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CASE REPORT

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Clinical outcomes of cracked tooth syndrome after 3 years of treatment: a case series

Desfechos clínicos da síndrome do dente trincado após 3 anos de tratamento: uma série de casos

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ABSTRACT

Background: Diagnosis of cracked tooth syndrome (CTS) requires clinical experience and scientific knowledge. Even providing an effective resolution of the symptoms, clinicians must inform their patients that cracks may progress and induce tooth separation. Thus, follow-up is essential. **Case-report:** This study describes the treatment of patients with cracked tooth syndrome through a series of three cases. It also includes their long-term follow-ups over three years, through clinical probing and radiography. The findings highlight the importance of periodic check-ups to manage potential complications. Regular follow-ups can help control undesirable responses that may cause pain or make future treatments unfeasible. On all the scenarios presented, an endodontic treatment was needed. On the first successful case the radiolucent lesion regressed with no discomfort or pain. The second case was an unsuccessful one. The patient returned to the dental office after 3 years when probing revealed a 10-mm pocket at the distal aspect of the tooth. The radiography showed distal bone loss. The tooth was extracted to prevent bone loss from progressing. The third report documented the treatment of a patient who declined follow-up care and only returned after 3 years. At that point, a severe mobility was apparent. The radiography revealed a large periapical radiolucency with extensive bone loss, and the tooth extraction became necessary. **Conclusion:** These cases underscore the importance of informing patients about the potential for crack progression and tooth separation and emphasizes the crucial role of regular follow-up care, as well as discussing the possibilities of restorative treatment.

KEYWORDS

Clinical evolution; Cracked tooth syndrome; Diagnosis, oral; Permanent, dentistry, operative; Tooth crown.

RESUMO

Contexto: O diagnóstico da síndrome do dente trincado (SDT) requer experiência clínica e conhecimento científico. Mesmo com a resolução dos sintomas, os clínicos devem informar seus pacientes que as trincas podem progredir e induzir a fratura dos dentes. Assim, o acompanhamento é essencial. **Relato do caso:** Este estudo descreve o tratamento de pacientes com síndrome do dente trincado através de uma série de três casos e acompanhamento a longo prazo, durante três anos, por meio de sondagem clínica e radiografia (RX). Os resultados destacam a importância dos controles periódicos para gerir potenciais complicações, o que pode ajudar a controlar respostas indesejáveis dolorosas ou inviabilização de tratamentos futuros. Em todos os cenários, foi necessário tratamento endodôntico. No primeiro caso bem-sucedido, a lesão radiolúcida regrediu sem qualquer desconforto ou dor. O segundo caso foi de insucesso. O paciente voltou ao consultório dentário após 3 anos, quando a sondagem revelou uma bolsa de 10 mm na distal do dente, com perda óssea detectada no RX, sendo indicada a extração. O terceiro relatório documentou o tratamento de um paciente que recusou o acompanhamento e só regressou após

3 anos. Nessa altura, era notável uma intensa mobilidade. O RX revelou uma grande radiolucência periapical com extensa perda óssea, sendo necessária a extração do dente. **Conclusão:** Estes casos destacam a importância de informar os pacientes sobre o potencial de progressão da fissura e separação do dente e enfatiza o papel crucial do acompanhamento regular, além de discutir as possibilidades de tratamento restaurador.

PALAVRAS-CHAVE

Evolução clínica; Síndrome de dente quebrado; Diagnóstico bucal; Dentística operatória; Coroa dentária.

INTRODUCTION

Painful symptomatology is a routine problem in the clinical challenge of the dentist, where identifying the cause and origin can be difficult [1]. In addition, pain can be odontogenic or non-odontogenic, and these classifications can be challenging for professionals [2]. Diagnosis is the key to identifying the cause and establishing treatment, requiring both clinical skill and accurate scientific knowledge [1,2].

When identifying the problem, the clinical aspect should be associated with complementary exams [2]. In dentistry, when the patient reports pain symptoms associated with their complaint, hypotheses suggestive of common conditions such as dentoalveolar trauma, pulpitis, cracks and fractures, dentine hypersensitivity, orofacial pain, or even atypical toothache can be highlighted [3-5]. Clinical conduct for each condition will depend exclusively on the identification of the cause during the diagnostic stage [1].

