Optical coherence tomography (OCT) is one technique for surface fracture identification that has garnered a lot of attention. When it comes to identify longitudinal cracks, cone-beam computed tomography (CBCT) and micro-CT seemed to be more effective than conventional.

ETIOLOGY	
ENAMEL CRACKS	DENTINAL CRACKS
<ol style="list-style-type: none"> 1. Multiple factors can contribute to enamel fractures. Dentin cracks are not often accompanied by enamel fissures. As restoration stop fracture propagation, microleakage, pulpal or periodontal tissue involvement early identification is essential.^[17] 2. This is especially important for ceramic restorations since crack formation and propagation can be facilitated by thermal expansion and cyclic pressure. Small fissures around a restoration's 	<ol style="list-style-type: none"> 1. When the tensile stress in the root canal wall is greater than the tensile stress in the dentin, dentinal fissures or root fractures result. 2. These stress concentrations may result in short or long-term dentinal cracks that are whole or incomplete. 3. Whether using single-file systems increases the chance of developing dentinal abnormalities is still up for debate.

perimeter may be a sign of structural vulnerability. Stress from polymerization contraction may be the cause of cracks along the edges of composite restorations

CLINICAL FEATURES

1. History of severe pain and discomfort for months when chewing or drinking cold liquids. When pressure is removed after consuming fibrous foods, "rebound pain" develops.
2. Patients unable to pinpoint the exact tooth causing discomfort. Heat stimuli response is negative.
3. The odontoblast processes inside the fracture alternately stretch and compress, causing these symptoms. Ultrasonic and even endodontic instruments can exacerbate dentinal and enamel fractures in teeth.^[18]

DIAGNOSIS

DEFINITIVE	CUMULATIVE
<ol style="list-style-type: none"> 1. The methods for diagnosing broken teeth have been macroscopic and symptom-driven approaches. 2. The bulk of these cracks can be detected to a limited extent using traditional visualization techniques. 3. Color changes inside enamel may signal early deterioration, microleakage, & loss of structural integrity of the dentin & enamel at severe magnification (14x & more). 4. In the past, tools such as methylene blue dye, caries indicator, transillumination, and alternative methods of hydrating and dehydrating tooth structure have made fissures easier to see. 5. Probably the most used method for traditional crack diagnosis is Trans-illumination. Two drawbacks: (1) minor colour changes unnoticeable; (2) dramatizes all flaws to the point where craze lines look as structural cracks. 6. Endodontists have long employed methylene blue dye to draw 	<ol style="list-style-type: none"> 1. Since some enamel fractures do not extend into the dentin and some frequently do so in the absence of dentinal fissures, the existence of enamel cracks does not always imply presence of the cracked tooth. 2. Enamel fractures can be accompanied by three different types of underlying pathology: severely weakened enamel, decay, and dentinal cracks. 3. It is appropriate to classify <i>dentinal cracks as structural cracks</i>. They are usually divided into two categories: oblique, which are placed at line angles of cavity preparations, and vertical, which are placed in the centre of the pulpal floor. 4. Vertical cracks might start in the enamel and moves to the dentine if the tooth is not healed. They progress apically & are seen in the middle of cavity preparations. They spread out in a mesiodistal orientation. 5. Usually, oblique fissures start in the dentin. The line angle just beneath the cusp is the starting point, as crack develops, it usually follows the internal

