Cracked teeth: What clinicians and specialists need to know

Kênia Maria Pereira de **TOUBES**[1]
Stéphanie Quadros **TONELLI**[1]
Eduardo **NUNES**[1]
Frank Ferreira **SILVEIRA**[1]

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ABSTRACT

The purpose of this literature review is to examine the existing evidence regarding etiology, signs, symptoms, methods of diagnosis, and treatment of cracked teeth. According to the American Association of Endodontists (AAE), the term cracked tooth (CT) is defined as "a fracture in a plane that breaks the continuity of the enamel and dentin, without separation of the parts, usually in the mesiodistal direction, passing through the surface occlusal, which may involve one or both of the marginal ridges." Due to its unknown depth and direction, this fracture can extend to the pulp and periodontal ligament, leading to reversible pulpitis, irreversible pulpitis, pulp necrosis, or even progress to a complete fracture. Currently, cracked teeth are related to the third largest cause of missing teeth, after caries and periodontal disease. Studies indicate a lack of consensus among professionals about treating cracked teeth, a clinically relevant issue that needs to be prioritized and clarified. In this context, this review addressed the etiology, signs and symptoms, diagnostic methods, and treatment of cracked teeth.

Keywords: Cracked teeth. Dental restoration. Full-coverage crown. Intracanal post. Onlay.

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[1] Pontifícia Universidade Católica de Minas Gerais (Belo Horizonte/MG, Brazil).

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Contact address: Kênia Maria Pereira Soares de Toubes
E-mail: keniatoubes@gmail.com

Introduction

The term fractured cusp odontalgia was introduced by Gibbs[1] and later referenced by Cameron[2] as cracked tooth syndrome. It is characterized by an incomplete fracture of a vital posterior tooth, involving the dentin and occasionally extending into the space of the dental pulp. Many other terminologies emerged over the years.[3-15] However, Kahler[16] argued that the term cracked tooth syndrome was misused, as a CT presented a series of symptoms that did not form a reliable and distinctive pattern according to its pulp diagnosis. In 2008, the American Association of Endodontists (AAE)[17] published an article describing five types of fractures identified in the vertical plane: fissure line or "craze line"; cusp fracture; cracked tooth; split tooth, and vertical root fracture. According to this criterion, cracked teeth are teeth that present an incomplete fracture plane, which continues through the occlusal surface, usually in the mesiodistal direction, involving one or both of the marginal ridges, with unknown depth and direction.

Generally, the fracture is more centralized in a cracked tooth, extending more apically than in a cusp fracture. These cracks can remain harmless and asymptomatic for years.[18,19] However, this asymptomatic condition changes drastically when the tooth is not restored correctly, in the presence of carious lesions, or when the dental element is subjected to occlusion stress, parafunction, or even the aging of the dentition.[2,20-30]

Contemporary literature suggests a variety of protocols for treating cracked teeth.[31-33] However, other studies indicate a lack of consensus among professionals regarding these protocols.[34,35] In this context, this study intends to provide the most current evidence about cracked teeth, including their etiology, signs and symptoms, methods of diagnosis, and treatment.

Cracked teeth

Etiology

Dental fractures are routinely detected by clinicians. The severity of the fracture and its consequences can vary from small cracks without treatment, to severe resulting in the need for endodontic treatment or tooth loss.[19] The etiology of cracked teeth is complex and multifactorial, requiring from the professional a careful analysis of the affected tooth and its relationship with the oral environment. In this context, it is believed that the best way to prevent dental fractures is to understand the factors that predispose a tooth to crack.[19,25,36] In healthy teeth, the anatomy, fragility of the cusps, root bifurcations, and the occlusal relationship with antagonistic teeth are determinants for the occurrence of cracked teeth.[26,36-38] Aged dentin may be more prone to cracking than the younger due to the microscopic changes that occur over the years due to its dehydration, making the mineralized structures of the teeth more brittle and less elastic.[24,28,30,35] Alternatively, in restored teeth, some studies suggest a direct relationship between the size of the restoration, the loss of the marginal crest, the wedge effect in the cusp-fossa relationship. The absence of cusp protection in the inlay/onlay design can predispose to the occurrence of a crack in the mesiodistal direction.[2,9,13,21-23,27,36,37,40-43] In addition, stress concentration during pin placement, hydraulic pressure during the laying of well-fitted cast restorations, physical forces during solid gold and amalgam condensation, and non-incremental placement of composite resin can make teeth more susceptible to fracture.[25,27,37,41,43]

