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Treatment and preservation of horizontal fracture and necrosis in maxillary incisors: a conservative clinical case

Tratamento e proservação de fratura horizontal e necrose em incisivos superiores: um caso clínico conservador

Alice Moraes **Loreto**[1] 0009-0006-5231-728X
Mariana de Carlo **Bello**[1] 0000-0003-2519-5724
Mônica Pagliarini **Buligon**[1] 0000-0002-7998-5126
Patricia Kolling **Marquezan**[2] 0000-0001-5061-6039
Pedro Henrique Fortes **Guerim**[2] 0000-0003-1163-9451
Flávia Kolling **Marquezan**[1] 0000-0003-1505-2447

ABSTRACT

Dental trauma is caused by direct impacts to the teeth and can occur in both children and adults, affecting the teeth and surrounding structures. In this context, the objective of this study was to report a clinical case of a 26-year-old female patient who required endodontic treatment of tooth 21 due to pulp necrosis, and follow-up (monitoring) of tooth 11, which presented a horizontal root fracture in the middle third, but with preserved pulp vitality. Both conditions were associated with

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[1] Universidade Franciscana, Curso de Odontologia. Santa Maria, RS, Brasil.
[2] Universidade Federal de Santa Maria, Departamento de Microbiologia e Parasitologia. Av. Roraima, Prédio 20, Sala 4208, 97105-900, Santa Maria, RS, Brasil. Correspondence to: PK Marquezan. E-mail: <patricia.marquezan@ufsm.br>.

trauma that occurred during childhood. A discussion was conducted regarding the main aspects related to diagnosis, clinical management, and long-term follow-up. The treatment plan consisted of complete endodontic therapy for tooth 21, using specific instrumentation techniques, intracanal medication, and obturation, as well as the follow-up of tooth 11 with a focus on preserving pulp vitality and monitoring the root fracture. Clinical and radiographic follow-up was carried out over a 12-month period, with evaluation through pulp sensitivity tests, clinical examination, and periapical radiographs. At the end of this period, tooth 11 maintained a positive response to sensitivity testing and showed no clinical signs of failure, while tooth 21 showed regression of the periapical lesion and absence of symptoms, indicating the success of the conservative treatment adopted. It is concluded that the management of patients with root fractures requires a thorough diagnostic approach, considering the degree of pulp and periapical involvement, and that long-term follow-up is essential to monitor potential late changes, ensuring treatment success and the maintenance of function and aesthetics of the affected tooth.

Indexing terms: Case reports. Endodontics. Root canal therapy. Tooth injuries.

RESUMO

Os traumatismos dentários são causados por impactos diretos contra os dentes, podendo ocorrer tanto em crianças quanto em adultos, afetando os dentes e estruturas circunvizinhas. Nesse sentido, o objetivo deste trabalho foi relatar um caso clínico de uma paciente de 26 anos de idade, que apresentou necessidade de tratamento endodôntico do dente 21, devido à necrose pulpar, e proservação do dente 11, que apresentava fratura radicular horizontal no terço médio, porém com manutenção da vitalidade pulpar. Ambas as condições estavam associadas a um trauma ocorrido na infância. Foi realizada uma discussão sobre as principais particularidades relacionadas ao diagnóstico, à conduta clínica e ao acompanhamento em longo prazo. O plano de tratamento consistiu na realização do tratamento endodôntico completo do dente 21, com uso de técnicas específicas de instrumentação, medicação intracanal e obturação, além da proservação do dente 11 com foco na manutenção da vitalidade e monitoramento da fratura radicular. O acompanhamento clínico e radiográfico foi conduzido por um período de 12 meses, com avaliação por meio de testes de sensibilidade pulpar, exame clínico e radiografias periapicais. Ao final desse período, o dente 11 manteve resposta positiva ao teste de sensibilidade e ausência de sinais clínicos de falha, enquanto o dente 21 apresentou regressão da lesão periapical e ausência de sintomatologia, indicando sucesso do tratamento conservador adotado.Conclui-se que o manejo de pacientes com fraturas radiculares requer uma abordagem diagnóstica minuciosa, considerando o grau de comprometimento pulpar e periapical, e que a proservação em longo prazo é fundamental para monitorar possíveis alterações tardias, garantindo o sucesso do tratamento e a manutenção da função e estética do elemento dentário acometido.