The development of cracks in dental tissues occurs physiologically in enamel due to aging, often associated with some type of local trauma. This can lead to cracked tooth syndrome (CTS), which typically presents and intense and localized pain that worsens during chewing [5]. CTS can develop with or without restorative materials, and depending on the extent of the crack and its involvement with the dentin, it can cause pulpal and/or periodontal damage, potentially leading to pathological changes [5,6]. Treatments include a variety of procedures which can involve direct or indirect procedures, involving or not cuspal protection and adhesion, with or without endodontic treatment. In more extreme cases, if left untreated, the crack can spread and even result in tooth loss [7].

A diagnosis requires careful analysis of the clinical characteristics alongside complementary exams [2]. The main complementary methods include periapical and/or interproximal radiographs, transillumination, CT scans, and stimulus tests such as bite response on each cusp and cold pulp vitality [8]. The location and extent of the crack determine the most appropriate treatment, which may vary between dentistry specialties according to the type of involvement, including enamel only, enamel and dentin, pulp and periodontal involvement [6,7].

This study aims to describe the treatment of three different cases of CTS and its long-term follow-ups after 3 years, highlighting the importance of periodic follow-ups, which can help to prevent undesirable responses such as pain or difficulty with future treatments, while also discussing other possibilities of CTS treatment.

CASES REPORTS

Case report 1

A healthy 55-year-old man was referred to the Restorative Dentistry Department at ICT-UNESP for a restorative evaluation. A clinical and radiographic examination of the patient's mandibular right first molar revealed a defective amalgam restoration with microleakage and mesial secondary caries, but no periodontal or periapical disease. The pulp responded normally to testing (Figure 1A). The proposed treatment was to remove the amalgam restoration from the first molar and replace it with a Class II direct adhesive restoration. After the amalgam was removed, microcracks were detected in the mesiodistal direction with an unclear extent (Figure 1B). The selected treatment at that time was to place the most conservative direct adhesive resin restoration possible.

The protocol started with cleaning of the cavity with an oil-free prophylaxis paste, by means of a robinson brush, followed by a detergent (Tergencal, Biodinâmica, Ibiporã, PR, Brazil) applied actively by means of a microbrush for 10s, followed by a washing and drying with absorvent paper. After, etching was performed with a

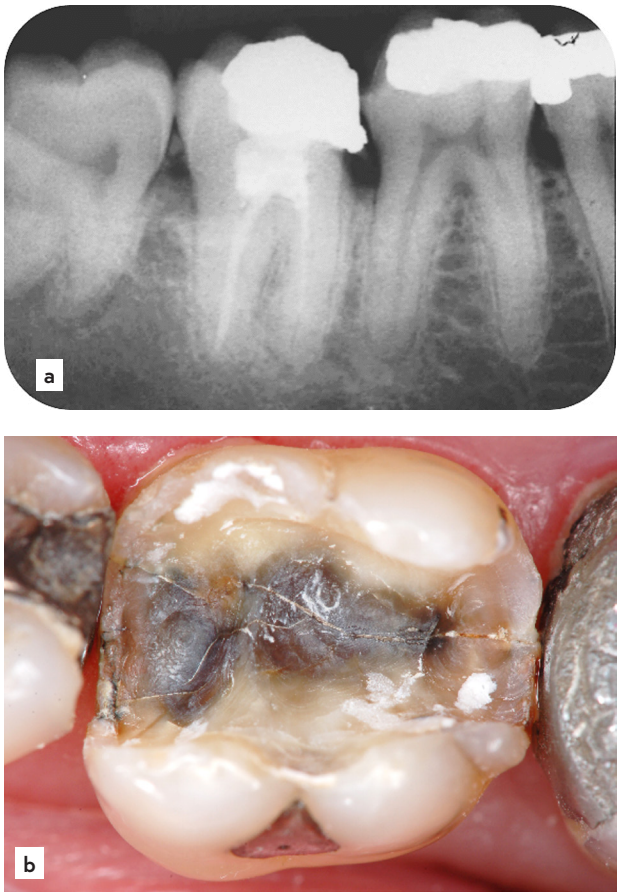

Figure 1 - (a) Tooth 46 with amalgam restoration and caries; (b) Tooth 46, after amalgam restoration removing.

35% phosphoric acid (Ultra-Etch, Ultradent, Indaiatuba, SP, Brazil) for 30s on enamel, and 15s on dentin, followed by intense washing for 20s, and gentle dry with absorvent paper, to keep the dentin moist. A double layer of 2-step etch-and-rinse adhesive system (Adper Single Bond 2, 3M do Brasil Ltda, Sumaré, SP, Brazil) was then applied in active mode, photopolymerized with a 1200mW/cm^2 LED photocuring device (Demi Plus, Kerr, Orange, CA, EUA) for 20s, followed by 2mm layers of composite resin (Filtek Z350, 3M do Brasil Ltda., Sumaré, SP, Brazil), individually photopolymerized for 20s each, until the full filling of the cavity.