Occlusal factors such as accidental chewing trauma when biting food, rigid objects, or the habit of chewing hard food, such as nuts, coconut, and others, can cause cracks or fractures due to the sudden and excessive masticatory load on the tooth.[44-46] Occlusal interference or premature contacts, bruxism, and tightening may also be associated with the appearance of fractures in the mesiodistal direction, especially in teeth with extensive restorations.[20,23,25,29,30,40,47-49] In addition, developmental factors such as incomplete fusion of calcification areas in molars and premolars, cyclical forces of rotary instruments during cavity preparation, used without refrigeration, sudden changes in temperature, and the presence of dental implants in occlusion with healthy teeth can lead to the presence of microcracks and fractures.[13,21,23,28,36,37,40,41]

Epidemiology

Cracked teeth usually occur in adults aged between 30 and 60 years.[2,25] Both sexes are equally involved.[35,38,39] As for the teeth most affected in the dental arch, molars are the most commonly involved.

Cameron[2] observes that the lower second molars, followed by the lower first molars, are the most often affected teeth. Rosen,[50] Hiatt,[40] Geurtsen,[21] Homewood,[51] Ratcliff, Becker, and Quinn[27] found a higher prevalence occurring in lower molars. Roh and Lee[38] found more cracks in teeth without restorations, especially in upper molars. Udoye and Jafarzadeh[52] observed that most cracked teeth were from upper first molars and lower second molars. In the study by Seo et al.[53], the most affected tooth was the upper first molar, followed by the lower first molar, lower second molar, and upper second molar. Kim et al.[54] observed that the lower first molars were the most affected, followed by the upper first molar, upper second molar, and lower second molar.

Kang, Kim, and Kim[55] observed that cracking occurred more in the lower second molars, followed by the lower first molars and intact teeth. Yang et al.[39] found more mandibular second molars, followed by mandibular first molars and maxillary first molars. Kanamaru et al.[29] found lower molars than upper molars. Krell and Caplan[35] observed that mandibular second molars were the most affected, followed by mandibular first molars and maxillary first molars. Wu, Lew, and Chen[56] evaluated the incidence of complications with pulpitis and necrosis in DGs with pulp vitality, where the lower first molars were the most prevalent, followed by the lower second molars and upper first molars. In the study by Davis and Shariff,[57] mandibular second molars and maxillary first molars were the most affected, followed by mandibular first molars, maxillary second molar, maxillary first premolar, and maxillary and mandibular second premolars. Hilton et al.[18] evaluated 2858 patients, noting that 82% of the cracked teeth were molars, and more than half were located in the mandible (n = 1675). Chen et al.[58] evaluated 62 cracked teeth endodontically treated, identifying that 48.4% were mandibular molars, followed by maxillary molars, maxillary premolars, and mandibular premolars.