Termos de indexação: Relatos de casos. Endodontia. Tratamento do canal radicular. Traumatismos dentários.

INTRODUCTION

Dental trauma occurs frequently in children and young adults, accounting for 5% of injuries that require dental care [1]. According to Levin et al. [2], among school-aged children, 25% have already suffered some type of dental trauma, while 33% of adults experienced dental injuries to the permanent dentition before the age of 19. Furthermore, among teeth affected by trauma, 18% to 25% are permanent teeth, with maxillary central incisors being the most prevalent – approximately 53% of affected teeth – due to their vulnerable position in the arch, making them the first to receive the impact of traumatic forces [1].

As a consequence of trauma to permanent teeth, root fractures account for 1.2% to 7% of all traumatic dental injuries [3]. Root fractures involve dentin, cementum, and dental pulp, and can occur in any direction or orientation. They are generally classified as vertical fractures (sometimes also involving the crown) or transverse fractures, often referred to as horizontal fractures [4]. In some cases, vertical fractures require tooth extraction followed by prosthetic rehabilitation, whereas the treatment of transverse fractures varies depending on their classification and severity. These fractures may be located in the apical, middle, or coronal third of the root, and their management also depends on pulpal status – whether pulp vitality is maintained or necrosis has developed [4].

Regarding tooth prognosis, it depends on factors such as patient age, root development stage, crown displacement, and the location and orientation of the fracture [5]. In general, the more apical the fracture is relative to the root length, the better the prognosis. Management may involve endodontic treatment limited to the coronal fragment, treatment of both fragments up to the root apex, or treatment followed by apicoectomy of the apical fragment. Moreover, the fracture must be monitored periodically. Both pulp tissues and periodontal ligament compete to repair the fracture line [6]. When properly managed according to clinical guidelines, root fractures show a 10-year survival rate of 87% [7].

The pulp plays a critical role in this context, and its management has a substantial impact on the long-term survival of the tooth [8]. Accurate diagnosis is therefore essential, as it forms the basis for developing an effective treatment and follow-up strategy aimed at achieving a favorable outcome [9]. Diagnosis includes detailed extraoral and intraoral examinations, apical palpation, vertical and horizontal percussion, pulp sensitivity testing, mobility assessment, and careful radiographic evaluation [9]. Another determining factor in diagnosing dental injuries is crown discoloration. A reddish hue immediately after trauma suggests pulpal hemorrhage, whereas over time, a yellowish or grayish discoloration may indicate pulp necrosis [9].

Radiographic examination is a standard requirement in dental trauma care, with periapical radiographs taken at different angulations during the initial patient evaluation. Cone-Beam Computed Tomography (CBCT), on the other hand, allows for more detailed visualization of trauma, compensating for the limitations of conventional two-dimensional radiographs by providing important additional information [10]. Pulp sensitivity testing performed immediately after trauma may yield inconsistent results, and is more reliable when carried out several weeks later [8].

Thus, it is understood that dental trauma followed by horizontal root fracture requires precise diagnosis and appropriate treatment, since an incorrect approach may lead the clinician to perform unnecessary invasive procedures. For this reason, the aim of this study was to present a clinical case report of a patient who sustained dental trauma with horizontal root fracture and to discuss the main particularities related to diagnosis, as well as the most appropriate treatment and follow-up approach.

CASE REPORT

The study was approved by the Research Ethics Committee under protocol number CAAE 84699324.1.0000.5306. The patient's treatment was planned and executed independently of the clinical case report proposal. For the preparation of this case report, the Informed Consent Form was presented and signed by the participant.

A 26-year-old female patient sought care at the Dentistry Program of the Universidade Franciscana (UFN) for evaluation and dental treatment. During the initial interview, she reported having received previous care at her local Primary Health Unit, where she was referred to the institution to continue the endodontic treatment of tooth 21. At the first appointment, anamnesis was conducted and previous medical and dental data were collected. Although she could not recall precise details, the patient reported a history of dental trauma to the region around the age of 8 or 9, following a fall from a bicycle. At the time of consultation, she did not complain of discomfort but reported a history of pain, mainly when consuming cold beverages.