After 17 months, the patient returned with a buccal sinus tract. Gutta-percha placed in the sinus tract at the root furcation demonstrated that there was an endodontic lesion (Figures 2A, 2B and 2C). Clinically, this tooth presented with pulpal necrosis. Root canal treatment (RCT) was performed after the sinus tract had healed completely and the patient remained asymptomatic. The crown was opened using spherical diamond tips, followed by the removal of necrotic pulp material from the pulp chamber using dentin curettes. Afterwards,

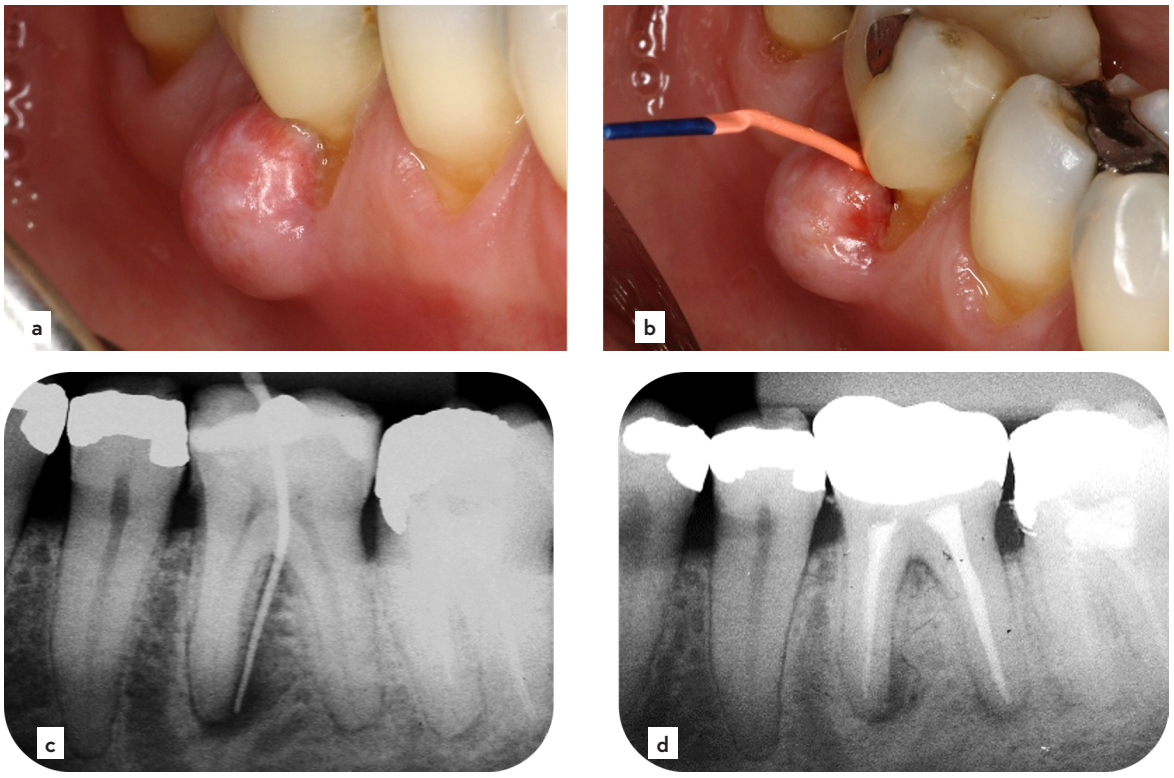

Figure 2 - (a) Fistulous tract in adjacent mucosa; (b) Guttapercha placed in the sinus tract at the root furcation; (v) Radiograph image of Gutta-percha reaching periapical lesion; (d) Radiograph after crown cementation.