Clinical signs and symptoms

Patients with cracked teeth can present several symptoms, ranging from occasional discomfort to intense and prolonged pain that is difficult to locate, related to the position and extension of the fracture line, which contributes to the difficulty in diagnosis and the treatment planning.[2,13,14,20,21,48] Swepston and Miller,[48] Agar and Weller,[20] and Zuckerman[14] have argued that teeth with incomplete fractures are more difficult to diagnose because the cracks are commonly not visible. On the contrary, Rosen,[50] Geurtsen, Schwarze, and Gunay[36] stated that, in the presence of complete fractures, the diagnosis is simple, as the fragment stands out and the painful symptomatology during mastication ceases or changes in sensitivity depending on dentin exposure. Brännström and Aström[59] and Brannström[11] mentioned that the physiological basis of pain during chewing could be explained by the sudden movement of the fluid present in the dentinal tubules, during the movement of the fractured parts of the tooth. In addition, thermal changes, air, evaporation, osmotic stimuli such as sucrose, and increases in hydrostatic pressure caused by cusp flexion can also act as stimuli for the rapid movement of dentinal fluid. Figdor[60] suggested that this movement could stimulate the A-delta nerve fibers in the vicinity of the odontoblastic processes and the pulp-dentin borderline region, resulting in short-lasting acute pain, indicative of a vital tooth. However, when the pain becomes prolonged and uncomfortable, poorly localized, radiating to the mandible, it is suggested that C fibers were activated in response to inflammation, heat, and mechanical deformation. The C fibers are more resistant to tissue anoxia and can respond positively for longer than A-delta fibers. A tooth with an incomplete fracture exhibiting C-fiber activation suggests pulp damage and may require endodontic treatment. Luebke[10] offered three terms for diagnosing pain caused by a cracked tooth: dentin origin – a short, sharp stitch; pulp origin – deep, acute and radiated, precipitated by thermal shock in an inflamed pulp, which can also be spontaneous; and periodontal origin – throbbing, suggesting irreversible pulpitis. Pain may persist with pressure maintenance and when pressure is removed.[2,11,13,41] Hiatt[40] warned that the pain could also be caused by consuming substances containing sugar and acidic foods. Davis and Overton[61] claimed that the perception of hypersensitivity to cold might occur due to the infiltration of harmful substances through the crack, which results in the subsequent release of neuropeptides, which cause a concomitant reduction in the pain threshold of the C-type fibers. Opdam et al.[62] stated that

pain depends on the pulpal and periapical status of a cracked tooth, concerning the extent of the crack and the duration of its symptoms. When the crack extends into the pulp space or is close to it, the entry of bacteria and their by-products will lead to pulp inflammation, which can progress to pulp necrosis and subsequent periapical pathologies. Radiographic images are not very reliable for the early diagnosis of cracked teeth because fractures occur in the mesiodistal direction. However, when the fracture extends apically, changes can be observed radiographically along the periodontal ligament.[30] Clinically, the symptoms are varied, and, in most cases, the teeth have the occlusal and proximal surfaces restored. Ehrmann and Tyas,[13] Clark, Sheets, and Paquette[63] reported that knowing the specific symptoms facilitates the identification of cracked teeth. The authors suggest that the diagnosis should be complemented by the patient's dental history and confirmed by reproducing the patient's symptoms through complementary tests. Lynch and McConnell[23] advise that professionals may suspect the presence of cracks when patients manifest prolonged discomfort on a tooth, avoiding some types of food, or even chewing only on one side. In addition, practitioners should also look at the history of repetitive dental treatments, with uncertain diagnoses involving repetitive occlusal adjustments or replacement of fillings without resolving symptoms. Udoye and Jafarzadeh[52] evaluated the characteristics and distribution of cracked teeth in adults in a school hospital in Nigeria. They observed that most patients had a positive response to the bite test and vitality tests. In contrast, other patients reported pain due to chewing accidents and bruxism. Hilton et al.[18], in an observational study, quantified changes in symptoms (pain) and the natural progression of cracks during a one year of follow-up, involving 1.850 vital teeth that had at least one visible crack. The results showed that most untreated cracked teeth, and some recommended for treatment but not treated, remained relatively stable for one year, with the bit of progression of the crack or symptoms.

