Thaís Christina Cunha

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Clinical factors associated with the diagnosis and prognosis of endodontic treatment: in vivo observations and systematic review

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Uberlândia, 2020

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Orientadora: Prof.Dra. Camilla Christian Gomes Moura

Coorientador: Dr. Felipe de Souza Matos

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DEDICATÓRIA

Este trabalho eu dedico ...

A minha mãe, **Maria José Neves Cunha**, minha melhor e mais sincera amiga, que apesar de tudo, sempre esteve ao meu lado, acreditando e não me deixando desistir ....meu amor incondicional.

Ao meu pai, **"José Abadio da Cunha",** que enquanto fisicamente comigo, muito me amou e me fez entender que o conhecimento está acima de qualquer bem material.

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"Eu acredito que estamos em um processo longo de construção, de evolução, de apredizado. Sei que é possível tirar algo de cada situação, não importa se feliz ou triste, é possível absorver a lição. Eu acredito que o destino faz parte de nossas escolhas, das nossas insistências. De compreender que Deus tem reservado para cada um de nós."

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SUMÁRIO

Resumo

A condução e a execução de todas as etapas do tratamento endodôntico devem ser criteriosas e estão diretamente relacionadas à realização de um diagnóstico correto. O objetivo deste trabalho foi verificar os fatores que influenciam no diagnóstico endodôntico e/ou no desenvolvimento álgico intra/pós-operatório e no sucesso do tratamento endodôntico. **Capítulo 1.** Acurácia do teste de sensibilidade da polpa dentária por spray a frio para o diagnóstico de doenças pulpares: estudo clínico observacional. Foi avaliada a acurácia do teste de sensibilidade pulpar (TSP) utilizando spray frio (1,1,1,2-tetrafluoroetano) no diagnóstico de doenças pulpares e o efeito de variáveis individuais e clínicas na confiabilidade do teste. Sessenta pacientes com indicação de tratamento endodôntico primário foram selecionados e examinados por meio de entrevista, exame clinicorradiográfico e TSP, entre agosto de 2017 a julho de 2018. Concluiu-se que o TSP com spray frio é um método de diagnóstico preciso e confiável, principalmente nos casos de pulpite irreversível. **Capítulo 2.** Influência da cinemática de glide path durante o tratamento endodôntico na ocorrência e intensidade da dor intra e pós-operatória: uma revisão sistemática de ensaios clínicos randomizados. A revisão sistemática seguiu as recomendações PRISMA e foi registrada no PROSPERO (CRD42020139989). A variabilidade entre os estudos quanto aos protocolos de tratamento e seleção dos pacientes inviabilizou a realização da metanálise. Concluiu-se que a cinemática do glide path pode influenciar na ocorrência e intensidade da dor intra e pós-operatória. **Capítulo 3.** Resultado do tratamento de molares jovens obstruídos por instrumentos endodônticos fraturados: relato de dois casos. Insertos ultrassônicos ou limas XP-Clean representam estratégias para melhorar a limpeza e desinfecção dos canais radiculares, mas não estão livre da possibilidade de fratura. Duas pacientes do sexo feminino, de 14 anos, foram submetidas a tratamento de canal dos dentes 37 (caso 1) e 47 (caso 2). Durante os protocolos finais de irrigação, o caso 1 apresentou uma lima XP-Clean fraturada dentro do canal mesiovestibular e dentro do canal distal no caso 2, que também apresentava pontas E1-Irrisonic fraturadas nos canais mesiovestibular e distal. O manejo não cirúrgico e o desvio dos fragmentos retidos foram bem-sucedidos em ambos os casos e podem ser considerados abordagens adequadas, permitindo preservar os dentes. **Capítulo 4.** Abordagem interdisciplinar em

molares de pacientes jovens, o desafio para evitar a extração prematura: relato de casos. Dois pacientes do sexo masculino, 14 e 17 anos, foram atendidos no projeto de extensão voltado para o tratamento endodôntico reabilitador de crianças e adolescentes de 8 a 18 anos. A limpeza e desinfecção dos dentes 46 e 36 foram realizadas com sistema automatizado TF Adaptive e completadas com limas XP Endo Finisher e irrigação final com pontas de ultrassom. Após 14 dias de curativo de demora com hidróxido de cálcio, os canais foram obturados e os dentes restaurados com restauração direta em resina composta bulk-fill. Reparo ósseo periapical e ausência de sinais e sintomas foram observados após 6 meses e 1 ano.

Palavras-Chave: Dor pós-operatória, Endodontia, Preparo de canal radicular, Resultado do tratamento, Teste da polpa dentária.

Abstract

The conduct and execution of all stages of endodontic treatment must be judicious and are directly related to making a correct diagnosis. The objective of this work was to verify the factors that influence the endodontic diagnosis and/or the intra/postoperative pain development and the success of the endodontic treatment. **Chapter 1.** Accuracy of dental pulp sensitivity test by cold spray for the diagnosis of pulp diseases: observational clinical study. The accuracy of the pulp sensitivity test (PST) using cold spray (1,1,1,2-tetrafluoroethane) was assessed in the diagnosis of pulp diseases and the effect of individual and clinical variables on the test's reliability. Sixty patients with indication for primary endodontic treatment were selected and examined by means of interview, clinic and radiographic examination and PST, between August 2017 and July 2018. It was concluded that PST with cold spray is an accurate and reliable diagnostic method, mainly in cases of irreversible pulpitis. **Chapter 2.** Influence of glide path kinematics during endodontic treatment on the occurrence and intensity of intra and postoperative pain: a systematic review of randomized clinical trials. The systematic review followed the PRISMA recommendations and was registered with PROSPERO (CRD42020139989). The variability between studies regarding treatment protocols and patient selection made the meta-analysis unfeasible. It was concluded that the glide path kinematics can influence the occurrence and intensity of intra and postoperative pain. **Chapter 3.** Result of the treatment of young molars obstructed by fractured endodontic instruments: report of two cases. Ultrasonic inserts or XP-Clean files represent strategies to improve the cleaning and disinfection of the root canals, but they are not free from the possibility of fracture. Two 14-year-old female patients underwent root canal treatment of tooth 37 (case 1) and 47 (case 2). During the final irrigation protocols, case 1 presented a fractured XP-Clean file within the mesiovestibular canal and within the distal canal in case 2, which also had a fractured E1-Irrisonic tip in the mesiovestibular and distal canals. Non-surgical management and bypassing retained instrument fragments were successful in both cases and they may be considered adequate approaches, allowing teeth to be preserved. **Chapter 4.** Interdisciplinary approach in molars of young patients, the challenge to avoid premature extraction: case

reports. Two male patients, 14 and 17 years old, were assisted in an extension project aimed at rehabilitating endodontic treatment of children and adolescents aged 8 to 18 years. Teeth 46 and 36 were cleaned and disinfected using the TF Adaptive automated system and completed with XP Endo Finisher files and final irrigation with ultrasound tips. After 14 days of intracanal medication with calcium hydroxide, the canals were obturated and the teeth were restored with bulk-fill composite resin by direct technique. Periapical bone repair and absence of signs and symptoms were observed after 6 months and 1 year.

Keywords: Dental pulp test, Endodontics, Postoperative pain, Root canal preparation, Treatment outcome.

1. Introdução e Referencial teórico

O tratamento endodôntico pode ser indicado por necessidade protética, inflamação ou necrose do tecido pulpar, com ou sem a presença de infecção bacteriana e tem como objetivo a manutenção do elemento dental em função no sistema estomatognático, sem causar danos à saúde do paciente (Dugas et al.,2002; Ng et al., 2011).

Para que se consiga excelência nessa terapia, é necessário que os passos clínicos sejam fundamentados em princípios biológicos, científicos e mecânicos. A condução e a execução de todas as etapas do tratamento (planejamento, efetivação do preparo biomecânico e obturação do sistema de canais radiculares) devem ser criteriosas e estão diretamente relacionadas à realização de um diagnóstico correto (Jespersen et al. 2014; Alghaithy & Qualtrough, 2017; Mousavi et al. 2017; Naseri et al. 2017; Lima et al., 2019). Dessa forma, testes de sensibilidade pulpar (TSP), com destaque ao teste térmico, através do gás refrigerante, auxiliam na identificação de alterações neurovasculares na polpa e são de extrema importância para o planejamento e evolução do tratamento (Jafarzadeh & Abbott 2010).

As últimas décadas foram marcadas por grandes avanços na instrumentação automatizada dos canais radiculares, sobretudo em relação ao tipo de liga, design, protocolos e cinemática de utilização das limas (Keskin et al. 2019). A maior parte dos sistemas de instrumentação recomenda a pré-modelagem do canal radicular, chamada de "glide path". Essa técnica diminui as interferências anatômicas (Alves Oliveira et al. 2012), preserva a anatomia original do canal, evita intercorrências nopreparo biomecânico (Coelho et al., 2016; Abu-Tahun et al. 2019) tais como condução de tecidos necróticos, debris contaminados e bactérias até a região periapical (Comparin et al., 2017; Gunes et al., 2018; Adıgüzel et al. 2019). A realização do "glide path" desempenha um importante papel na redução do desenvolvimento álgico e agudização do quadro clínico das patologias perirradiculares (Pasqualini et al. 2012).

Por mais de meio século, o Hipoclorito de sódio (NaOCl) e o ácido etilenodiamino tetra-acético (EDTA) tem sido empregadas e permanecem como substâncias químicas auxiliares de escolha no tratamento endodôntico (Haapasalo et al.

2014; Virdee et al.,2020) por reduzirem substancialmente, por meio da irrigação convencional, o número de microrganismos da dentina radicular. No entanto, bactérias profundamente alojadas nos túbulos dentinários muitas vezes não são afetadas por essa forma de irrigação (Wong & Cheung 2013, Azim et al. 2016, Vatkar et al. 2016). A agitação de soluções por meio de técnicas de ativação acústica e hidrodinâmica (Jiang et al., 2010; Conde et al., 2017) utilizando dispositivos ultrassônicos (Conde et al., 2017, Bueno et al., 2019; Kirsch et al., 2019) e limas acionadas a motor, tais como XP Endo Finisher (Dentaire, La Chaux-de-Fonds, Switzerland) e XP Clean (MK Life, Porto Alegre, RS, Brazil) é proposta com o objetivo de facilitar a dispersão e reposição das soluções, otimizando suas propriedades (Carvalho et al., 2019).

A tríade endodôntica é completada pela execução de uma obturação adequada nos sentidos apical, cervical e lateral, impedindo que espaços vazios sirvam como nichos para o crescimento bacteriano. Nos últimos anos tem-se notado o surgimento de novos cimentos endodônticos capazes com propriedades bioativas, entre os quais se destacam os cimentos à base de silicato de cálcio (Tyagi et al. 2013). Porém, mesmo com a evolução desses seladores, o tipo de cimento possui um papel pouco relevante caso a técnica de instrumentação e obturação não seja bem executada.