Extraoral examination revealed no alterations. Intraoral clinical examination showed no edema or fistula, but a provisional restoration was observed on the palatal surface of tooth 21, indicating a previous root canal access, along with crown discoloration characterized by darkening (figure 1).

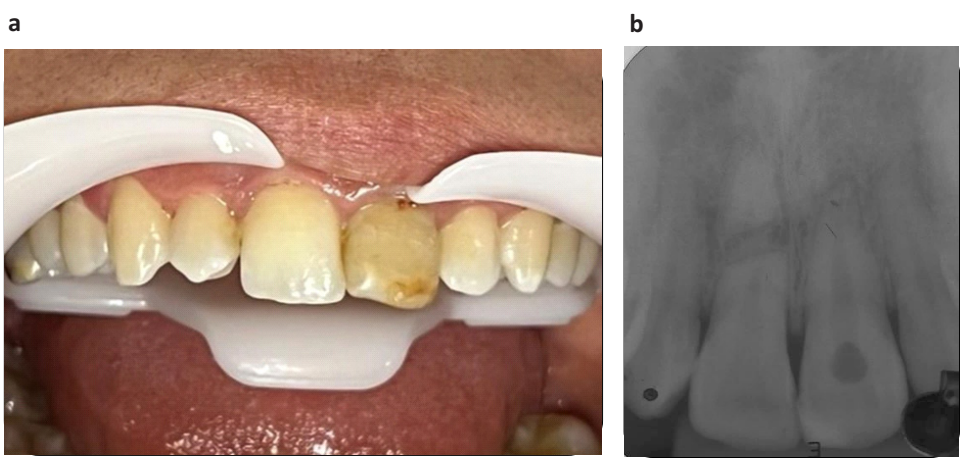

Figure 1. a) Initial clinical photograph showing the esthetic appearance of the maxillary incisors, with slight discoloration of the affected tooth. b) Initial periapical radiograph demonstrating a radiolucent line consistent with horizontal root fracture.

At the first appointment, horizontal and vertical percussion tests, apical palpation, mobility assessment, cold sensitivity testing, and periapical radiographs of teeth 11 and 21 were performed. Apical palpation produced no painful symptoms. Vertical percussion tests caused discomfort only in tooth 11, which also presented mobility. Tactile evaluation classified this mobility as grade 2 according to Miller's index. This index categorizes mobility into four grades: grade 0 indicates no mobility; grade 1, slight horizontal mobility; grade 2, moderate horizontal mobility with possible vertical displacement; and grade 3, severe mobility with significant horizontal and vertical movement, often referred to as "floating tooth" mobility [12].

Cold sensitivity testing was performed using refrigerant spray "Ice Test" (Iodontosul, Rio Grande do Sul, Brazil). Tooth 21 showed a negative response, while tooth 11 responded positively. The initial periapical radiograph of the anterior maxillary region revealed complete root formation of the anterior teeth, previous coronal opening of tooth 21, and a horizontal root fracture in tooth 11 at the middle third, with separation of apical and coronal fragments.