Diagnostic methods

A careful clinical history and evaluation of signs and symptoms, particularly sensitive to cold and acute pain when biting hard food, which ceases with the release of pressure, are important indicators for the early diagnosis of cracked teeth. Complementary tests, such as sensitivity and vitality tests, periodontal probing, radiographic examination, surgical exploration, and cone-beam computed tomography, are recommended.[13,17,63-67] Some cracks can be detected during a routine clinical examination or cavity preparation, although they are not always apparent.[9,10,14,15,23,36,68] The use of absolute isolation is recommended to diagnose cracks, as it promotes temporary dehydration of the suspected element, and the fracture line becomes more evident.[51,69] A transilluminator is also an effective diagnostic method for identifying cracks on the proximal surfaces of unrestored teeth, vertical cracks, and supragingival horizontal cracks. In these circumstances, the presence of the crack will cause an interruption in light transmission.[9,14,50,63,64,68,70] The use of dyes such as gentian violet or methylene blue has also been suggested to help visualize cracks.[9,13,37,42] The use of magnifying lenses, intraoral cameras, or operating microscopes improves the early diagnosis of cracked teeth.[23,27,36,63,64] Percussion, bite, and sensitivity tests are suggested to try to reproduce the patient's symptoms.[23] Some authors have suggested that vitality and percussion tests are significant, although sometimes affected teeth may show signs of hypersensitivity to cold thermal stimuli due to the presence of pulp inflammation.[16,41] Alternatively, Seo et al.[53] suggested that the bite test would be the most reliable method to reproduce CT symptoms. The probing depth is another determining factor for the prognosis of cracked teeth, as it can reveal the approximate depth of the fracture and its severity.[25,29,35,38,52-55,70-72] Teeth with probing greater than 4.0 mm adjacent to the fracture line present an unfavorable long-term prognosis.[55] In this context, it can be said that the diagnosis of a CT is challenging even for more experienced professionals and that its prognosis is linked to early diagnosis and restorative planning.

Treatment and prognosis

Treatment for cracked teeth must be carried out at the right time and appropriately to alleviate the symptoms of pain when biting and prevent the propagation of the crack and the penetration of microorganisms towards the dental pulp[2,13.20]. In this sense,

the early identification of fracture lines, their location, direction, and extension, and the evaluation of the character and duration of the pain, are fundamental steps for choosing the treatment plan.[13,17,21,60] The management of this treatment consists of two stages, one immediate and one definitive.[32] The immediate phase is intended to provide relief to the patient by either performing an occlusal adjustment and initial endodontic treatment and stabilizing the fracture lines with a copper ring, orthodontic band, temporary acrylic, or a composite resin splint.[9,13,14,21,23,32,73] Some studies suggest removing the carious tissue and placing a sedative material (reinforced zinc oxide cement or a bioceramic material) before definitively restoring the CT with an onlay crown or a full-coverage crown.[30,53] In irreversible pulpitis or pulp necrosis, endodontic treatment must be carried out before performing the definitive restoration. Some authors have advised provisionally immobilizing the CT after the occlusal adjustment using a well-adapted orthodontic band, without occlusal interference or damage to the gingival tissues. Others prefer using temporary acrylic crowns instead of orthodontic bands in teeth with extensive cavities, as these stabilize better and temporarily alleviate symptoms, allowing the necessary time to assess whether or not there is a need for endodontic treatment before a definitive restoration.[14,23,68,69,74]