A despeito de toda evolução nas técnicas e materiais utilizados em endodôntia, a prevalência de falhas no tratamento endodôntico é relativamente alta e podem ocorrer devido a inadequação do preparo biomecânico, iatrogenias ou reinfecção do sistema de canais radiculares (Marques et al., 2020). Vários estudos foram realizados para identificar a influência das iatrogenias na obtenção de resultados técnicos ideais (Hulsmann et al. 1999; Spili et al.,2005; Mandarati et al., 2013). A fratura de instrumentos rotatórios de níquel-titânio no interior dos canais é um acidente ocasionado por falha torcional e/ou à fadiga cíclica da lima. Sua ocorrência pode alterar de imediato o grau de dificuldade do preparo biomecânico e o prognóstico do tratamento (Parasho et al., 2006; Mandarati et al., 2013). O êxito ou não da terapia está condicionado à anatomia dentária, à presença ou não de patologia apical, ao momento do rompimento da lima (antes ou após o preparo do conduto) e à localização do fragmento no canal radicular (Parashos et al., 2006; AAE 2017). A estratégia clínica para a resolução desse tipo de intercorrência é alcançar a limpeza e desinfecção do

conduto, removendo ou transpassando a porção segmentada (Nevares et al., 2012; Parashos & Messer, 2006; Simon et al., 2008).

A realização de uma restauração coronária bem adaptada e de boa qualidade após a obturação do sistema de canais radiculares é considerada a etapa final para conclusão da terapia endodôntica (Ng et al., 2011). Sua relevância clínica é reforçada por prevenir a reinfecção pós-operatória do conduto, evitando a entrada de qualquer microrganismo presente no meio ambiente bucal (Bayram et al., 2013; Tabassum et al., 2016).

O objetivo dessa tese foi avaliar, por meio de revisão sistemática, estudo retrospectivo observacional e relatos de casos clínicos, os fatores que influenciam no diagnóstico endodôntico e/ou no desenvolvimento álgico intra/pós-operatório e no sucesso do tratamento endodôntico.

Capítulo 1

Accuracy of the dental pulp sensibility test using cold spray for the diagnosis of pulp diseases: an observational clinical study

Accuracy of the dental pulp sensibility test using cold spray for the diagnosis of pulp diseases: an observational clinical study

Accuracy of cold spray

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Conflict of Interest

The authors deny any conflicts of interest.

Accuracy of the dental pulp sensibility test using cold spray for the diagnosis of pulp diseases: an observational clinical study

ABSTRACT

Introduction: The dental pulp sensibility test is one of the main auxiliary resources for the diagnosis of pulp pathologies, and its accuracy is still debatable. This retrospective observational study evaluated the accuracy of the pulp sensibility test (PST) using cold spray (1,1,1,2-tetrafluoroethane) for the diagnosis of pulp diseases and determined the effect of individual and clinical variables on the reliability of this test. **Methods and Materials:** The paper was designed following the STROBE statement. Sixty patients with indications for primary endodontic treatment were selected and examined from August 2017 to July 2018. Data collection was performed through interviews, clinical/radiographic examinations and the PST. The results of the cold test, along with data on sex, age, the tooth type regarding the root number, and the presence of restorations and caries, as well as the recent consumption of analgesics, were recorded. The presence of bleeding within the pulp chamber was used as the gold standard. **Results:** The PST with the use of cold spray showed a sensitivity of 0.88, a specificity of 1.00, a positive predictive value of 1.00, a negative predictive value of 0.86, and an accuracy of 0.93. The accuracy of the cold spray was not affected by individual or clinical variables ($p > 0.05$; chi-square test). **Conclusion:** The PST with the use of cold spray is an accurate and reliable method for determining the diagnosis of pulp diseases, especially in cases of pulp vitality or irreversible pulpitis.

Keywords: Oral Diagnosis; Endodontics; Pulpitis; Dental Pulp Necrosis; Dental Pulp Test.

Introduction

The early detection of pulp pathologies prevents the development and/or progression of inflammatory processes in the pulp tissue and the resorption of dental and periradicular hard tissues, thus allowing the tooth to be treated more conservatively

[1,2]. However, since dental pulp is surrounded by dentin walls and is not clinically visible, determining its real state is quite difficult [3]. Pulp diagnosis depends, in most cases, on the combination of information obtained from the anamnesis, the clinical and radiographic examinations, and complementary examinations based on neurovascular analysis [1,3–6].

Ideally, the appropriate method for pulp condition assessment should be simple, objective, reliable, reproducible, inexpensive, and noninvasive [1,5,7,8]. Most of these goals are achieved through pulp sensibility tests (PSTs), such as the cold test, which has been the most clinically used test to assess pulp condition [4,7,9]. The diagnosis obtained with this test is established by stimulating the myelinated nerve fibers of the pulp connective tissue, that is, by means of thermal conduction [3,7].

Many authors agree that the thermal PST associated with anamnesis findings and clinical and complementary examinations is an accurate and reliable method for determining the true condition of the pulp and therefore has a high chance of guiding the correct endodontic therapy in most cases [2–4,10]. However, the PST does not directly analyze tooth vitality, as it depends on a patient's subjective response (sensibility or pain) to an external stimulus of the nervous system [11]. Its quantification is based on verbal reports, and its perception is directly related to psychobiological factors influenced by the patient's emotional state and the use of drugs [12,13].

Thus, considering that the thermal PST is one of the main auxiliary resources in the diagnosis of pulp pathologies and that its accuracy is still debatable due to the possibility of false-positive and false-negative results [3,4,12], the analysis of its accuracy and reliability is fundamental for guiding its use in clinical practice. This study aimed to evaluate the accuracy of the PST test using cold spray (1,1,1,2-tetrafluoroethane) in the diagnosis of pulp diseases and to determine the effect of individual and clinical variables on the reliability of the test.

Materials and Methods

This research was developed with a cross-sectional observational study model and followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement (https://www.strobe-statement.org). The protocol of the study was

approved by the local Institute Review Board (Certificate of Presentation for Ethical Consideration: 46838715.8.0000.5207), and all volunteer patients signed an informed consent form before the clinical tests.

Patients of both sexes with indications for primary endodontic treatment and without any restriction regarding tooth type were recruited over a 12-month period from August 2017 to July 2018. After a full general and dental examination, systemically healthy patients aged between 12 to 60 years old whose teeth had mature apices, with or without pain sensation, were included in the study. The exclusion criteria were patients with intellectual disability; those whose teeth were diagnosed as having normal pulp, reversible pulpitis, or periapical disease; those who had been previously treated or who had previously initiated therapy; teeth that were unavailable for evaluation due to a fixed prosthesis, full-surface crowns, large restorations, recent trauma (last 6 months), regressed pulpal chambers or calcified root canals; those with periodontal changes (pockets >3 mm, mobility >I, or gingival edema); and orthodontic treatment.

Data collection was performed by a single examiner through interview, clinical/radiographic examination and the PST. The interview was conducted using a predesigned questionnaire, which included sociodemographic characteristics (sex and age), tooth number, characteristics of previous pain (i.e., spontaneous or elicited, mild or severe, lingering or intermittent), and analgesic consumption in the last 12 hours. The clinical and radiographic examinations were performed to confirm the type and position of the tooth and to evaluate the presence of caries or restorations as well as the tooth or periodontal tissue responses to apical palpation, horizontal and vertical percussion, and mobility tests.

The PST was performed by a different examiner who was blinded to the clinical signs and symptoms, dental histories, and radiographic findings. Before testing, each tooth was isolated with cotton rolls and dried thoroughly. A healthy tooth was tested as a control before the experimental tooth to observe the baseline normal response. The examiner sprayed a cotton pellet with cold spray (1,1,1,2-tetrafluoroethane) (Endo-Ice®, Maquira Dental, Maringá, PR, Brazil), and the pellet was then placed onto the crown of the tooth at the middle third of the buccal surface (incisors and canines) or in the center of the occlusal surface (premolars and molars) for 10 s or until the participant raised a hand to indicate cold sensation [6,8]. The severity and duration of the pulpal response to

the sensibility test were recorded as mild or severe and short (< 10 s) or lingering (> 10 s), respectively [14].

The PST data together with the information obtained from the interview and clinical examination were analyzed together to establish a clinical diagnosis of the pulp condition; pulp was classified as normal pulp, reversible pulpitis, symptomatic irreversible pulpitis, asymptomatic irreversible pulpitis, or pulp necrosis according to the terminology recommended by the American Association of Endodontists [14,15], as shown in Table 1.

Teeth diagnosed with symptomatic or asymptomatic irreversible pulpitis and pulp necrosis underwent endodontic treatment. After local anesthesia with 2% lidocaine with epinephrine 1:100,000 (Alphacaine; DFL, Indústria e Comércio Ltda., Rio de Janeiro, RJ, Brazil), the access cavity was prepared under rubber dam isolation, and the pulp status (irreversible pulpitis / pulp necrosis) was recorded by observing bleeding within the pulp chamber. The presence (irreversible pulpitis) or absence (pulp necrosis) of bleeding was used as the gold standard to compare with the clinical diagnosis and to identify the true-positive, false-positive, true-negative, and false-negative responses. The patients underwent routine conventional endodontic treatment of the clinic.

Data are described in tables by means of absolute (n) and relative (%) frequencies and measures of sensitivity (true positive / true positive + false negative), specificity (true negative / true negative + false positive), positive predictive value (true positive / true positive + false positive), negative predictive value (true negative / true negative + false negative), and accuracy (true positive + true negative / total). A comparison between the subgroups according to the individual and clinical variables was performed using the chi-square test with a level of significance of 5% ($p < 0.05$), taking into account the accuracy achieved in each subgroup. Additionally, ROC (receiver operating characteristic) curve analysis was performed to assess the overall performance of the diagnostic test. Statistical procedures were performed using IBM SPSS Statistics version 20.0 and MedCalc version 19.0.7 software, considering a 95% confidence interval to obtain the estimates.

Results

One hundred and ninety-six patients were initially recruited for the study, but 129 did not meet the inclusion criteria, and seven patients who declined participation were excluded (Figure 1). Thus, 60 patients were analyzed for the accuracy of the PST using cold spray for the diagnosis of pulp diseases. Each participant contributed one tooth to the analysis for a total of 60 teeth. The mean age of the patients was 45 years old. Table 2 shows the general characteristics of the sample, including the clinical diagnosis and gold standard (bleeding), the tooth types, the clinical evaluations of the teeth, and analgesic consumption. The PST identified 31 of the 35 vital/inflamed pulp tissues as vital/inflamed (true-positives) and 25 of the 25 necrotic pulp tissues as necrotic (true-negatives), and the remaining four teeth had false-negative responses. The sensitivity, specificity, positive predictive value, negative predictive value and accuracy are shown in Table 3. The sensitivity was 0.88, and the specificity was 1.00. This result indicates that 88% of the teeth with vital/inflamed pulp tissues were identified as vital/inflamed, whereas 100% of the teeth with necrotic pulp tissues were identified as necrotic. The positive predictive value was 1.00, and the negative predictive value was 0.86. Thus, there was a probability of 100% that positive responses to cold spray represented vital/inflamed pulp and a probability of 86% that negative responses to cold spray represented necrotic pulp. The accuracy was 0.93, indicating that the PST with the use of cold spray had a probability of 93% for determining the correct diagnosis. ROC curve analysis demonstrated high or near-optimal performance (AUC = 0.93) of the PST (Figure 2). The accuracy of the cold spray was not affected by individual or clinical variables ($p > 0.05$) regarding sex, age, tooth type, the presence of restoration or caries, and analgesic consumption (Table 4).