<p>attention to radicular fractures & cracks. Advantageous due of its propensity to pool and is distinct due to its flocculent properties.</p>	<p>line angles.</p> <p>6. If an oblique crack crosses a buccal/lingual groove or a marginal ridge, it may have a vertical component. The term "oblique" in this context does not fully capture the three-dimensional structure of the crack.</p> <p>7. At the beginning, these horizontal and diagonal enamel fissures are faint, therefore magnification levels greater than x16 may be necessary for visualization.</p>
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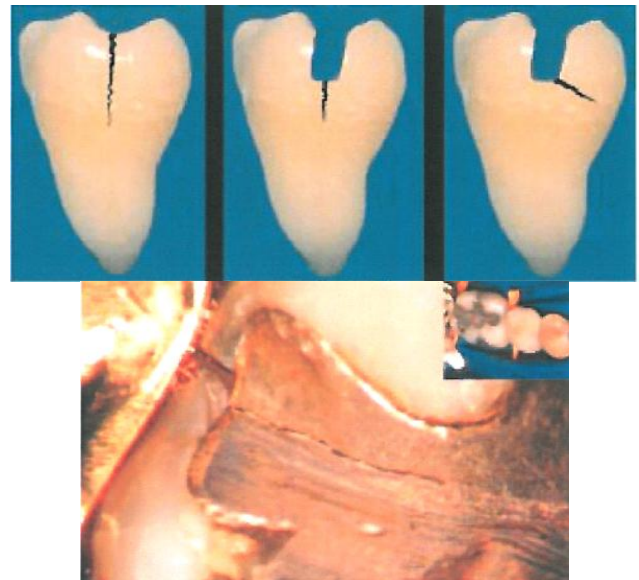


Figure 9
(Based on various studies)

PREVENTIVE CAVITY DESIGN AND PROACTIVE TREATMENT:

1. Composite bonded restorations' versatility together with minimally intrusive preparations offer alternatives to conventional treatment plans.
2. Preventive preparations aim to minimize dentin involvement and avoid connecting different occlusal preparations to one another. More preventive design alterations are possible with a greater understanding of how cracks propagate.
3. Selecting the right preparation design is crucial once structural dentinal fissures have been identified. To halt the advancement of cracks, the authors advise equilibration and bonded intra-coronal repairs.
4. Periodontium is frequently affected by vertical fissures. When this happens, a decision must be taken regarding the gingival margin's position in relation to the biologic width.
5. Research is required to determine the long-term effects of this decision, with idiopathic periodontal disintegration being a key to worry.^[19]

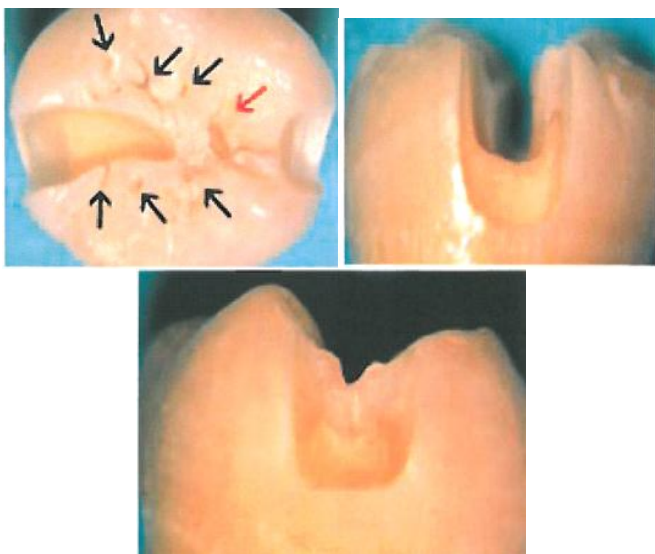


Figure 8

ENDODONTIC PROCEDURES RESULT IN FORMATION OF DENTINAL CRACKS

ROOT END RESECTION: The issue of identifying and perhaps treating apical root-end dentinal fractures persists. Burs or ultrasonic tips are frequently used in apical surgery for root-end cutting and apical cavity preparation, which may expose or even cause fissures in the apical root-end dentin establishing a channel of communication between the periodontium and the root canal. These routes can impede the healing of apical tissues and result in the leakage of germs and their byproducts into the surgical site.

ROTARY FILES: VRF may arise from dentinal flaws caused by transient stress concentrations in the root dentin caused by the instrument's contact with the canal walls during preparation. In rotary files, more cracks in the coronal region than in the apical region. Thus, one possible contributing element to the creation of dentinal cracks could be the taper of the files. Furthermore, a larger taper result in a lower RDT. Example: Dentinal microcracks are caused by Pro-taper Gold & Neo-endo flex as it transfers greater tensile stresses.