Regarding the definitive stage, the literature suggests restoring these teeth with restoration protocols that involve protective covering of the cusp[19,32]. Tanaka et al.[75] recommended restoring cracked teeth with onlay adhesive restorations, as these are biologically more conservative and cause less trauma to the pulp tissues. Other authors recommend restoring cracked teeth with dental amalgam (conventional or adhesive), composite resin, and glass ionomer cements.[36,41,62,76-80] Yap[81] presented a case report of the treatment of a CT with the metallic restoration of cobalt and cast chromium cemented with adhesive resin. Guthrie and Difiore[69] defend the use of full crowns as the adequate way of restoring CT due to how the crown is retained and due to the action of the cement, which helps in the immobilization of tooth fragments, thus minimizing their movement, regardless of occlusal forces. Liebenberg[74] suggested restoring symptomatic cracked teeth with leucite-reinforced ceramics, with partial coverage of the cusp, as they have greater resistance to fracture and greater flexion and compression strength. Ailor Júnior[64] suggested that teeth with vertical fractures should be stabilized with an orthodontic band or a temporary crown before endodontic treatment. In the absence of symptoms, a permanent crown should be placed as soon as possible. However, Opdam and Roeters[73] observed that the application of indirect ceramics requires temporary restoration, which in cases of cracked teeth can increase the risk of pulp complications. The proportion of cracked teeth with subsequent need for additional endodontic therapy is significantly higher after applying full-coverage crowns than among cases immobilized by other restorative means.[69,72,83] Griffin Júnior[84] described two cases of cracked teeth that were successfully managed over two years, using an onlay porcelain restoration with partial coverage fabricated by CAD/CAM. The restorations were carried out in a single treatment session, avoiding the steps of provisional restoration, which can cause irritation in the manufacturing process and provisional cementation, increasing the chances of bacterial invasion along the fracture and the absence of pulp tension in a second visit. Signore et al.[28] suggested that indirect composite resin onlay restorations may effectively treat symptomatic cracked teeth. The AAE[17] suggests that if the crack is evident on the cavity floor and proximal external surface, its extension should be more carefully evaluated. If the crack extends over the proximal outer surface, removal of the crack below the level of the cementoenamel junction is generally not indicated. Removal of the proximal marginal ridge and associated tooth structure decreases tooth strength and its resistance to fracture. However, not removing the crack on the proximal surface may allow bacterial penetration to continue, eventually leading to the need for endodontic treatment or even tooth extraction. Kahler[16] suggested a treatment plan adapted to the treatment recommended by Abbott and Leow.[31] Lubisich, Hilton, and Ferracane[19] reported minimal consensus among professionals about which cracked teeth need a protective restoration, what this restoration should be, or when the intervention is appropriate. Furthermore, they report that clinical studies show that the tooth can be restored with a full crown, complex amalgam, or indirect composite resin in cracked teeth with re-

versible pulp damage. About the treatment plan, Seo et al.[53] concluded that most longitudinal fractures occurred in restored teeth, while only 28.0% were found in intact teeth. Compared with resin or porcelain, the use of non-adherent restoration materials, such as gold or amalgam, increased (18.7%) the occurrence of longitudinal fractures of the teeth. Kim et al.[54] concluded that cracks occurred mainly in teeth with non-adherent restorations, such as gold and amalgam, and 48.6% of the cracks were found in intact teeth. In that study, 60 teeth required endodontic treatment before being restored with a permanent crown; only 12 teeth remained with pulp vitality and were restored with a permanent crown without endodontic treatment. The proportion of teeth with root canal treatment increased in DGs with accentuated probing depth. Michaelson[85] described a treatment option for three cracked teeth with endodontic treatment. A fracture line extended apically, which consisted of locating the fracture line, removing it with a drill, generating a perforation, and sealing it with mineral trioxide aggregate (MTA). According to the researcher, this technique provided relief for the patient and improved the periodontal status adjacent to the tooth. In the study by Kang, Kim, and Kim,[55] cracked teeth diagnosed with normal pulp or reversible pulpitis were restored with natural resin. Teeth with mild sensitivity to cold or biting pain received provisional crowns. In the absence of symptoms, these teeth were restored with permanent crowns. When symptoms persisted, endodontic treatment was performed. For cracked teeth with irreversible pulpitis, pulp necrosis, or previous treatment, endodontic treatment or retreatment was indicated. Of 175 cracked teeth, 88 were endodontically treated and received a temporary restoration or stainless-steel orthodontic band. Murchie[30] suggested that endodontically treated cracked teeth, weakened by the loss of one or more marginal ridges and a cavity > 1/2 the width of the tooth, should be restored with cusp protection in the form of an onlay or full crown. Kanamaru et al.[29] recommended that cracked teeth, especially those originating from occlusal interference, be protected with full crown restorations. Alkhalifah et al.[34] carried out a cross-sectional survey structured by questionnaire, with prosthetists, endodontists, and general practitioners, evaluating the treatment approach for five different clinical scenarios of cracked teeth, concluding that there is a large difference in the planning approach by professionals and specialists, both as a whole and within each specialty. Davis and Shariff[57] carried out a prospective cohort study evaluating the success in treating 70 cracked teeth with fracture lines with intraradicular extension, suggesting that treatment in cracked teeth with root extensions can be improved using the following protocols: microscope-assisted intra-orifice barriers placed apically to the crack extension, complete occlusal reduction, specific postoperative instructions, and rapid placement of a full-coverage restoration.