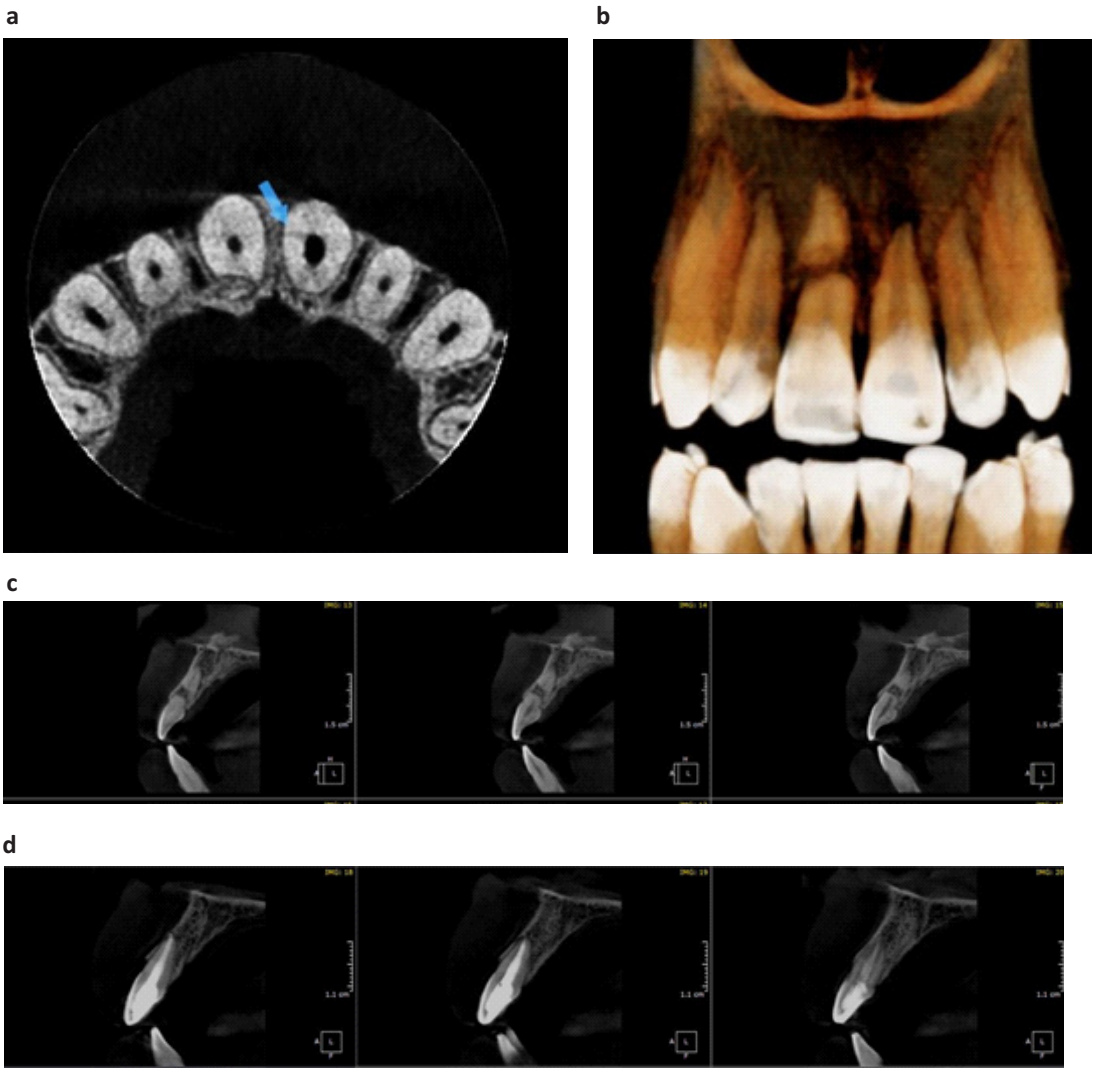

Figure 2. a) CBCT cross-sectional image of the coronal portion of the maxillary anterior roots, showing a root crack in tooth 21. b) Frontal reference of the tomographic image of the maxillary anterior teeth, revealing periapical radiolucency in tooth 21, as well as separation between the apical and coronal fragments of tooth 11 after consolidated fracture. c) CBCT sagittal section showing the lesion and initial fracture. d) Sagittal section after follow-up.

In addition, Cone-Beam Computed Tomography (CBCT) was requested, which showed a crack in the middle third of tooth 21 (figure 2a–d), as well as a radiolucent image at its root apex that was not fully visible in the periapical radiograph, which suggested only slight apical thickening (figure 3).

Based on these examinations, the diagnosis was defined as normal pulp with no periapical alteration for tooth 11, and chronic apical periodontitis for tooth 21. The treatment plan included preservation of tooth 11 and complete endodontic treatment of tooth 21. The decision to proceed with endodontic treatment of tooth 21, despite the crack, is supported by the literature.