Discussion

Differential diagnosis in endodontics requires professional scientific knowledge and the ability to analyze and interpret clinical information to achieve proper treatment planning [4,6]. When the pulp tissue suffers from a mainly infectious origin, a reversible or irreversible inflammatory process is initiated as a defense mechanism to maintain the integrity of the pulp. However, if the agent of damage is not removed and persists, pulp inflammation compromises local blood microcirculation, with consequent

pulp tissue necrosis and nerve fiber degeneration, which, if not diagnosed and treated early, can cause severe damage to the dental and periodontal hard tissues, such as resorption and periradicular lesions [10,16]. Thus, the determination of tooth vitality is usually based on the PST to indirectly assess the intrapulp blood supply, which is the most accurate and currently used pulp health status indicator [1,9]. In the current study, we investigated the accuracy of the dental PST using cold spray to determine the diagnosis of pulp diseases.

The PST with the use of cold spray, a diagnostic feature routinely used in endodontic practice, works by stimulating myelinated Aδ nerve fibers in the dentin-pulp complex through the flow of cold spray fluid into the dentinal tubules [9,13]. Although the insulating effects of dental hard tissues do not allow the determination of the degree of pulp disease from this nervous stimulus, the thermal PST evaluates neurovascular changes based on temperature variation, extrapolating its results to the histological condition of the pulp [3,4,7]. However, since this assessment is based solely on the patient's subjective report of pulp nerve fiber stimulation, whose responsiveness may be altered by reduced tissue oxygenation, false-positive and false-negative responses may be found [6,9]. The presence or absence of bleeding within the pulp chamber after crown opening has been used as a valid measure to determine pulp status, as most degenerative processes begin in the clinical crown [3,8].

The present study showed that the PST with the use of cold spray, associated with the clinical and complementary examinations, had a satisfactory performance for establishing an endodontic diagnosis, with an accuracy of 0.93, a sensitivity of 0.88 and a specificity of 1.00; these values are similar (0.94, 0.88 and 1.00, respectively) to those reported by Villa-Chavéz *et al.* [8]. The test was applied to teeth that, after interviews as well as the clinical and radiographic examinations, possibly presented some pathological pulp alterations (irreversible pulpitis or pulp necrosis) and, therefore, did not evaluate the diagnostic efficacy of cold spray in teeth with healthy pulp. The sensitivity of the cold spray was not 100% satisfactory, probably because in advanced stages of pulp inflammation, oxygen-dependent Aδ nerve fibers degenerate with no sensitive response when cold spray is applied to teeth [8,17]. Considering the negative predictive value of 0.86, it can then be suggested that there is a 14% probability that negative responses to the cold test do not represent pulp necrosis, that is, even if

responding negatively, there may still be pulp blood flow. On the other hand, positive responses to the cold test are more likely to represent pulp vitality since the positive predictive value was 1.00.

Psychobiological factors associated with the patient's emotional state and drug use (sedatives, tranquilizers or painkillers) may also affect the pulp response and the patient's response to sensibility tests leading to false-positive or false-negative results [12]. In this context, the present study evaluated whether individual and clinical variables such as sex, age, type of tooth regarding number of roots, presence of restorations and caries, and recent consumption of analgesics could interfere with the accuracy of the PST using cold spray. When performing the PST on teeth of patients who had recently used analgesics, it was expected that the response to the test, specifically the negative responses, could be related to the increase in the pulp nerve stimulation threshold caused by the medication (false-negative results). However, when comparing the accuracy of the test between individuals who used analgesics in the last 12 hours and those who did not, no statistically significant difference was found (Table 4), suggesting that recent use of analgesic did not change the accuracy of the thermal PST, which is consistent with other works [3,5,12].

Molar and premolar teeth are more likely to exhibit false-positive and false-negative results because they have a larger enamel and dentin thickness, a larger volume of pulp tissue and multiple roots, and they may present regions of necrosis and pulp vitality on at least one of the canals [3,4]. In this study, there was no statistically significant difference in the accuracy level of the thermal PST between uniradicular and multiradicular teeth (Table 2). The cold test was not efficient in determining the pulp condition in four cases of the total sample, three of which were uniradicular premolars and one of which was a multiradicular molar. The response of these teeth to cold spray was negative, suggesting pulp necrosis. However, after crown opening, there was the presence of bleeding, which was then equivalent to false-negative responses. These findings have also been reported in a previous study [7] that observed, through histological analysis of the pulp, progressing coagulation necrosis in the crown pulp and, apically, the presence of living tissue and dystrophic calcification.

Another factor that may interfere with the accuracy of the PST is the age of the patient [3,11,13]. Although some studies state that incomplete root development and

pulp innervation influence only the results of the electrical PST, young patients, because they are more anxious, may present inaccurate responses to the thermal PST [9]. In older patients, however, decreased pulp innervation and increased dental mineralization with reduced pulp volume may mainly contribute to false-negative responses [5,11]. The amount of secondary or tertiary dentin acts as a thermal insulator, making it difficult for the tooth to respond to the stimulus provided by the cold spray [11]. In the present investigation, there was no significant difference in the accuracy of the thermal PST when comparing three different age groups (12-18, 19-40 and 41-60) (Table 2). This result is in disagreement with the study by Jespersen *et al.* [3], in which patients aged 21 to 50 years exhibited a more accurate response to the cold test than patients in other age groups. The absence of a significant difference among the age subgroups in our study may be justified by the fact that the sample size was not large enough to determine a significant difference.

The presence of caries in vital teeth may improve the accuracy of the thermal PST by inducing an inflammatory response in the pulp tissue, which decreases the excitability threshold of Aδ nerve fibers [3,16]. Even so, the positive response to cold should not be interpreted as a true-positive result in the presence of caries, as pulp status cannot be known with certainty at the time of testing [3]. Reinforcing previous studies [5] and disagreeing with others [3], in this research, the presence or absence of caries did not interfere with the accuracy of the diagnosis using cold spray (Table 2). Restorative status and sex were also analyzed as possible interference factors in the PST results. Restorative procedures can act as thermal, chemical or mechanical irritants to the pulp and trigger tissue inflammation and alterations of the nerve excitability threshold. It is believed that females suffer more commonly from psychosomatic illnesses than males and that their pain is governed by emotional factors under strong hormonal influence, suggesting that women tend to display lower pain thresholds and pain tolerance than men, which could interfere with the PST results [18,19]. However, neither restorative status nor sex resulted in significant differences with regard to thermal PST accuracy, which is consistent with previous works [3,20,21].

In addition to sensitivity, specificity and accuracy, the positive and negative predictive values of the cold test were also calculated. Although not commonly used, these measurements provide valuable insight into the diagnostic effectiveness of a test.

According to the data presented, the cold spray had a positive predictive value (PPV) of 1.00, which means that a tooth diagnosed with irreversible pulpitis was approximately 100% likely to actually have the condition. The negative predictive value (NPV) was 0.86, which indicates that the probability of a nonsensitive reaction representing a necrotic pulp was 86%. These results are similar to those found by Villa-Chavéz *et al.* [8], whose PPV was 1.00 and NPV was 0.90, but the results are different from those reported by Jespersen *et al.* [3], whose PPV was 0.862 and NPV was 0.937. Methodological differences and factors related to the general characteristics of the sample may have caused divergences between study results. Although the sample size may compromise the strength of the results, this observational clinical study provides important unpublished information on the accuracy of the thermal PST and its correlation with individual and clinical variables, thereby reinforcing its clinical utility as an important auxiliary resource in the diagnosis of pulp diseases.

Conclusion

The dental pulp sensibility test using cold spray is an accurate and reliable method for determining the diagnosis of pulp diseases (vitality vs. necrosis). Positive responses to the pulp sensibility test are more reliable for determining pulp vitality than negative responses for determining pulp necrosis. Sex, age, tooth type regarding the root number, presence of restorations and caries, and recent consumption of analgesics (last 12 hours) did not interfere with the accuracy of the pulp sensibility test.

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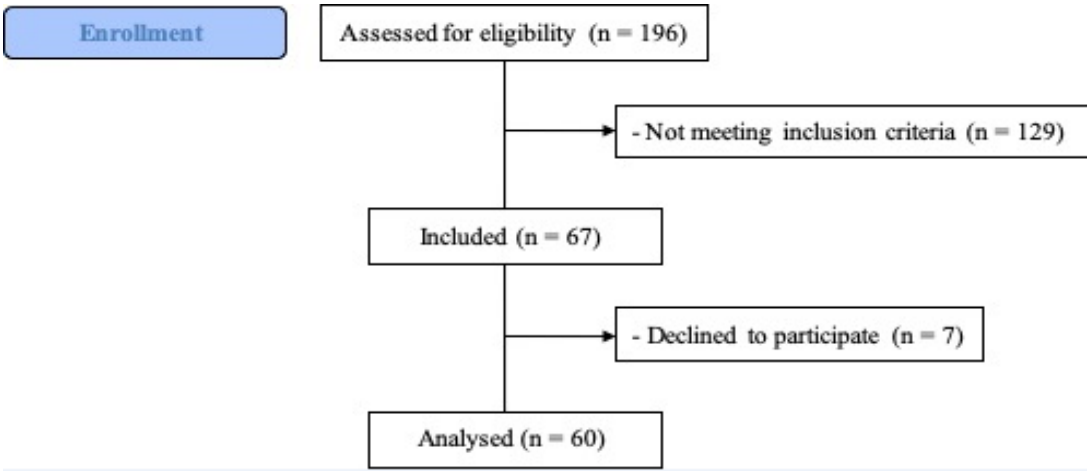

Figure 1. Flow diagram of the cross-sectional observational study.