POST REMOVAL: Teeth that had received root canal therapy but no posts, teeth that had had posts extracted with ultrasonic energy showed noticeably more cracks.

OBTURATION TECHNIQUES: These fissures in cold lateral condensation techniques may be caused by the spreader's direct contact with the root canal wall or by the force of lateral condensation. Furthermore, in the warm vertical condensation procedures, dentine surfaces may crack as a result of a plugger coming into direct touch with the root canal wall at 200°C.

CONCLUSION

In order to minimize and control the possibility of a tooth fracture, an operative dentist must be aware of the biomechanical implications of occlusal stresses on a tooth. It is advised to develop adhesive-based integrated restorations

that reduce tensile strains and levels of stress in the remaining tooth structure.

Significant cracks can be found using a clinical microscope at magnification levels of 14x and higher, long before incomplete coronal fractures and fractured teeth show symptoms. All the research's will contribute to better restorative management of broken teeth, endodontic retreatment instances, and elderly patients, in addition to improving our understanding of the variables that predispose endodontically treated teeth to fracture.

References

1. Metzger, Zvi & Tamse, Louis. (2015). Cracks and Fractures.
2. Hasan S, Singh K, Salati N. Cracked tooth syndrome: Overview of literature. *Int J Appl Basic Med Res*. 2015 Sep-Dec;5(3):164-8
3. Bushra Almas, H. Murali ' Rao, B.S Keshava Prasad (May-2022). Vertical Root Fractures- A Review. *IOSR Journal of Dental and Medical Sciences*.21; 5(3):23-30.
4. Cameron CE. Cracked-tooth syndrome. *The Journal of the American Dental Association*. 1964; 68(3):405-411.
5. Cameron CE. The cracked tooth syndrome: Additional findings. *J Am Dent Asso*1976; 93:971-975.
6. Abbott, P. Endodontics and dental traumatology. An overview of modern endodontics. 1999
7. Luebke RG. Vertical crown-root fractures in posterior teeth. *Dent Clin North Am* 1984; 28:883-894.
8. American Association of Endodontists: Cracking the cracked tooth code: detecting and treatment of various longitudinal tooth fractures. Endodontics; colleagues for excellence, Chicago, summer 2008, *American Association of Endodontists*.
9. Rosen H: Cracked tooth syndrome, *J Prosthet Dent* 47:36, 1982.
10. Geurdsen W, Schwarze T, Günay H: Diagnosis, therapy and prevention of the cracked tooth syndrome, *Quintessence Int* 34:409, 2003.
11. Berman LH, Kuttler S: Fracture necrosis: diagnosis, prognosis assessment, and treatment recommendations, *J Endod* 36:442, 2010.
12. Hovland EJ. Horizontal root fractures: treatment repair. *Dent Clin North Am* 1992; 36: 509–525.
13. Malhotra, Neeraj; Kundabala, M; Acharaya, shashirashmi (2011). A review of root fractures: diagnosis, treatment and prognosis. *Dental Update*, 38(9), 615–628.
14. Tamse A, Fuss Z, Lustig J, Kaplavi J: An evaluation of endodontically treated vertically fractured teeth, *J Endod* 25:506, 1999.
15. Dang DA, Walton RE: Vertical root fracture and root distortion effect of spreader design, *J Endod* 15:294, 1989.
16. Banerji S., Mehta S.B., Millar B.J. Cracked Tooth Syndrome. Part 1: Aetiology and Diagnosis. *Br. Dent. J.* 2010; 208:459-463.
17. Kahler W. The cracked tooth conundrum: Terminology, Classification, Diagnosis, and Management. *Am. J. Dent.* 2008; 21:275.
18. Kim S.-Y., Kang M.-K., Kang S.-M., Kim H.-E. Effects of Ultrasonic Instrumentation on Enamel Surfaces with Various Defects. *Int. J. Dent. Hyg.* 2018; 16:219–224.
19. Clark DJ, Sheets CG, Paquette JM. Definitive diagnosis of early enamel and dentin cracks based on microscopic evaluation. *J Esthet Restor Dent.* 2003; 15(7):391-401.

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