Krell and Davis[86] published a modern take on CT management protocols and their results. When symptomatic, cracked teeth with cusp fractures require a full-coverage restoration. In cases where the pulp diagnosis is reversible pulpitis, no endodontic intervention is required, and a crown should be placed as soon as possible. A night plate can be another preventive measure in patients with CT. A study published by de Toubes et al.[49] presented a series of three clinical cases of cracked teeth. These teeth exhibited the presence of crack lines in various directions and extensions and were early restored with a full-coverage crown made by CAD/CAM. After following up for five years, the authors suggest that diagnosis and early restoration with full crown should be the treatment priority. The study results by Chen et al.[58] suggested that cracked teeth endodontically treated with restorations having full definitive coverage had a success rate of 93.6% after two years. Furthermore, they warn that a preoperative periapical lesion, inadequate permanent restoration, and a post after root canal treatment reduce the success rate.

Epidemiological and survival studies

Considering the great importance and relevance of the topic, the literature shows a relative scarcity of epidemiological and survival studies involving cracked teeth. In the study by Tan et al.[71], it was observed that terminal cracked teeth in the dental arch, with probing depth and teeth with multiple cracks, were the most likely to be extracted. Krell and Rivera[72] found that if a crack is identified early in the marginal crest in teeth with reversible pulpitis and a crown is placed early, endodontic treatment will be necessary within six months in about 20% of these cases. Ab-

bot and Leow[31] evaluated the symptoms and signs for five years in 100 cracked teeth with reversible pulpitis, suggesting a treatment protocol that consisted of removing carious and restorative processes and identifying the cracks, followed by placement of a sedative dressing and a provisional restoration. In case of pulp exposure or insufficient tooth structure, endodontic treatment was indicated. After three months, the teeth were re-evaluated, and, in the absence of symptoms, they were restored with an onlay restoration or a full-coverage crown. The authors suggested that the pulp diagnosis should always be considered provisional, waiting from six weeks to three months for the placement of the definitive restoration. The authors concluded that cracked teeth with reversible pulpitis could be treated conservatively, without endodontic treatment, in approximately 80% of cases.

Udoye and Jafarzadeh[52] highlighted that patients with unexplained pain in an amalgam-restored vital tooth (especially in upper molars), with or without a history of chewing accident, may have a CT. Lubisich, Hilton, and Ferracani[19] reviewed the literature and concluded there is little consensus among professionals about which CT needs protective restoration and when to put it on. They suggest that more controlled clinical studies should be carried out regarding the type of restoration and pulp health as there is no evidence showing which treatment option has the highest success rate. Ricucci, Loghin, and Siqueira Júnior[87] analyzed, through histopathological and histobacteriological exams, the dentin and pulp conditions in twelve cracked posterior teeth and eight teeth with significant friction, extracted for reasons not mentioned. The study identified histologically that the cracks were colonized by bacterial biofilms, especially when the crack extended perpendicularly to the dentin. The authors highlighted that crack identification alone is not enough to determine the pulpal and periapical status. The pulp tissue response will vary according to the crack's location, direction, and extension. Therefore, the greatest challenge for the clinician will be to determine the extent of the crack.