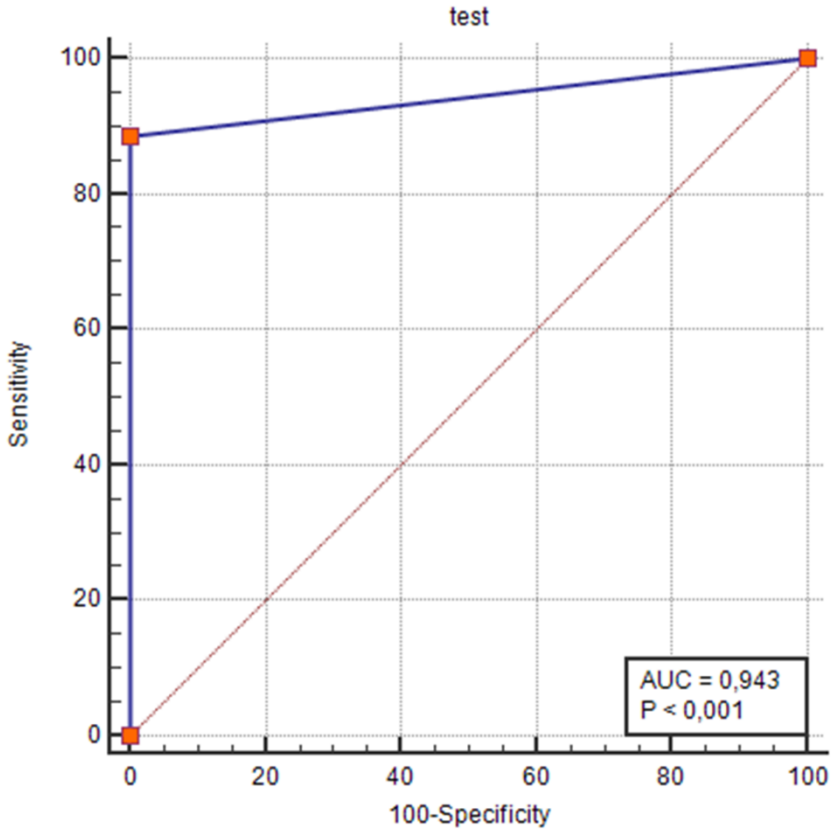

Figure 2. ROC curve demonstrating the diagnostic performance of the cold spray. AUC = Area under the ROC curve.

Table 1. Signs and symptoms of dental pulp diseases.

Signs and symptoms	**Reversible pulpitis**	**Symptomatic irreversible pulpitis**	**Asymptomatic irreversible pulpitis**	**Pulp necrosis**
History of pain	Elicited, mild and intermittent	Spontaneous, severe and lingering	Elicited, severe and intermittent	No pain
Response to cold spray	Positive: mild and subsides quickly (< 10 s)	Positive: severe and subsides slowly (> 10 s)	Positive: severe and subsides slowly (> 10 s)	Negative
Response to apical percussion and palpation	Negative	Negative or rarely positive	Negative or rarely positive	Negative or positive
Radiographic findings	Normal	Normal or rarely with periodontal ligament thickening	Normal or rarely with periodontal ligament thickening	Normal or with periodontal ligament thickening and apical lesion

Table 2. General characteristics of the sample.

Characteristics		**n**	**%**
Clinical diagnosis	PN	29	48.3
	AIP	28	46.7
	SIP	3	5.0
Bleeding	Absent	25	41.7
	Present	35	58.3
Sex	Female	39	65.0
	Male	21	35.0
Age	12-18	7	11.7
	19-40	37	61.7
	41-60	16	26.7
Tooth	Single-rooted	26	43.33
	Multiradicular	34	56.67
Restoration	Absent	21	35.0
	Present	39	65.0
Caries	Absent	20	33.3
	Present	40	66.7
Analgesic	No	48	80.0
	Yes	12	20.0

PN = pulp necrosis; AIP = asymptomatic irreversible pulpitis; SIP = symptomatic irreversible pulpitis.

Table 3. Performance of dental pulp sensibility test using cold spray.

Sensitivity	Specificity	PPV	NPV	Accuracy
0.88	1.00	1.00	0.86	0.93

PPV = positive predictive value; NPV = negative predictive value.

Table 4. Comparison of cold spray accuracy between subgroups according to the individual and clinical variables.

Subgroup		Sensitivity	Specificity	Accuracy	p
Sex	Female	0.905	1.000	0.949	0.515 ns
	Male	0.857	1.000	0.905	
Age	12-18	1.000	1.000	1.000	0.264 ns
	19-40	0.826	1.000	0.892	
	41-60	1.000	1.000	1.000	
Tooth	Single-rooted	0.786	1.000	0.885	0.186 ns
	Multiradicular	0.952	1.000	0.971	
Restoration	Absent	1.000	1.000	1.000	0.129 ns
	Present	0.826	1.000	0.897	
Caries	Absent	0.700	1.000	0.850	0.067 ns
	Present	0.960	1.000	0.975	
Analgesic	No	0.875	1.000	0.938	0.796 ns
	Yes	0.909	1.000	0.917	

ns = statistically not significant difference.

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Capítulo 2

Cunha TCC, Matos FS, Paranhos LR, Bernardino IM, Moura CCG. Influence of glide path kinematics during endodontic treatment on the occurrence and intensity of intraoperative and postoperative pain: a systematic review of randomized clinical trials. BMC Oral Health. 2020;20(175):1-13.

Influence of glide path kinematics during endodontic treatment on the occurrence and intensity of intraoperative and postoperative pain: a systematic review of randomized clinical trials.

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Abstract

Background: Preliminary canal enlargement (glide path preparation) may play a significant role in the development of pain. The aim of this systematic review of randomized clinical trials was to assess the influence of glide path kinematics during endodontic treatment on the occurrence and intensity of intraoperative and postoperative pain. **Methods**: A search was performed in June 2019 in six electronic databases (PubMed, Scopus, LILACS, SciELO, Embase and Web of Science) and two grey literature databases (OpenGrey and OpenThesis). The bibliographic references of the eligible articles were also hand-searched. The included clinical studies assessed the occurrence and intensity of intraoperative and/or postoperative pain after root canal preparation without glide path preparation (WGP) or with glide path preparation using manual (M-GP), continuous rotary (CR-GP), or reciprocating (R-GP) instruments. The primary outcome was the occurrence and intensity of intraoperative and postoperative pain, while analgesic consumption was the secondary outcome. The full texts of the eligible studies were analyzed by two reviewers who performed calibration exercises to verify the risk of bias and quality of the individual studies using the Joanna Briggs Institute Critical Appraisal tool. **Results:** From 1283 identified articles, only six studies were included in the qualitative analysis of the results, with a total sample of 884 patients/teeth. Three studies presented a high risk of bias, while three studies presented a moderate risk. Two studies reported that CR-GP causes lower pain levels than M-GP and WGP, and three studies showed no differences between CR-GP and R-GP. Regarding analgesic consumption, two studies found no differences among glide path kinematics, and one study reported lower consumption for CR-GP than for M-GP.

Because of the limited number of studies and methodological differences, no statistical analyses were performed for the glide path kinematics comparisons. **Conclusions**: Compelling evidence indicating a significantly different occurrence and intensity of pain among glide path kinematics is lacking. The systematic review protocol was registered in the PROSPERO database [CRD42020139989].
Keywords: Endodontics, Glide path, Pain, Periapical periodontitis, Root canal treatment.

Background

The instrumentation technique used during root canal preparation can play an important role in pain development, as necrotic tissues, contaminated debris and bacteria can be transported to the periapical region, inducing an acute inflammatory response [1–3]. The last decades have been marked by considerable advances in the automated instrumentation of root canals, especially regarding the types of alloy, designs, protocols and kinematics of the files [4]. The use of reciprocating motion was introduced by Yared in 2008 and is an evolution of the balanced force technique [5], which is associated with reduced fatigue fracture of the file, as counterclockwise rotations decrease torsional stresses during the active instrumentation procedure [6, 7]. Despite lower stress values being exerted on the instrument, some studies have linked the performance of this movement to greater debris extrusion compared to continuous rotations [8, 9]; continuous rotations provide a passageway for the removal of debris from the root canal, reducing the incidence of pain and postoperative complications [10]. However, clinical studies on root canal instrumentation comparing reciprocating and continuous rotation kinematics in relation to their effects on debris extrusion and postoperative pain have conflicting results [1, 11–13]. Currently, most automated systems recommend to create a glide path (smooth radicular patency from the root canal orifice to the apical construction) prior to automated root canal instrumentation [14] in order to remove anatomical interferences [15], preserve the original anatomy of the canal [16], and reduce the occurrence of operative accidents, such as canal transportation, step formation, perforations, fractures of nickel-titanium instruments, and apical extrusion of debris [2, 17]. Thus, glide path preparation may also be an important procedure to reduce the occurrence of postoperative pain [18]. Several

instruments and techniques have been developed for preinstrumentation, including small diameter stainless steel hand files, such as ISO (International Organization for Standardization) 06, 08 and 10 to ISSO 20 [19], and motor-driven nickel-titanium files, which make glide path preparation simpler, safer [20] and faster [21]. Canal transportation and debris extrusion produced by glide path preparation are also considered risk factors that increase postoperative discomfort [22–24]. Thus, the use of stainless steel hand files for glide path preparation, despite their advantages of having a lower cost and better tactile feel than other files [25], tend to rectify the canal path due to their rigidity and create preparations with asymmetrical and irregular wear in all directions of the apical region [23], increasing the incidence of apical canal transportation [25–27]. On the other hand, automated continuous rotation systems such as PathFile® and ProGlider® and reciprocating systems such as R-Pilot® and Wave One Gold Glider® have enhanced modeling capabilities with increased flexibility, and the original geometry of the root canal can thereby be retained [28]. Although previous studies have also reported that manual glide path preparation produces a greater amount of debris extrusion [17, 26], which is associated with the development of pain, the clinical relevance of the relative difference in the incidence of canal transportation and in the amount of apically extruded debris after using stainless steel hand files and continuous rotary or reciprocating glide path systems remains unclear. Therefore, this study aimed to assess and compare, through a systematic review of randomized clinical trials, the influence of glide path kinematics during endodontic treatment of human permanent teeth on the occurrence and intensity of intraoperative and postoperative pain. The null hypothesis tested was that there is no difference between root canal preparation without glide path preparation (WGP) or with glide path preparation using manual (M-GP), continuous rotary (CR-GP), or reciprocating (R-GP) instruments regarding the occurrence and intensity of intraoperative and postoperative pain.

Methods

Protocol and registration

This systematic review was performed according to the recommendations of the PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analysis)

statement [29] and the Cochrane guidelines [30]. The systematic review protocol was registered in the PROSPERO database under no. CRD42020139989.

Study design and eligibility criteria

This study was a systematic review of randomized clinical trials that aimed to answer the following guiding question: "Does the kinematics of glide path preparation during endodontic treatment of human permanent teeth influence the occurrence and intensity of intraoperativeor postoperative pain?".The clinical question under review was structured according to the PICOS format (Population, Intervention,

Comparison, Outcome and Study design): P – human permanent teeth, I – glide path preparation, C – alternative glide path preparation or no glide path preparation, O – occurrence and intensity of intraoperative or postoperative pain, S – randomized clinical trials. The studies included assessed the occurrence and intensity of intraoperative and/or postoperative pain after root canal preparation without glide path preparation (WGP) or with glide path preparation using manual (MGP), continuous rotary (CR-GP), or reciprocating (RGP) instruments, without restrictions of the year, language, or publication status (in press). The following types of articles were excluded: 1) studies not related to the topic and 2) literature reviews, laboratory studies, case reports, case series, letters to the editor or editorials, congress abstracts, personal opinions, and books and/or book chapters.