At the second appointment, based on the initial radiograph, the Apparent Tooth Length (ATL) was determined as 24 mm, and by subtracting 2 mm, the Real Instrument Length (RIL) was set at 22 mm. After

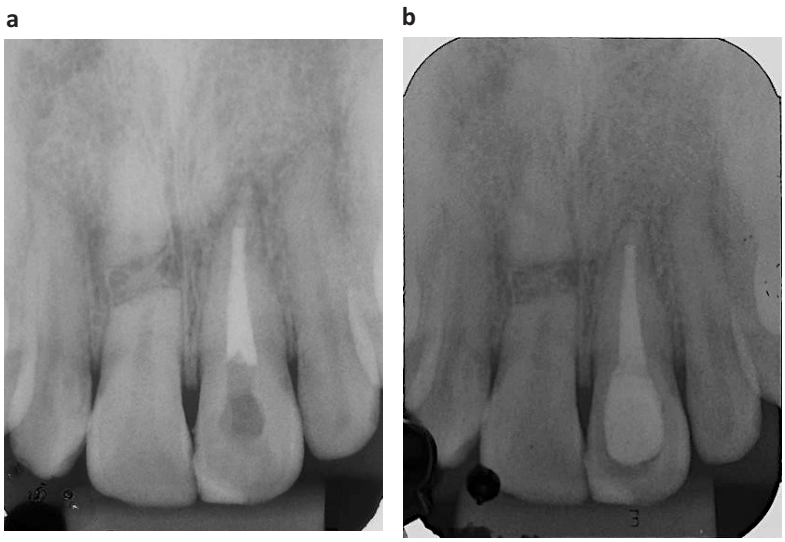

Figure 3. a) Final periapical radiograph showing root canal obturation of the treated tooth with proper adaptation of the filling material and absence of voids. b) Follow-up radiograph demonstrating maintenance of periapical integrity and absence of resorptive signs, indicating successful endodontic treatment during the follow-up period.

anesthesia and rubber dam isolation, the provisional restoration was removed, and the canal was explored with K-files #08, #10, and #15 (MkLife, Rio Grande do Sul, Brazil), with abundant irrigation using 1% sodium hypochlorite (Asfer, São Paulo, Brazil). Intracanal medication with Tricresol Formalin (Biodinâmica, Paraná, Brazil) was applied, and the canal was sealed with temporary restorative material (Bioplic, Biodinâmica, Paraná, Brazil).

At the third appointment, cervical third preparation was performed with Largo drills I and II (Angelus, Paraná, Brazil) and radiographic odontometry to establish the Working Length (WL), measured at 21 mm. At the end of the session, intracanal medication with Tricresol was reapplied, and temporary restoration with Bioplic was performed.

At the fourth appointment, root canal instrumentation was performed using the Crown-Down technique, with Initial Apical File (IAF) #55 and final apical file (FAF) #80, with irrigation using 17% Ethylenediaminetetraacetic Acid (EDTA) (Biodinâmica, Paraná, Brazil). Intracanal medication with calcium hydroxide paste (Calen with PMCC, SSWhite, Rio de Janeiro, Brazil) was applied, followed by provisional restoration with Bioplic. After 15 days, the patient returned with gingival edema and suppuration through the vestibular gingival sulcus. Canal irrigation with 2.5% sodium hypochlorite, instrumentation with K-file #15 and memory file, irrigation with 17% EDTA and saline, followed by new intracanal medication (Calen with PMCC), and provisional restoration with Bioplic were performed.

After one month, clinical reassessment showed persistent drainage through the gingival sulcus, requiring another medication change. Fifteen days later, edema regression and absence of suppuration were observed, making it possible to proceed with obturation. Intracanal medication was removed with abundant irrigation using 1% sodium hypochlorite and instrumentation with K-file #15 and memory file. The canal was irrigated with 17% EDTA to remove the smear layer, then dried with sterile paper points (size #80) until dryness was confirmed. The master cone was selected based on visual, tactile, and radiographic

criteria, ensuring adequate fit at WL. Canal obturation was performed using the lateral condensation technique with resin-based sealer (Sealer Plus, MkLife, Rio Grande do Sul, Brazil), chosen for its simplicity, low cost, good apical compaction, and satisfactory sealing quality [11].

The pre-final radiograph revealed some filling defects. Considering the crack in the root, the obturation quality was improved using Tagger's Hybrid Technique, employing the McSpadden instrument (Dentsply Sirona, São Paulo, Brazil). Provisional coronal restoration was performed with Bioplic, and the patient was referred for definitive restoration.