compensatory grinding was carried out with Gates Glidden tips (1 and 2) to access the root canals, followed by immediate neutralization with 1% sodium hypochlorite solution. Odontometry and chemical-mechanical preparation was made with files (K-Flexofile, Dentsply, Charlotte, NC, EUA) from number 10 to 35, and the irrigation process with 1% sodium hypochlorite followed by saline solution. The canals were dried with sterile absorbent paper cones and irrigated with 3% liquid Trisodium EDTA (Biodinâmica, Ibiporã, PR, Brazil) for 3 minutes, with oscillatory movements of the file inside the canals in the last minute. A paste made from a mixture of 2% chlorhexidine gel and P.A. calcium hydroxide powder (Biodinâmica, Ibiporã, PR, Brazil) was used as intracanal medication, with a provisional glass ionomer restoration (Vidrion R, SSWhite, Rio de Janeiro, RJ, Brazil). The canal was filled with number #35 gutta-percha cones and AH Plus cement (Dentsply, Charlotte, NC, EUA) using the lateral condensation technique. The access chamber was definitively restored with resin composite (Filtek Z350, A1, 3M do Brasil Ltda., Sumaré, SP, Brazil) and then received a full-coverage metal crown cemented with zinc phosphate cement (SSWhite, Rio de Janeiro, RJ, Brazil) (Figure 2D).

The patient was recalled after 1 year (Figures 3A and 3B) and 3 years (Figures 4A and 4B). Clinical tests, including percussion, probing depths, biting stimulation, and periapical radiographs were performed. After 3 years, the radiolucent lesion appeared to have regressed. During the follow-up period, the patient reported no discomfort or pain. As for the furcal and periapical lesion still present, despite of the significative regression on x-ray image comparing the immediate and the 1- and 3-years follow-up, considering the absence of symptoms and the apparent stability after the passing of years, it was clarified with the patient the need of periodical follow-up with clinical probing and radiograph.

Figure 3 - (a) Clinical aspect after 1 year; (b) X-ray after 1 year.

Figure 4 - (a) Clinical aspect after 3 years; (b) X-ray after 3 years.

Case report 2

A 44-year-old woman sought treatment in a private practice for spontaneous pain in her right mandible. The pain was exacerbated by chewing and biting on a cotton roll, particularly on different cusps of the mandibular right second molar (47). A thermal test elicited an exaggerated response. This tooth, which had a Class I amalgam restoration, presented with a mesiodistal crack line on its occlusal surface (Figure 5A – red arrows). A periapical radiograph revealed an apical radiolucency on the distal root (Figure 5B). Probing was performed for initial evaluation, but with no significant changes. Treatment options and their corresponding prognoses were explained to the patient, who

opted to retain the tooth instead of extraction. The restorative materials were removed, and endodontic treatment was performed with the same material of case 1 (Figure 5C).

The access chamber was definitively restored with composite resin with the same protocol used in case 1, to serve as an adhesive filling material, and then the tooth was prepared for a full-coverage metal crown. After taking impressions, a dental laboratory technician fabricated a temporary crown, which was cemented with zinc phosphate cement (SSWhite, Rio de Janeiro, RJ, Brazil).

The patient returned to the dental office after 3 years. Probing revealed a 10-mm pocket on the distal aspect of the tooth. A radiograph showed distal bone loss (Figure 6A – red arrow). At this point, the tooth was extracted to prevent further bone loss. A crack line was evident on the distal root, extending to the apical third and splitting into two separate lines running buccally and lingually (Figure 6B – red arrows).

Case report 3

A 68-year-old female patient presented with a cracked tooth syndrome in her mandibular left first molar (Figure 7A). Symptoms involved pain when bitting and cold temperature. The tooth received endodontically treatment with the same protocol used on case 1, and was restored with a conventional glass ionomer (Vidrion R, SSWhite, Rio de Janeiro, RJ, Brazil) as a pulp chamber filling, and a definitive metal crown procedure was performed with the same protocol reported on the previous cases. After treatment for the cracked tooth, the patient declined follow-up care and only returned after 3 years, which made impossible a rigorous control and documentation of the case. At this time, a severe mobility was readily apparent, and a radiograph revealed a large periodontal radiolucency (Figure 7B – red arrows), with extensive bone loss and furcal involvement. The tooth was then extracted.