Sources of information and search

The PubMed (including MedLine), Scopus, Latin- American and Caribbean Health Sciences Literature (LILACS), SciELO, Embase and Web of Science databases were the primary sources that were searched. OpenGrey and OpenThesis partially covered the "grey literature". A manual search was also performed through a systematized analysis of the references of the eligible articles. All steps were performed with the aim of minimizing selection and

publication biases. MeSH (Medical Subject Headings), DeCS (Health Sciences Descriptors), and Emtree (Embase Subject Headings) were used to select the search descriptors. Several combinations of the Boolean operators "AND" and "OR" enhanced the research strategy (Table 1). The bibliographic research was performed in June 2019. The results obtained were exported to EndNote Web™ software (Thomson Reuters,

Toronto, Canada), with which duplicates were removed. The remaining results were exported to Microsoft Word™ 2010 (Microsoft™ Ltd, Washington, USA), with which the remaining duplicates were manually removed.

Study selection

Before starting the study selection process, as a calibration exercise, the reviewers discussed the eligibility criteria and applied them to a sample of 20% of the studies retrieved to determine interexaminer agreement. After achieving a proper level of agreement (Kappa ≥ 0.81), the study selection process was performed in three different phases by two eligibility reviewers. In the first phase, the reviewers independently performed a methodical analysis of the titles of the studies. The reviewers were not blinded to the names of authors and journals. Articles with titles not related to the topic were eliminated in this phase. In phase 2, two reviewers also analyzed the abstracts systematically and excluded studies according to the eligibility criteria. The studies that were related to the topic but did not have abstracts available were fully analyzed in the third phase. In this phase, the

full texts of the preliminary eligible studies were analyzed to verify whether they fulfilled the eligibility criteria.When an agreement could not be reached in the assessment, a third reviewer was consulted to make a final decision.

Process of data collection and extraction

After selection, the studies were analyzed, and two reviewers extracted data on the following information: identification of the study (author, year of publication, and study location); sample characteristics (number of patients or teeth, distribution by sex, mean age and range, types of teeth, inclusion criteria, study groups, and outcome measure); and intervention characteristics (operators, working length, glide path system, instrumentation system, surgical diameter, number of sessions, and root canal filling, if applicable). To ensure consistency among reviewers, both reviewers performed a calibration exercise during which information was extracted jointly from an eligible study. The reviewers solved any disagreements through discussions, and when both reviewers disagreed, they consulted a third reviewer for a final decision. Risk of bias and individual quality of the studies. The risk of bias and individual quality of the studies selected was assessed by the Joanna Briggs Institute Critical Appraisal Tools for use in JBI Systematic Reviews Checklist for Randomized Controlled Trials [31]. Two

authors assessed each domain independently and systematically regarding the potential risk of bias, as recommended by the PRISMA [29]. The reviewers solved any disagreements through discussions, and when both reviewers disagreed, they consulted a third reviewer for a final decision. The following criteria were used for the assessment: Q.1) Was true randomization used for assignment of participants to treatment groups?; Q.2) Was allocation to treatment groups concealed?; Q.3) Were treatment groups similar at the baseline?; Q.4) Were participants blind to treatment assignment?; Q.5) Were those delivering treatment blind to treatment assignment?; Q.6) Were outcomes assessors blind to treatment assignment?; Q.7) Were treatment groups treated identically other than the intervention of interest?; Q.8) Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?; Q.9) Were participants analyzed in the groups to which they were randomized?; Q.10) Were outcomes measured in the same way for treatment groups?; Q.11) Were outcomes measured in a reliable way?; Q.12) Was appropriate statistical analysis used?; Q.13) Was the trial design appropriate, and any deviations from the standard RCT design (individual randomization, parallel groups) accounted for in the conduct and analysis of the trial?. The risk of bias for a study was ranked as “high” when up to 49% of the answers corresponded to "yes", “moderate” when 50% to 69% of the answers corresponded to "yes", and “low” when more than 70% of the answers corresponded to "yes".

Summary measures

The occurrence and intensity of intraoperative and postoperative pain after glide path preparation were the main outcomes evaluated. Analgesic consumption, i.e., the number of analgesic tablets consumed for pain resolution, was the secondary outcome. Intraoperative pain assessments included assessments of pain performed during the first treatment session and immediately after glide path preparation and/or root canal instrumentation. Postoperative pain assessments included those performed after the end of the first treatment session and between 6 and 72 hours after obturation and/or temporary filling of the crown.

Results

Study selection

The first selection phase resulted in 1283 studies distributed in eight electronic databases. After the duplicates were removed, 598 studies remained for the analysis of the titles and abstracts. Then, after the titles were read, 108 studies remained for the analysis of the abstracts. After the abstracts were analyzed, only six studies were considered eligible for the full text assessment. The references of the six studies were carefully assessed to identify studies retrieved through the main search strategy, but none were found. Therefore, the six studies [2, 4, 18, 32–34] were included in the qualitative analysis of the results. Figure 1 shows the search, identification, inclusion, and exclusion processes for the articles.

Study characteristics

Table 2 shows a summary of the main population characteristics of the studies. The analysis of the six studies resulted in a total sample of 884 patients/teeth, whose ages ranged from 16 to 70 years. From the six studies analyzed, only three [2, 4, 34] mentioned the ethical criteria involved, three [2, 4, 34] followed the CONSORT statement, and two reported the use of informed consent forms for the research participants [4, 34]. Table 3 shows a summary of the main intervention characteristics of the studies. Pain occurrence and intensity were evaluated after several operative steps: during the operative session, after glide path preparation [34] or after both glide path preparation and root canal instrumentation [32, 33]; following the first treatment session, after glide preparation, root canal instrumentation and obturation with gutta-percha and AH Plus sealer [2, 4], or after glide path preparation and the placement of a cotton pellet in the root canals and temporary filling [18].

Risk of bias and individual quality of the studies

Table 4 shows information regarding the risk of bias and individual quality of the studies included in this systematic review. According to the analysis of the JBI Critical Appraisal Checklist for Randomized Controlled Trials [31], three studies [18, 32, 33] presented high risk of bias, while three studies [2, 4, 34] presented moderate risk. Questions Q.1 and Q.2 were considered “unclear” for three studies [18, 32, 33] because the authors stated that the patients were randomly allocated to the study groups, but the authors did not provide details about the randomization procedure and allocation concealment, respectively. Question Q.5 was considered “not applicable” for all studies

[2, 4, 18, 32–34] because the operator could not be blind to the instrumentation technique he/she is using. Questions Q.6 and Q.11 were considered "not applicable" for all studies [2, 4, 18, 32–34] because the results were evaluated by means of a pain scale form or visual analogue scale completed by the research participants themselves. Question Q.9 was considered "not applicable" for three studies [2, 33,34] because there was no loss of patients included in the trial.

Specific results of the eligible studies

Table 5 shows a summary of the parameters and results collected for the studies included in the qualitative analysis. Three studies [32–34] evaluated the occurrence and intensity of intraoperative pain, and three studies [2, 4, 18] evaluated the occurrence and intensity of postoperative pain and analgesic consumption. In Table 5, for the comparison between postoperative pain levels in each study, only the 24-, 48- and 72-hour periods were considered because these were the periods evaluated in the three studies [2, 4, 18]. Figure 2 shows the intensity of intraoperative and postoperative pain reported in the eligible studies after glide path preparation with different kinematics. Considering the individual results of the eligible studies concerning the influence of glide kinematics on the occurrence and intensity of intraoperative and postoperative pain, the following statements can be made: 1) Two studies [4, 18] reported that CR-GP leads to lower pain levels than M-GP, but one study [33] found no difference between CR-GP and M-GP, and two studies [2, 32] showed better results for CR-GP than for WGP. 2) One study [4] reported that R-GP leads to lower pain levels than M-GP, but another study [2] found no difference between R-GP and WGP. 3) Three studies [2, 4, 34] showed no differences between CR-GP and R-GP, and one study [34] reported that CR-GP causes lower pain levels than RGP. Regarding analgesic consumption, two studies [2, 4] found no differences among M-GP, CR-GP, R-GP and WGP, and only one study [18] reported lower analgesic consumption per subject for CR-GP than for M-GP.

Discussion

Preliminary manual or mechanical root canal enlargement (glide path preparation) has been recommended to reduce the anatomical interferences of the canal walls and to

soften the descent path of the instruments used in the chemical-mechanical preparation [15]. This procedure facilitates root canal preparation, enabling a safer use of files and thus preventing instrument fractures [16, 35], root canal deformation [18, 23, 36] and apical extrusion of contaminated debris [2, 17]. Different glide path systems with variable kinematics are commercially available, and their effects on apical debris extrusion and influence on the development of postoperative symptoms remain unclear. Therefore, the objective of this systematic review was to search the available literature for clinical evidence supporting a relationship between glide path kinematics and intra- and postoperative symptoms to guide the selection of a glide path system for safe clinical use and to improve patients' well-being, thus improving the treatment prognosis. The null hypothesis was rejected since glide path kinematics during endodontic treatment may influence the development of pain. However, the moderate [2, 4, 34] or high [18, 32, 33] risk of bias as well as the heterogeneity of the included studies made direct comparisons among them or statistical manipulations such as a metaanalysis impossible, decreasing the evidence strength of the results of this systematic review. This issue draws the attention of the scientific community to the need for the standardization of clinical study designs according to the CONSORT guidelines, with which important information should be evaluated before starting the research study and before the publication of the results. Allocation concealment, blinding the participants, operators and outcome assessors to the treatment assignments are important factors in minimizing confounders and avoiding performance bias [37]. Although all clinical trials included in this systematic review used randomization [2, 4, 18, 32–34], three of them [18, 32, 33] did not describe the randomization process and did not provide details on the allocation concealment method used for assigning the participants to treatment groups. In five works [2, 4, 18, 32, 33], the people involved were not blinded. One of the main concerns regarding the study of pain is its form of assessment since pain is a sensory, subjective and intrapersonal experience whose threshold varies between subjects [18, 38]. According to Conti et al., no "standard" is available to quantify pain, and the visual analogue scale (VAS) is the most suitable method for pain assessment [39]. VAS corresponds to a horizontal line of 100 mm, without numbers, whose minimum reading refers to "no pain" and the maximum reading to "the worst imaginable pain" by the patient. This scale is a simple and