After one year, a follow-up session was conducted with clinical and radiographic examinations. Vertical and horizontal percussion tests of teeth 11 and 21 showed no alterations; apical palpation revealed no sensitivity; mobility was within normal limits; and pulp sensitivity test showed a normal positive response in tooth 11. Radiographic examination revealed regression of the periapical lesion of tooth 11 and no periapical alterations in tooth 21.

DISCUSSION

This study presented a clinical case report of a patient with a history of dental trauma to the anterior teeth approximately 20 years earlier due to a bicycle accident. This situation reflects what is reported in the literature regarding epidemiological indices as well as the main etiological factors [1,2]. In one study [13], 739 children aged between 8 and 10 years were evaluated, of whom 16% had suffered dental trauma. It is well established in the literature that in this age group the prevalence of trauma is higher, ranging from 4.6% to 14%. Moreover, children are more exposed to falls, play, and sports activities without adequate protection, making them more susceptible to dental trauma [2].

In the present case, the patient sought dental care a long time after the accident. This can be explained by the fact that some root fractures are not diagnosed at the time of trauma, since displacement of the coronal fragment may not be evident immediately after the incident. Therefore, if appropriate imaging exams are not performed and if the teeth are not regularly monitored after trauma, root fractures may remain undetected [14].

The delayed search for dental care is also associated with the fact that the clinical signs and symptoms related to pulp involvement appeared only after a certain period following the trauma, including pain and darkening of the crown of tooth 21. The delay in seeking treatment significantly affected the prognosis of the compromised tooth. Complications such as pain and crown discoloration, as in this case, are among the main negative impacts described in the literature, potentially affecting patients' quality of life by causing functional and esthetic problems [15].

When treatment is postponed after trauma, there is a greater likelihood of complications such as pulp necrosis, resorption, or calcification of the pulp chamber. Early follow-up after the trauma could have enabled the detection of pulp or root changes that might have been monitored or treated before discoloration occurred. Crown staining, in most cases, indicates pulp necrosis, as in the case reported, or the presence of internal hemorrhage [9,15].

In the clinical case described, pulp sensitivity testing with refrigerant spray was performed on teeth 11 and 21, which yielded positive and negative responses, respectively. This test was chosen because it is the most widely used clinically to assess pulp status [16,17], stimulating the myelinated Aδ nerve fibers in the dentin-pulp complex through fluid movement in the dentinal tubules, generating a subjective pain response

[17]. Thermal pulp sensitivity testing, when associated with findings from anamnesis, clinical examination, and imaging, is an effective method to determine pulp condition, guiding diagnosis and endodontic therapy in most cases [18].

To complement the diagnosis, a conventional periapical radiograph was taken, which revealed a horizontal fracture line in the middle third of the root of tooth 11. This type of exam has limitations, such as a limited field of view restricted to a small area, two-dimensional imaging, overlapping of anatomical structures, and possible image distortions [10,19]. In this case, CBCT was essential, as it allowed a more detailed visualization of the fracture in tooth 11 and revealed a periapical lesion and a crack in the middle third of the root of tooth 21, which were not observed in the initial periapical radiograph. Alongside periapical radiography, tomographic imaging is widely recommended in cases of dental trauma, as it provides a detailed and three-dimensional view of oral structures [10,19].

The fracture in tooth 11 was classified as a horizontal root fracture in the middle third of the root, which is the most common site affected in trauma cases [3,20]. Furthermore, the management of root fractures and their prognosis are directly related to this classification [20]. In a retrospective study by Sheikhnezami et al. [15], 125 teeth with root fractures were evaluated, of which 92% showed favorable outcomes, demonstrated by radiographic healing of the fracture line and the absence of clinical signs or symptoms. Moreover, healing of the fracture line is reported as the most likely outcome in both short- and long-term evaluations, with a 77% success rate [3]. This scenario highlights the need for a more conservative approach to fractured root teeth, countering the common perception that such teeth have uncertain or poor long-term prognosis, which often leads to their being considered for replacement with dental implants [3].