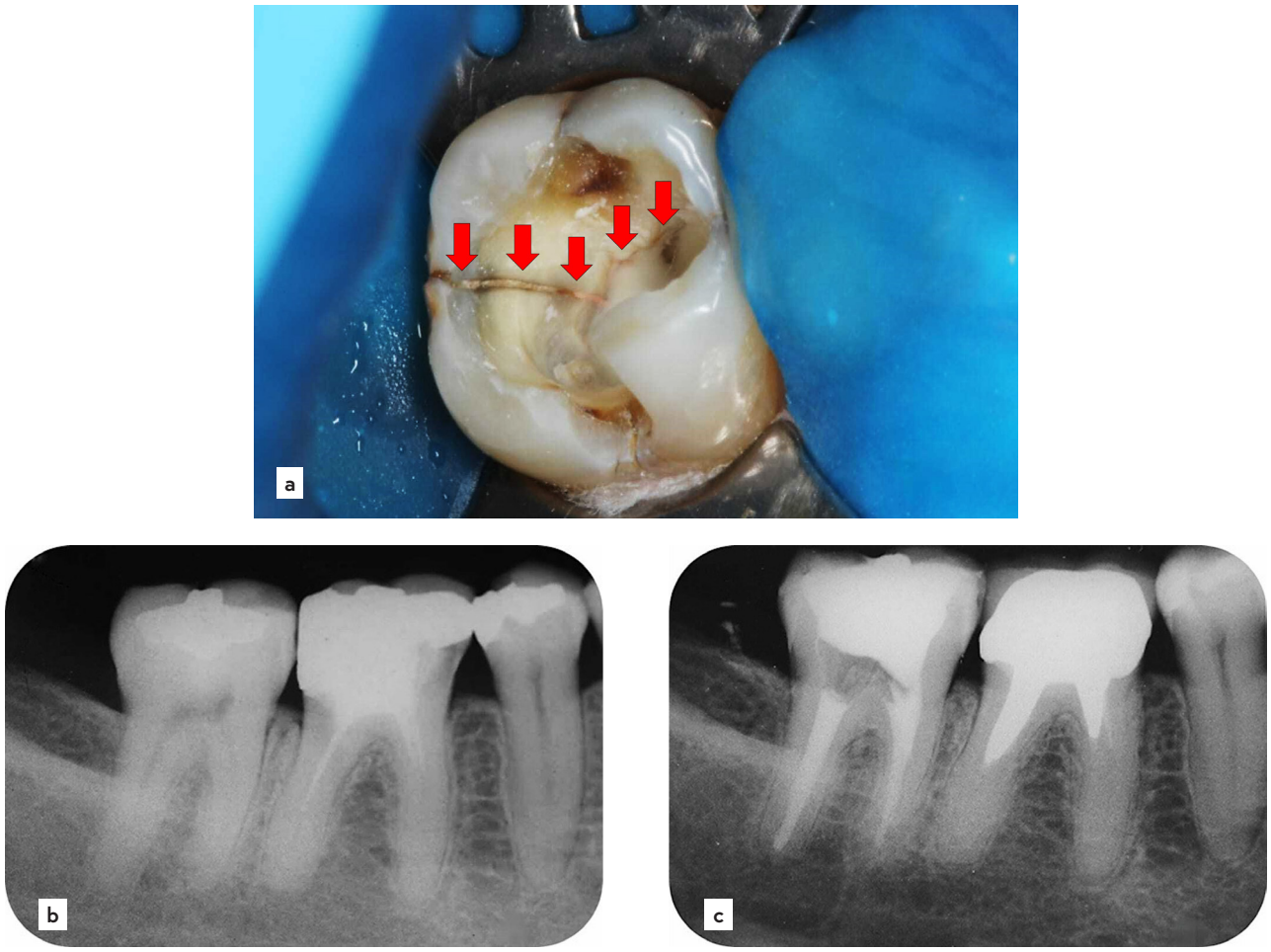

Figure 5 - (a) Mesiodistal crack line; (b) Initial case tooth 47; (c) X-ray after 1 year.

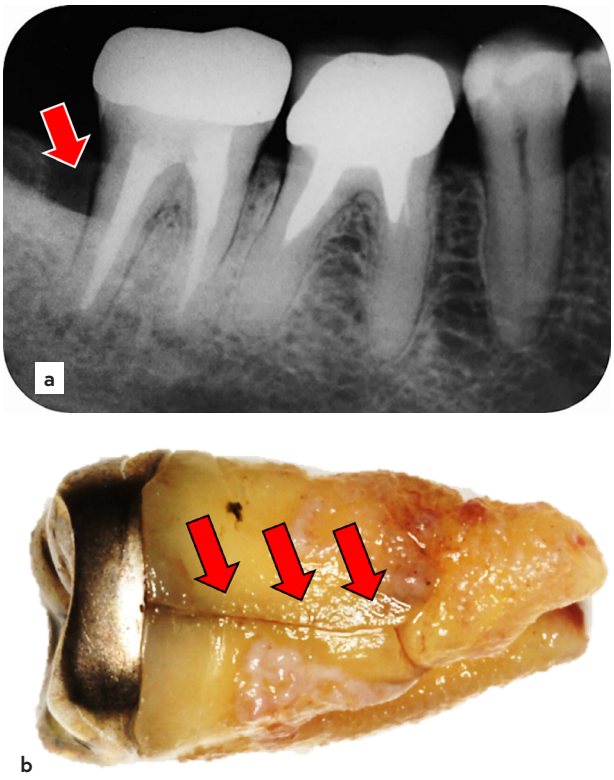

Figure 6 - (a) Periodontal disease and bone lose are evidenced radiographically; (b) A crack line was present on the distal aspect of the tooth, extending all the way to the apical third. At this point, it bifurcated into two separate crack lines running to the vestibular and lingual aspects of the distal root.