important tool to assess the prevalence and severity of pain and changes resulting from treatments [39]. In addition, VAS is considered accurate because it has few steps and is reliable because the patient would not be biased by numbers usually present in standard numerical scales that are not very objective due to the heterogeneity of personal character [39, 40]. In the included studies, pain was assessed primarily through a visual analogue scale (VAS) [2, 4, 33, 34], but two studies applied numbered scales [18, 32]. In addition, there were differences in the definitions of the pain scales used, that is, the same degree of pain may have different meanings in different scales, which make it impossible to directly compare the results of the studies or statistical combinations of the results. Although the VAS is a simple and valuable tool for assessing pain intensity and alterations due to treatment, it does not allow the cause of pain to be determined, making the clinical significance of the VAS scores questionable [38, 41]. The presence of preoperative pain as reported in four studies [4, 18, 32, 33] reinforces this argument, as it is considered the major determinant or prognostic factor of postoperative pain [4, 42, 43]. Thus, pain intensity should be reported in relation to its improvement or deterioration, with a decrease or increase in a numerical value, regardless of the scale used, to make the results clinically important and comparable [44]. Pain perception is characterized by inter-individual variability related to sex and age, their level of catastrophizing and anxiety [45, 46]. In this systematic review, three studies evaluated pain in both male and female patients, with homogeneous distributions [2, 4, 34]. However, it has been reported that females typically tend to display lower pain thresholds and pain tolerance than men [47, 48]. Many studies have sought to clarify the female predominance in the prevalence of pain, and it is believed that females suffer more commonly from psychosomatic illnesses and that their pain is governed by emotional factors [49]. More legitimate explanations are based on biological variations between the sexes: differences in pelvic levels and reproductive organs; hormonal factors associated with changes in serotonin and norepinephrine levels, leading to an increased prevalence of pain during menstrual periods [50, 51] and hormone replacement processes or the use of oral contraceptives [52]. Several hypotheses have also been proposed to explain the relationship between age and pain. The selected articles evaluated patients ranging in age from 16 to 70 years [2, 4, 18, 33, 34]. The literature reports that with aging, there is an increase in the pain threshold in response to

stimuli. Because pain is a function of the brain, it is subject to age-related changes, so interactions between brain aging and pain processing are likely to interfere with the experience of pain in older people. Studies have suggested peripheral changes, such as impaired activity of delta A myelinated fibers and structural changes in specific regions of the central nervous system, which is involved in pain processing, to be possible reasons for changes in the perception of pain [53–55]. These findings suggest that in future studies, pain should be measured in relation to sex and age to reduce bias in pain assessments and treatments, thus leading to a better understanding of the factors that influence pain perception during or after endodontic treatment. Although all root canal instrumentation techniques are associated with debris extrusion, the amount of debris extruded may vary depending on the instrument's kinematics and design [2, 3, 56, 57]. When transported to periapical tissues, infected debris can induce an acute or chronic inflammatory response with or without pain and swelling [18, 48, 56, 58]. Considering the individual results of the studies included in this systematic review, CR-GP or R-GP may cause lower rates of intraoperative and postoperative pain compared to root canal preparation without glide path (WGP) or with M-GP (Fig. 2). Other studies have also shown that most motor-driven nickel titanium (NiTi) instruments extrude less debris into the periapical tissues than manual instruments due to their rotary kinematics associated with abundant irrigation, minimizing postoperative discomfort [57, 59–61]. In addition, both rotary and reciprocating kinematics have shown to exert similar and minimal effects on the intraoperative discomfort of patients [62]. However, in the study by Hou et al., the incidence of postoperative pain was lower in patients treated with rotary instruments than in those treated with reciprocating instruments because there was less debris extrusion, which reduces irritation and minimizes inflammation and the release of chemical mediators, such as neuropeptides, arachidonic acid metabolites, cytokines, lysosomal enzymes, platelet activation factors, fibrinolytic peptides, vasoactive amines, anaphylatoxins and kinins, which can lead to postoperative complications [10, 63]. Other intraoperative factors can also influence the development of pain including the number of treatment sessions, the type of chemical substance used in the root canal instrumentation and intracanal medication, as well as the root canal obturation technique [48, 61]. Several irrigants are used during endodontic therapy, with sodium hypochlorite (NaOCl) being the most commonly used due to its antimicrobial

and antibiofilm activities, and the dissolving power of organic tissues [64, 65]. On the other hand, when extruded to the periapex, it is irritating to periapical tissues, especially in high concentrations (5.25%), and even in low concentrations (0.5%) it can induce an inflammatory reaction, which increases the probability of occurrence of intra and postoperative pain [64–66]. Standardizing irrigation protocols, such as controlling the depth of needle penetration, can help eliminate the effects of intraoperative variables on results [67]. Four of the selected articles [2, 4, 18, 32] reported the use of 5.25% hypochlorite as an irrigating solution, but none of them provided information about the irrigation technique and control of irrigating solution extrusion, making it impossible to define the interference of substances used during the endodontic treatment in the incidence of pain. In two studies [2, 4], analgesic consumption was not influenced by glide path kinematics, whereas in the study by Pasqualini et al. analgesic consumption was reduced in the patients treated with continuous rotary glide path preparation compared with those who underwent manual glide path preparation [18]. Severe postoperative pain requiring posttreatment analgesic medication is commonly associated with biomechanical preparation procedures that stimulate an immune response to the irrigants and microorganisms present in extruded debris, overinstrumentation, or foreign body reactions to filling materials [68]. In the study by Pasqualini et al., the manual glide path procedure probably increased analgesic consumption compared with the continuous rotary glide path procedure by extruding more contaminated debris into the periapex [17, 18]. Pulpal and periodontal diagnoses, pre-operative pain and intraoperative factors such as irrigation solution and system, instrumentation technique, use and type of medicament, root canal filling technique and occlusal reduction have been previously shown to influence post-operative pain and could justify differences between study results [3, 69–72]. The main limitation of this systematic review is the low number of eligible articles that may compromise the strength of the evidence. In addition, methodological differences related to sample and intervention characteristics limited the evaluation of results and direct comparisons of the investigated outcomes among the eligible articles. Thus, some divergences in clinical findings may have been caused by the variation in the instrumentation protocols, the number and clinical experience of operators [73, 74] and the systems used [12, 24]. However, this systematic review answers a relevant and unpublished clinical

question, thereby contributing to an improvement in glide path protocols during endodontic treatment, its prognosis, and therapeutic success levels. Additional randomized controlled clinical trials that avoid the aforementioned limitations should be conducted in accordance with the CONSORT guidelines to provide more compelling evidence on the influence of glide path kinematics on pain development.

Conclusion

Considering the individual results of the eligible studies, glide path kinematics during endodontic treatment may influence the development of pain. Continuous rotary (CR-GP) or reciprocating (R-GP) glide path systems appear to cause lower rates of intraoperative and postoperative pain compared to root canal preparation without glide path preparation (WGP) or with glide path using manual instruments (M-GP). However, compelling evidence indicating a significantly different occurrence and intensity of pain among glide path kinematics is lacking. Variability in treatment protocols, patient selection, and treatment effects made it impossible to statistically compare the individual results of studies.

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Table 1 – Strategies for database search.

Database	Search Strategy (June, 2019)
PubMed http://www.ncbi.nlm.nih.gov/pubmed	((“Apical Periodontitis” OR “Dental Pulp Disease” OR “Dental Pulp Necrosis” OR “Periapical Disease” OR “Periapical Periodontitides” OR “Pulpitis” OR “Root Canal” OR “Root Canals” OR “Teeth” OR “Tooth”) AND (“Glide Path” OR “Hyflex GPF” OR “Nickel-Titanium Rotary Instruments” OR “One G” OR “PathFile” OR “ProGlider” OR “R-Pilot” OR “Scout RaCe” OR “Wave One Gold Glider”))
Scopus http://www.scopus.com/	((“Apical Periodontitis” OR “Dental Pulp Disease” OR “Dental Pulp Necrosis” OR “Periapical Disease” OR “Periapical Periodontitides” OR “Pulpitis” OR “Root Canal” OR “Root Canals” OR “Teeth” OR “Tooth”) AND (“Glide Path” OR “Hyflex GPF” OR “Nickel-Titanium Rotary Instruments” OR “One G” OR “PathFile” OR “ProGlider” OR “R-Pilot” OR “Scout RaCe” OR “Wave One Gold Glider”))
LILACS http://lilacs.bvsalud.org/	(“Glide Path” OR “Nickel-Titanium Rotary Instruments” OR “PathFile”)
SciELO http://www.scielo.org/	(“Glide Path” OR “Nickel-Titanium Rotary Instruments” OR “PathFile”)
Embase http://www.embase.com	('apical periodontitis'/exp OR 'apical periodontitis' OR 'dental pulp disease'/exp OR 'dental pulp disease' OR 'dental pulp necrosis'/exp OR 'dental pulp necrosis' OR 'periapical disease'/exp OR 'periapical disease' OR 'periapical periodontitides' OR 'pulpitis'/exp OR 'pulpitis' OR 'root canal'/exp OR 'root canal' OR 'root canals' OR 'teeth'/exp OR 'teeth' OR 'tooth'/exp OR 'tooth') AND ('glide path' OR 'hyflex gpf' OR 'nickel-titanium rotary instruments' OR 'one g' OR 'pathfile' OR 'proglider' OR 'r-pilot' OR 'scout race' OR 'wave one gold glider')
Web of Science http://apps.webofknowledge.com/	((“Apical Periodontitis” OR “Dental Pulp Disease” OR “Dental Pulp Necrosis” OR “Periapical Disease” OR “Periapical Periodontitides” OR “Pulpitis” OR “Root Canal” OR “Root Canals” OR “Teeth” OR “Tooth”) AND (“Glide Path” OR “Hyflex GPF” OR “Nickel-Titanium Rotary Instruments” OR “One G” OR “PathFile” OR “ProGlider” OR “R-Pilot” OR “Scout RaCe” OR “Wave One Gold Glider”))
OpenGrey http://www.opengrey.eu/	(“Glide Path” OR “Nickel-Titanium Rotary Instruments” OR “PathFile”)
OpenThesis http://www.openthesis.org/	(Glide Path OR Nickel-Titanium Rotary Instruments OR PathFile)

Table 2 – Summary of the main population characteristics of the eligible studies.

Author, year, and country	Sample (n) and sex	Mean sample age and range (years)	Types of teeth	Inclusion criteria	Study groups	Outcome Measure
Pasqualini et al., 2012. Italy.	295 patients (+)	42 (16–70)	Single rooted and multirooted teeth	Asymptomatic irreversible pulpitis, symptomatic irreversible pulpitis, or pulp necrosis with or without apical periodontitis	[1]CR-GP (PathFile) and [2]M-GP (Stainless-steel K-file)	Postoperative pain Analgesic consumption
Chen et al., 2013. China.	88 teeth (+)	+	Molars and premolars	+	[1]CR-GP (PathFile + Reciproc), [2]CR-GP (PathFile + ProTaper), and [3]WGP (ProTaper)	Intraoperative pain
Guo et al., 2014. China.	80 patients (+)	+ (17–60)	First and second molars	Pulp inflammatory disease	[1]CR-GP (PathFile, experienced physicians), [2]CR-GP (PathFile, unexperienced physicians), [3]M-GP (Stainless-steel K-file, experienced physicians), and [4]M-GP (Stainless-steel K-file, unexperienced physicians)	Intraoperative pain
Adıgüzel et al., 2019. Turkey.	93 patients (43♀ 50♂)	40 (20–65)	Single-canaled mandibular premolars	Asymptomatic non-vital pulp	[1]CR-GP (One G), [2]R-GP (R-Pilot) and [3]WGP	Postoperative pain Analgesic consumption
Keskin et al., 2019. Turkey.	240 patients (137♀ 103♂)	+ (18–60)	Maxillary and mandibular teeth	Asymptomatic irreversible pulpitis, symptomatic irreversible pulpitis, symptomatic apical periodontitis or asymptomatic apical periodontitis	[1]R-GP (R-Pilot), [2]CR-GP (ProGlider) and [3]M-GP (stainless-steel K-file)	Postoperative pain Analgesic consumption
Tüfenkçi et al., 2019. Turkey.	88 patients (50♀ 38♂)	40 (18–69)	First and second mandibular molars	Asymptomatic irreversible pulpitis	[1]R-GP (R-Pilot), [2]R-GP (WaveOne Gold Glider), [3]CR-GP (One G) and [4]CR-GP (ProGlider)	Intraoperative pain

Superscript numbers mean group number; +Not mentioned by the author; ♀ Women; ♂ Men; M-GP manual glide path; CR-GP continuous rotary glide path; R-GP reciprocating glide path; WGP without glide path.