Kang, Kim, and Kim[55] analyzed over five years the distribution and characteristics of 175 cracked teeth. The authors concluded that endodontic treatment was a reliable procedure, with a survival rate of 90.0% at two years. Probing depth > 3 mm was considered a risk factor for survival of endodontically treated DGs. Sim et al.[88] investigated factors related to the survival of 84 endodontically treated cracked teeth over five years. They showed that an endodontically treated CT is functional and can reasonably survive for five years or more and that the presence of a crack passing through the floor of the pulp chamber reduces the chance of survival. The AAE[17] has published a guideline for methodological studies involving cracked teeth, intending to allow institutions, practice-based research networks, large-group offices, and even private dentists to collect and publish essential data regarding the incidence and prevalence of cracks or fractures the roots. Kanamaru et al.[29] evaluated the associations between clinical findings and 44 vitalized cracked teeth management, including restoration and occlusion (based on AAE criteria). Balancing side interference was recognized in 38 cases (86.4%). The authors suggest that cracked teeth, mainly originated due to occlusal interference, should be restored with a toral crown. Alkhalifah et al.[34] carried out a cross-sectional survey structured by questionnaire, with 32 prosthetists, 34 endodontists, and 29 general practitioners, evaluating the treatment approach for five different clinical scenarios dealing with cracked teeth. Participants received a clinical situation, a photograph, an x-ray, and a list of treatment plan options to choose from it. Despite the offer of a treatment plan, this study concluded a significant difference in the approach to planning by professionals and specialists. Krell and Caplan[35] evaluated the distribution and treatment outcomes of endodontically treated CT over 25 years. The three most significant factors in the bivariate analyses were pocket depth, cracks in the distal marginal crest, and periapical diagnosis. Subsequently, they generated an index named Iowa Staging Index, which helps professionals decide whether to try to save a CT or not, based on in-depth probing and periapical diagnosis. Wu, Lew, and Chen[56] observed the incidence of pulpitis and necrosis in 199 cracked teeth with pulp vitality, reporting that 71% of cracked teeth with reversible pulpitis and early restoration remained healthy after three years. Davis and Shariff[57] carried out a prospective cohort study with two to four years of follow-up, evaluating the success and survival of 70 cracked teeth with fracture lines with intraradicular extension. The authors concluded that

the success and survival rates of cracked teeth with root extensions might be similar to those of endodontically treated teeth, using the following protocols: microscopic-assisted intraorifical barriers, complete occlusal reduction, specific postoperative instructions, and quick placement of a full-coverage crown. In a systematic review with meta-analysis, Leong et al.[89] analyzed the treatment outcomes of endodontically treated cracked teeth and determined the factors that influenced the outcome. The authors reported that teeth with single cracks and those with cracks in the crowns had a lower risk of extraction. In contrast, teeth with periodontal probing > 3 mm, and teeth that were terminal abutments had a higher chance of extraction. The authors concluded that the survival rate of endodontically treated cracked teeth is moderately high. Therefore, endodontic treatment rather than extraction should be considered for DGs. Additionally, they suggested carrying out studies in this area. Olivieri et al.[90] carried out a systematic review and meta-analysis and observed that the presence of a periodontal pocket associated with the crack resulted in a higher risk of tooth loss. Chen et al.[58] observed that the presence of a periapical lesion, inadequate permanent restoration, and a post after root canal treatment could reduce the margin of success in treating cracked teeth.

Conclusion

The most crucial factor for the correct diagnosis of a cracked tooth is knowledge of the existence of the disease. The causes are multifactorial, and, generally, the signs and symptoms are variable or non-specific. In addition, they may resemble those of other pathologies, making this step challenging even for more experienced professionals. It is believed that the use of conventional and advanced diagnostic methods, such as microscopy and cone-beam computed tomography, helps in the early diagnosis of CT. In addition, the choice of the immediate and definitive restoration (onlay or full crown) and the time for its placement are determining factors for the survival of these teeth.

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