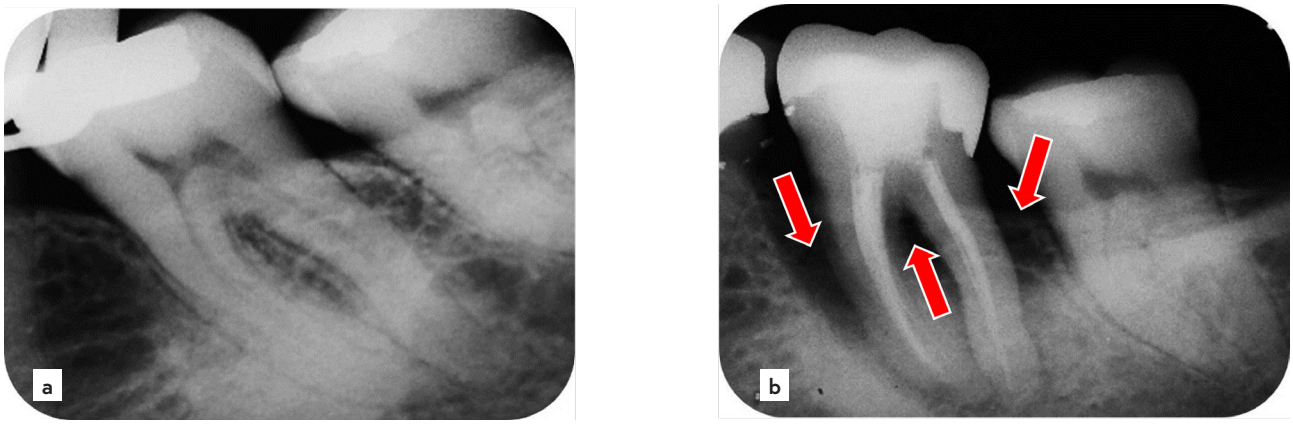

Figure 7 - (a) The mandibular left first molar has been diagnosed with CTS symptoms. It was further endodontically treated and restored with definitive metal crown; (b) Tooth 36 after 3 years, presenting a large periodontal radiolucency.

DISCUSSION

Cracked teeth pose an initial challenge to both diagnosing the need for endodontic treatment and selecting the appropriate restorative procedure [2,9]. The location of the crack can further complicate diagnosis and treatment planning, as it influences the signs and symptoms that manifest [10]. Cracks present on the inner surface of the crown often extend to the pulp chamber and may even reach the entrance of the root canal orifices [2,5].

Cracks that remain within the dentin without contacting the external surface of the root generate a more favorable clinical situation for the success of endodontic and restorative treatment. In this scenario, there is a more incomplete fracture indication, which makes restorative treatment more predictable in terms of damage control [11,12]. In contrast, when cracks are present on the external surface of the crowns, identifying their end is essential for planning [7,13]. Cracks that remain above

the gingival sulcus can be incorporated into the prosthetic restoration, but cracks that invade the junctional epithelium are more complex and have a dubious prognosis [6]. This is because local inflammation in the periodontal ligament caused by the presence of microorganisms leads to sensitivity during chewing and vertical percussion, and the presence of microorganisms in the area accelerates bone resorption, forming a localized periodontal pocket [14], which happened on case 2.

Dental procedures, such as preparation with burs, extensive tooth preparation, insufficient protection of weakened cusps, larger amalgam restorations, and an inappropriate incremental technique during restorative procedures with composite resin, can initiate microcracks [9,11]. The cracked mandibular first molar described in the first clinical report may have resulted from the "wedging effect" of occlusion with the prominent mesiopalatal cusp of the maxillary first molar [10,12]. Pacquet et al. [13], reported that this tooth is the second most commonly affected tooth, and cracks occur because the masticatory force is increased close to the temporomandibular joint. The three patients in this article illustrate that the mandibular molars are the most commonly affected teeth [15].