Table 3 – Summary of the main intervention characteristics of the eligible studies.

Authors	Operators	Working length	Glide path system	Instrumentation system	Surgical diameter	No of sessions	Root canal filling
Pasqualini et al., 2012	21 endodontists	Full root canal length, i.e. up to the apical foramen	[1]PF (#13, #16, #19, taper 0.02) and [2]KF (#08, #10, #12, #15, #17, #20)	#	#	1	Empty (cotton pellet)
Chen et al., 2013	Single operator	Full root canal length, i.e. up to the apical foramen	[1,2]PF (#13, #16, #19, taper 0.02) and [3]without glide path	[1]Reciproc (R25), [2,3]ProTaper (#S1, #S2, #F1, #F2)	25/0.08	#	#
Guo et al., 2014	Experienced[1,3] or unexperienced[2,4] physicians	Full root canal length, i.e. up to the apical foramen	[1,2]PF (#13, #16, #19, taper 0.02) and [3,4]KF (#10, #15, #20)	ProTaper	+	#	#
Adıgüzel et al., 2019	Single endodontist	Full root canal length, i.e. up to the apical foramen	[1]OG (#14, taper 0.03), [2]RP (#12.5, taper 0.04) and [3]without glide path	Mtwo	30/0.05	1	Gutta-percha and AH Plus sealer
Keskin et al., 2019	Four endodontists	Full root canal length, i.e. up to the apical foramen	[1]RP (#12.5, taper 0.04), [2]PG (#16, variable taper), and [3]KF (#08, #10, #15)	ProTaper Next	30/0.07, 40/0.06 or 50/0.06	1	Gutta-percha and AH Plus sealer
Tüfenkçi et al., 2019	Single operator	Full root canal length, i.e. up to the apical foramen	[1]RP (#12.5, taper 0.04), [2]WOGG (#17, variable taper), [3]OG (#14, taper 0.03), [4]PG (#16, variable taper)	#	#	#	#

Superscript numbers mean group number; +Not mentioned by the author; #Not applicable; KF Stainless-steel K-File; OG One G; PF PathFile; PG ProGlider; RP R-Pilot; WOGG WaveOne Gold Glider.

Table 4 - Risk of bias assessed by the Joanna Briggs Institute Critical Appraisal Tools for use in JBI Systematic Reviews for Randomized Controlled Trials. The risk of bias was classified as high when the study reached up to 49% of "yes" score, moderate when the study reached from 50% to 69% of "yes" score, and low when the study reached more than 70% of "yes" score.

Authors	Q.1	Q.2	Q.3	Q.4	Q.5	Q.6	Q.7	Q.8	Q.9	Q.10	Q.11	Q.12	Q.13	% yes/risk
Pasqualini et al., 2012	U	U	√	--	--	N/A	√	√	--	√	N/A	√	√	46% yes/ high risk of bias
Chen et al., 2013	U	U	U	--	--	--	√	--	--	√	--	√	√	31% yes/ high risk of bias
Guo et al., 2014	U	U	√	--	--	--	√	√	N/A	√	--	√	√	46% yes/ high risk of bias
Adıgüzel et al., 2019	√	√	√	--	--	N/A	√	√	N/A	√	N/A	√	√	61% yes/ moderate risk of bias
Keskin et al., 2019	√	√	√	--	--	N/A	√	√	--	√	N/A	√	√	61% yes/ moderate risk of bias
Tüfenkçi et al., 2019	√	√	√	U	U	N/A	√	√	N/A	√	N/A	√	√	61% yes/ moderate risk of bias

√ - Yes; -- - No; U – Unclear; N/A – Not applicable.

Table 5 – Summary of the parameters and results collected for the studies included in the qualitative analysis.

Intraoperative and postoperative pain assessment					Analgesic consumption
Authors	**Method**	**Period**	**Classification**	**Results**	
Pasqualini et al., 2012	5-level pain scale form	24, 48, 72 h	No pain (0), slight pain (1), mild pain (2), severe pain (3), very severe pain (4), extremely severe pain (5)	^{2}M-GP(KF) > ^{1}CR-GP(PF)	^{2}M-GP(KF) > ^{1}CR-GP(PF)
Chen et al., 2013	+	#	Completely painless (1); mild pain, does not affect occlusion and eating (2); severe pain, affecting occlusion and eating (3)	^{3}WGP > ^{1,2}CR-GP(PF)	#
Guo et al., 2014	Visual analogue scale	#	10 cm ruler marked 0 to 10 scale: pain (value 3-10) or no pain (value <3)	^{1,2}CR-GP(PF) = ^{3,4}M-GP(KF)	#
Adıgüzel et al., 2019	Visual analogue scale	24, 48, 72 h	No pain (0), mild pain (1–3), moderate pain (4–6), severe pain (7–10)	24 h: ^{2}R-GP(RP) = ^{3}WGP > ^{1}CR-GP(OG) = ^{2}R-GP(RP) 48/72 h: ^{1}CR-GP(OG) = ^{2}R3-GP(RP) = ^{3}WGP	^{1}CR-GP(OG) = ^{2}R-GP(RP) = ^{3}WGP
Keskin et al., 2019	Visual analogue scale	24, 48, 72 h	+	^{3}M-GP(KF) > ^{1}R-GP(RP) = ^{2}CR-GP(PG)	^{1}R-GP(RP) = ^{2}CR-GP(PG) = ^{3}M-GP(KF)
Tüfenkçi et al., 2019	Visual analogue scale	#	No pain (0), mild pain (1–3), moderate pain (4–6), severe pain (7–10)	^{3}CR-GP(OG) = ^{1}R-GP(RP) = ^{2}R-GP(WOGG) > ^{4}CR-GP(PG) = ^{3}CR-GP(OG)	#

Superscript numbers mean number of groups; +Not mentioned by the author; #Not applicable; >statistically significant difference; =not statistically significant difference; M-GP manual glide path; CR-GP continuous rotary glide path; R-GP reciprocating glide path; WGP without glide path; KF Stainless-steel K-File; OG One G; PF PathFile; PG ProGlider; RP R-Pilot; WOGG WaveOne Gold Glider.

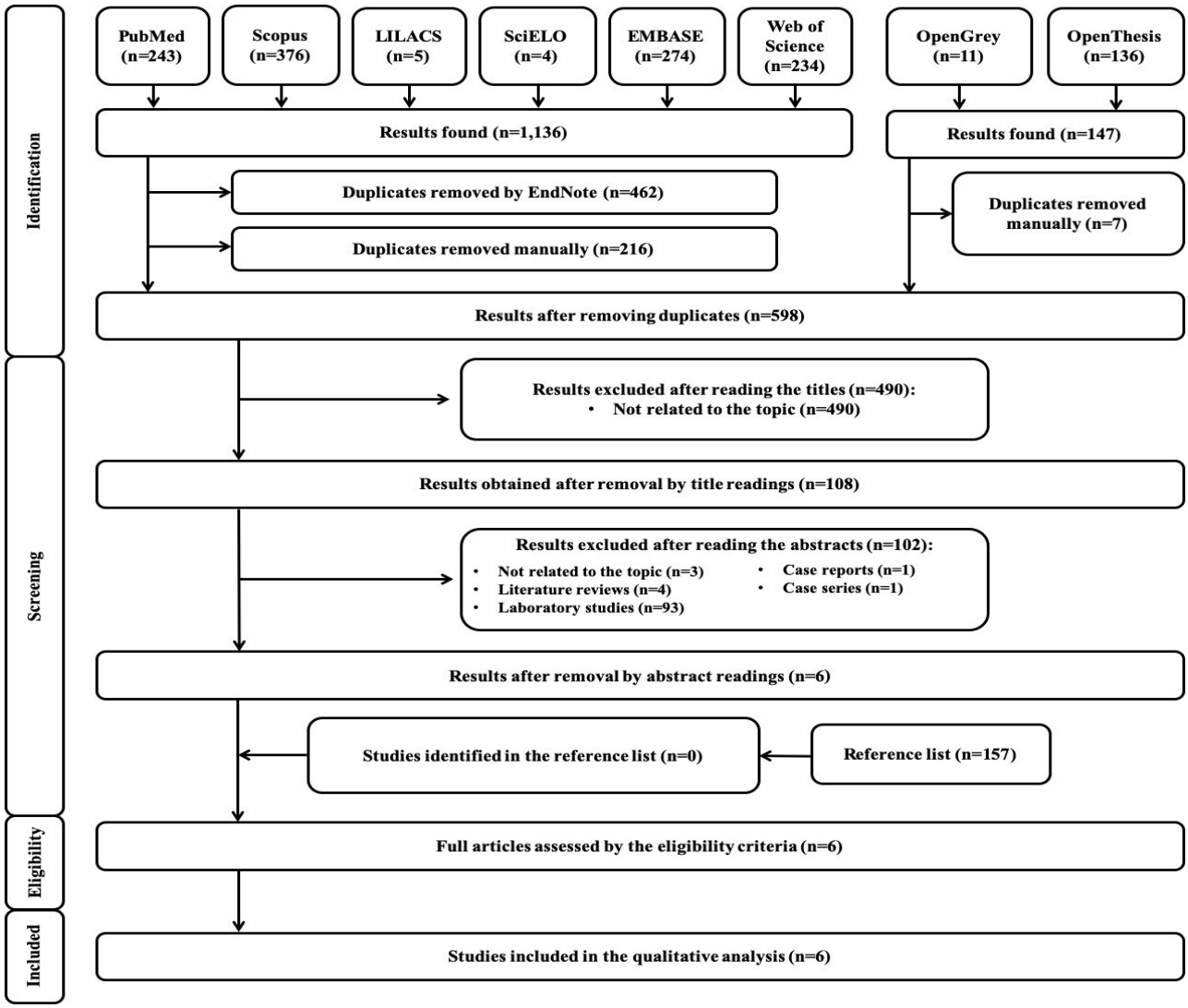

Fig. 1 Flowchart adapted from the PRISMA statement showing the literature search and selection processes.