The unique clinical situation described in this report raises interesting questions about the different mechanisms that may be triggered after trauma. The crack detected in the CBCT image of tooth 21 may have acted as a pathway for bacteria and their byproducts, causing pulp tissue inflammation and, consequently, pulp necrosis [21]. The indication for endodontic treatment is consistent with the existing scientific literature [22]. Moreover, the survival and success rates of teeth with cracks after endodontic treatment have been evaluated in studies. The survival rate of cracked teeth after endodontic treatment was analyzed in two systematic reviews with meta-analyses [23,24]. Overall, both reviews reported survival rates between 84.1% and 88% within 12 to 60 months after intervention, which are comparable to those for endodontically treated teeth in general (86%–93% over 2–10 years) [25], confirming that root canal therapy may be a viable treatment option when cracks are present. Another study [24] observed that 57 of 63 cracked teeth treated with endodontics (90.5%) survived after an average follow-up of 3.3 years. Regarding success rates, 82% of cracked posterior teeth treated endodontically were considered “successful” after 1 year of follow-up, representing a favorable outcome for tooth preservation [22].

Despite the significant fracture in the middle third of the root of tooth 11, with separation between coronal and apical fragments, pulp vitality was maintained. According to Pedrosa et al. [3], this may be related to the location and degree of the fracture impact, which may not immediately or severely affect pulp tissue. This indicates that in some cases, the mere presence of a root fracture does not necessarily result in pulp necrosis. Moreover, considering that the patient was approximately 8 years old at the time of the trauma, age may have contributed to pulp vitality maintenance, since younger patients demonstrate better tissue healing between apical and coronal root segments and, consequently, better prognosis [2].

A combination of a detailed trauma history, comprehensive clinical examination, and imaging tests to identify the degree and extent of injuries are fundamental for defining the most appropriate treatment. Existing literature emphasizes that a multidimensional diagnostic approach enables more effective and

targeted care [21,26]. Therefore, once pulp necrosis of tooth 21 was confirmed, endodontic treatment was indicated to eliminate the infection, while tooth 11 was preserved under follow-up since it remained vital despite the extensive root fracture.

CBCT imaging was employed for the diagnosis of horizontal root fracture based on recommendations [27], published guidelines [28], and scientific evidence supported by two meta-analyses [29,30]. CBCT images improve the sensitivity of diagnosing this type of fracture (CBCT vs. periapical radiograph; sensitivity = 88% vs. 69%, accuracy = 93% vs. 82%) and can aid in clinical decision-making, increasing self-reported confidence in diagnosis [31]. Additionally, CBCT can help to determine the exact location, extent, and orientation of fracture lines or cracks [32]. In agreement with this perspective, CBCT also enabled a more accurate assessment of the extent of the periapical lesion in tooth 21.

One year after completion of the endodontic treatment of tooth 21, a follow-up consultation was performed for teeth 11 and 21. The follow-up interval chosen was based on the guidelines of the International Association of Dental Traumatology (IADT), which consider this period appropriate to evaluate clinical stability and treatment effectiveness [29].

In the present case, the outcomes observed in the clinical and radiographic examinations at follow-up – including a normal positive response to pulp sensitivity testing, absence of clinical signs and symptoms, and reduction of the periapical lesion visible on the radiograph after one year – confirmed the success of the treatment during the observation period.

CONCLUSION

This case report highlights the importance of a thorough clinical and radiographic assessment in patients with a history of dental trauma. Therefore, it can be concluded that the management of patients with root fractures requires a careful diagnostic approach in order to select the most appropriate treatment, according to the degree of pulpal and periapical involvement identified. Furthermore, the importance of long-term clinical and radiographic follow-up is emphasized, since late complications may occur, making monitoring essential for the success of conservative treatment.

Conflict of interest: The authors declare that there are no conflicts of interest.

Data availability: The research data are available from the corresponding author upon reasonable request

Collaborators

AM Loreto and PHF Guerim, conceptualization, project administration, data curation, writing – original draft. MC Bello, resources, writing – original draft. MP Buligon, project administration, validation. PK Marquezan, conceptualization, validation, writing – review & editing. FK Marquezan, validation, writing – review & editing.

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