Diagnosing a cracked tooth can be difficult. During clinical examination, visualizing a crack is challenging, and the radiographic examination typically remains inconclusive [1,8]. Authors have suggested that removing restorations and using contrasting color of a rubber dam can improve visualization of the crack [6,16]. Patients with cracked tooth syndrome report brief pain while chewing, sensitivity to cold stimuli, and pain after biting hard food [7].

Some authors have suggested using stains such as gentian violet or methylene blue to improve visualization of cracks [10]. During diagnosis, important aspects to consider for treatment planning include the direction of fracture propagation, the characteristics of the bone tissue around the suspected fracture or crack, and the pulpal condition [1,7]. An early diagnosis can lead to successful restorative treatment with a good prognosis [17]. Relevant aspects such as dental history and patient habits, such as chewing ice, hard candy, pencils or other things that might lead to cracked teeth, should be identified [10,17].

To solve the problem of incomplete posterior tooth fracture, various treatment has been advocated, including directly bonded intracoronal restorations, directly bonded extracoronal restorations, and indirect extracoronal restorations, with or without endodontic treatment [4,18]. The first patient was initially treated with a conservative class II restoration, which seems to have been successful in terms of prevent the crack spread along the months. However, as no biological protection was used, such as with glass ionomer cement, as reported in the literature [19], the direct adhesive restoration on the dentin may have led to irreversible pulp involvement.

Due to the endo-perio lesion installed, an indirect cuspal-coverage was necessary to keep the protection to the remaining tooth after the endodontic treatment. This treatment can leave the tooth dry and increase susceptibility to fracture due to the internal wear necessary for endodontic access. The other two patients were also treated with indirect cuspal-coverage restorations due to the extension and location of the cracks in their posterior teeth [19-22]. After a longitudinal evaluation, Batalha-Silva et al. [12] reported satisfactory results with no symptoms when the teeth were restored with composite resin bonded directly with cusp coverage. This is in agreement with others who proposed complete cuspal coverage to treat cracked teeth [5,14,19-23].

In this sense, there are controversial results in the literature regarding the need for prior endodontic treatment. While some authors such as Leong et al. [21] argue that endodontic treatment leads to more predictable tooth maintenance results, others such as de Toubes et al. [19] have reported success with cusp protection treatments performed without prior endodontic treatment.

Another important point of discussion is the type of material used and the restorative technique [7]. Adhesive restorations are now preferred to promote better union between the cracked parts [23]. However, ceramics can pose a risk by transmitting the masticatory load [14]. In the cases presented, metallic restorations with cusp coverage and conservative wear were used after an endodontic treatment to preserve of the dental remnant to a greater extent. This is in agreement with the literature, which indicates

better prognostic for teeth treated with minimally invasive restorations [14,21,23].

Krell and Rivera [24] reported that 20% of 127 cracked teeth with reversible pulpitis treated with complete crowns required endodontic treatment after 6 months, while the other teeth remained vital for 6 years of evaluation. Endodontic treatment of cracked teeth has been considered an appropriate treatment with a 2-year survival rate of 90.0% [6,21]. Monitoring is essential, as cracks can remain intact or evolve into a complete fracture. Furthermore, high probing depth indicates the presence of a periodontal pocket, which predisposes to the progression of cracks in the root and affects the qualities of the periodontium [21,22]. The extensive bone involvement in the third case could have been avoided if the patient had returned within the recommended periods [6].

Krell and Caplan [17] identified pocket depth exceeding 5 mm and a crack across the distal marginal ridge as the key factors most associated with failure (Figures 5C and 6A). Additionally, cracks harbor biofilms, allowing bacteria to propagate and reach the pulp and periodontal ligament [24,25]. Clinicians have a responsibility to inform patients that cracks can progress, potentially leading to tooth separation, and offer treatment options [13,21]. The flowchart below outlines a protocol for treating cracked teeth based on their pulp and periapical condition (Figure 8).

CONCLUSION

This study highlights to clinicians the necessity to inform their patients that cracks may progress and lead to tooth separation, and that follow-up is essential to prevent further damage. This clinical report also suggests clinicians to carefully consider the protocol for treating cracked teeth with different pulp and periapical conditions. In cases where endodontic treatment is not an option and pulp vitality is maintained, a cement with biocompatible

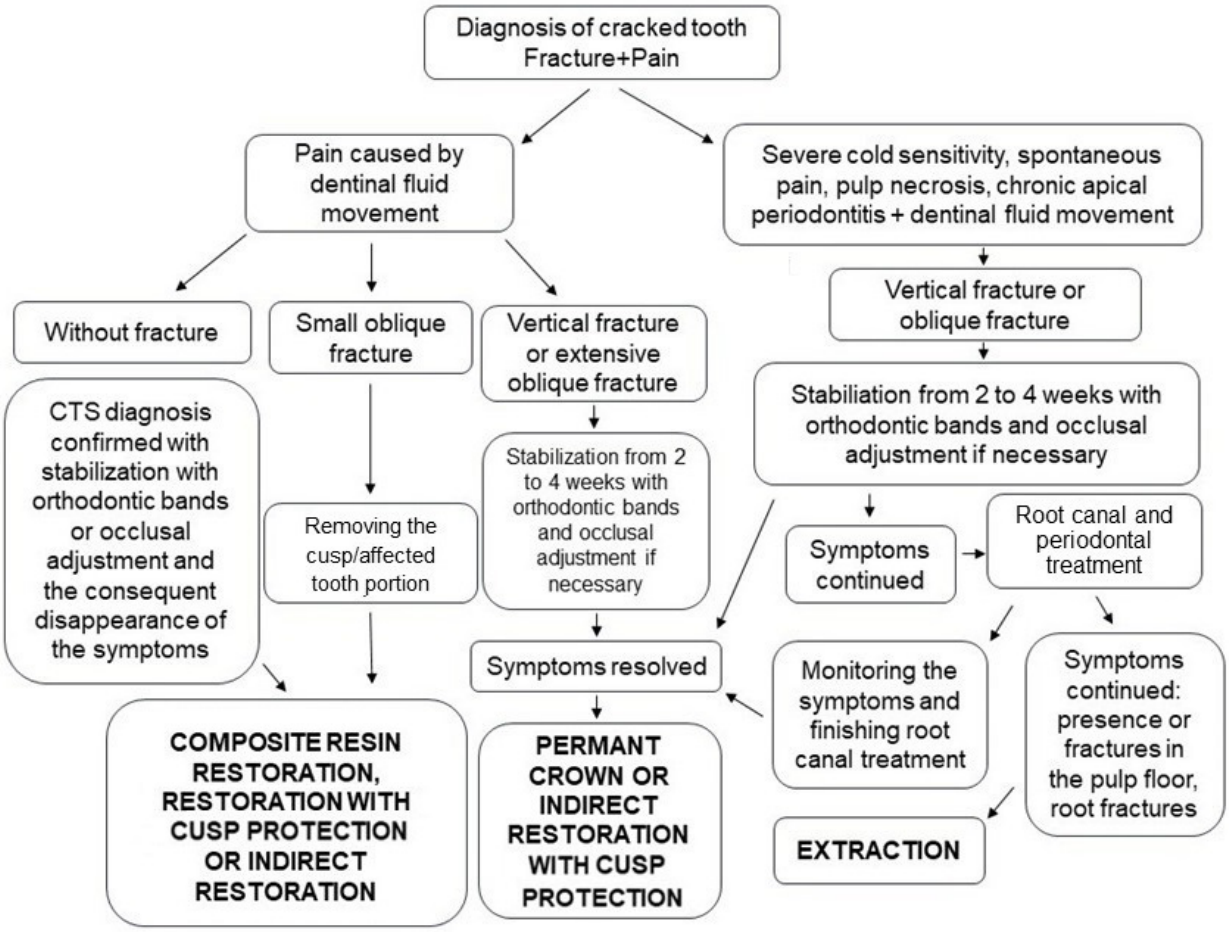

Figure 8 - Flow-chart: protocol for treating cracked teeth presenting different pulp and periapical conditions.
Source: Provided by the authors.

characteristics such as glass ionomer cement should be preferred to direct adhesion with methacrylate-based materials (cytotoxic). After endodontic treatment, however, minimally invasive restorations with cuspal protection, such as metal ones, are preferable.

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Author's Contributions

KCKY: Formal Analysis, Data Curation, Writing – Original Draft Preparation. JPSJ: Conceptualization, Investigation, Software, Writing – Original Draft Preparation. CSF: Investigation, Software, Writing – Original Draft Preparation. RPM: Data Curation, Writing – Original Draft Preparation. FNA: Conceptualization, Methodology. HBD: Writing – Review & Editing, Methodology. EB: Writing – Review & Editing, Supervision. SEPG: Visualization, Supervision.

Conflict of Interest

The authors have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article.

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Regulatory Statement

This study was conducted in accordance with all the provisions of the local human subjects oversight committee guidelines and policies: Free consent was signed by the patients.

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