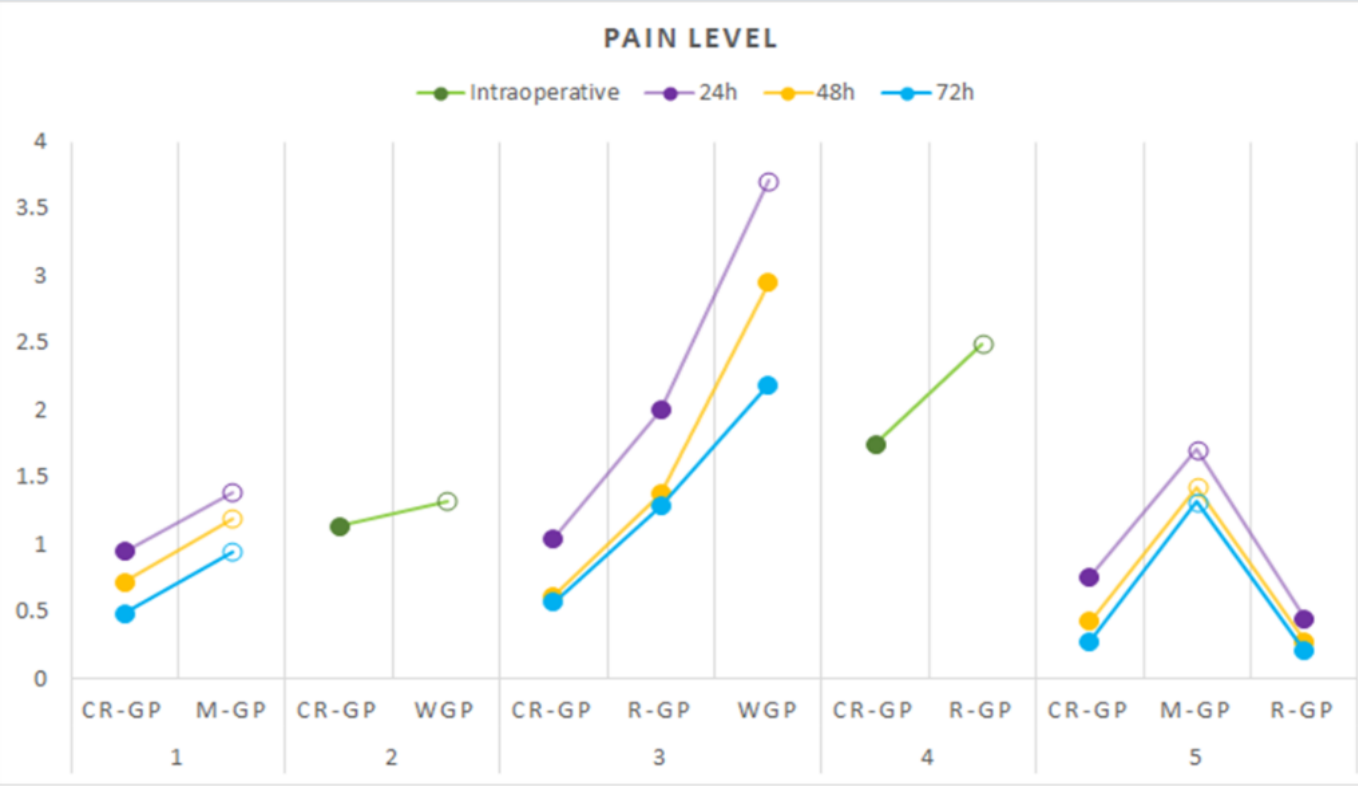

Fig. 2 Mean values of the intensity of intraoperative and postoperative pain reported in the eligible studies after glide path preparation with different kinematics: M-GP, manual glide path; CR-GP, continuous rotary glide path; R-GP, reciprocating glide path; WGP, without glide path. 1, Pasqualini et al. [18]; 2, Chen et al. [32]; 3, Adiguzel et al. [2]; 4, Tufenkçi et al. [34]; 5, Kesklin et al. [4]. Unfilled circles represent a significantly higher level of pain than the other groups in the same assessment period and in each study. In the study by Tufenkçi et al. [34], the only one in which pain level values were expressed as medians, the intensity of intraoperative pain attributed to R-GP was obtained by calculating the mean of R-GP (RP) and R-GP (WOGG) medians, and the intensity of intraoperative pain attributed to CR-GP was obtained by calculating the mean of CR-GP (OP) and CR-GP (PG) medians. The study by Guo et al. [33] was not included in the graph because it did not report intraoperative pain levels in the studied groups, but only the percentage of pain occurrence: 15-20% for CR-GP and 25-35% for MG-GP, with a statistically significantdifference between them.

Capítulo 3

Cunha TCC, Matos FS, Paranhos LR, Moura CCG. Treatment outcome of young molars obstructed by fractured endodontic instruments: two case reports. Research, Society and Development. 2020,9(10) e3149108537.

Treatment outcome of young molars obstructed by fractured endodontic instruments: two case reports

Running title: Fractured endodontic instruments.

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Abstract

Ultrasonic tips and anatomic finishing files have been used as strategies to improve the cleaning and disinfection of root canals, especially in complex anatomies. These instruments are also subjected to fractures, which can hinder the endodontic treatment and negatively affect the outcome. This article presents two cases of successful management of intracanal-fractured instruments with unfavourable prognosis, emphasizing on treatment protocols and outcomes. Two 14-year-old female patients underwent root canal treatment of teeth 37 (case 1) and 47 (case 2). During the final irrigation protocols, case 1 presented a fractured XP- Clean file within the mesiobuccal canal and within the distal canal in case 2, which also showed fractured E1-Irrisonic tips within the mesiobuccal and distal canals. Non-surgical management and bypassing retained instrument fragments were successful in both cases and they may be considered adequate approaches.

Keywords: Endodontics; Fractured instrument; Root canal preparation; Treatment outcome.

Resumo

Pontas ultrassônicas e limas anatômicas de acabamento têm sido utilizadas como estratégias para melhorar a limpeza e a desinfecção dos canais radiculares, principalmente em anatomias complexas. Esses instrumentos também estão sujeitos a fraturas, o que pode dificultar o tratamento endodôntico e afetar negativamente o resultado. Este artigo apresenta dois casos de manejo bem-sucedido de instrumentais fraturados dentro do canal radicular, com prognóstico desfavorável, com ênfase em protocolos de tratamento e resultados. Duas pacientes do sexo feminino, de 14 anos, foram submetidas a tratamento de canal dos dentes 37 (caso 1) e 47 (caso 2). Durante os protocolos de irrigação final, o caso 1 apresentou uma lima XP-Clean fraturada dentro do canal mesiovestibular e dentro do canal distal no caso 2, que também apresentava pontas E1-Irrisonic fraturadas nos canais mesiovestibular e distal. O manejo não cirúrgico e o desvio dos fragmentos dos instrumentos retidos foram bem-sucedidos em ambos os casos e podem ser considerados abordagens adequadas.

Palavras-chave: Endodontia; Instrumento fraturado; Preparo de canal radicular; Resultado do tratamento.

Resumen

Las puntas ultrasónicas y las limas de acabado anatómico se han utilizado como estrategias para mejorar la limpieza y desinfección de los conductos radiculares, especialmente en anatomías complejas. Estos instrumentos también están sujetos a fracturas, lo que puede dificultar el tratamiento endodóntico y afectar negativamente el resultado. Este artículo presenta dos casos de manejo exitoso de instrumentos fracturados dentro del conducto radicular, con un pronóstico desfavorable, con énfasis en los protocolos y resultados del tratamiento. Dos pacientes mujeres de 14 años fueron sometidas a tratamiento de conducto 37 (caso 1) y 47 (caso 2). Durante los protocolos finales de irrigación, el caso 1 presentó una lima XP-Clean fracturada dentro del canal mesiovestibular y dentro del canal distal en el caso 2, que también presentaba puntas E1-Irrisonic fracturadas en los canales mesiovestibular y distal. El manejo no quirúrgico y el desvío de fragmentos de los instrumentos retenidos fueron exitosos en ambos casos y pueden considerarse abordajes apropiados.

Palabras clave: Endodoncia; Instrumento fracturado; Preparación del conducto radicular; Resultado del tratamiento.

1. Introduction

New endodontic irrigation techniques using acoustic and hydrodynamic activation with sonic and ultrasonic devices (Bueno et al., 2019; Conde et al., 2017; Jiang et al., 2010) and anatomic finishing motor-driven files such as the XP-Endo Finisher (FKG Dentaire, La Chaux-de-Fonds, Switzerland) and XP-Clean (MK Life, Porto Alegre, RS, Brazil) (Bao et al., 2017; Carvalho et al., 2019; Vaz-Garcia et al., 2018) were developed to improve the effectiveness of root canal cleaning and disinfection protocols (Nagendrababu et al., 2018; Susila & Minu, 2019). Nevertheless, data regarding the fracture resistance of these instruments are scarce (Kirsch et al., 2019; Vaz-Garcia et al., 2018).

Overall, mechanized instrument fractures are concerning because retained intracanal fragments may hinder the adequate preparation of the root canal space and negatively affect the prognosis success of the endodontic treatment (Madarati et al., 2013; Panitvisai et al., 2010; Spili et al., 2005). The fracture rate of NiTi rotary instruments within root canals varies from 1.3% to 10% (Madarati et al., 2013), although there are no specific data regarding the clinical incidence of fracture on finishing nickel-titanium files. The management of intracanal-fractured instruments includes attempts to bypass and remove the fragment, preparation and filling of the root canal to the coronal level of

the fragment, or surgical removal (Gencoglu & Helvacioglu, 2009; Parashos & Messer, 2006). The ultrasonic technique has been successfully used to remove fractured rotary files (Shahabinejad et al., 2013), although its improper use may generate a secondary fracture of separated file fragments (Arslan at el., 2020; Terauchi et al., 2013). However, there are no reports about clinical management in cases of fractured ultrasonic tips during irrigation.

This study aimed to present two cases of successful management of intracanal fractures of anatomic finishing files (XP-Clean) and ultrasonic inserts (E1-Irrisonic) with unfavourable prognosis, emphasizing on treatment protocols and outcomes. **2. Methodology**

This case report followed the CARE 2013 guidelines (Gagnier et al., 2013). All procedures performed in this case report were in accordance with the Helsinki Declaration. The parents of the patients signed an informed consent form authorizing the publication of the case and any accompanying images.

Two 14-year-old female patients were referred to endodontic treatment in the left (tooth 37, case 1) and right (tooth 47, case 2) mandibular second molars. A detailed review of the patient's medical and dental histories revealed no systemic disease and contributory oral conditions. Intraoral examinations showed negative responses to pulp sensitivity tests and palpation in the apical region and the absence of pathological mobility, but both patients reported positive responses to percussion, with the presence of caries. The radiographic examination revealed periapical radiolucent lesions (Figures 1a and 2a) and the pulp and periradicular status were diagnosed as pulp necrosis and asymptomatic apical periodontitis, respectively.

A single and experienced operator performed the root canal treatments of cases 1 and 2 using local anaesthesia and absolute isolation with a rubber dam. First, manual glide path preparations were performed with #08, #10, and #15 K-files (Dentsply Maillefer, Ballaigues, Switzerland) and 2.5% NaOCl (Rioquímica Ltda., São José do Rio Preto, SP, Brazil). The working lengths (WL) were determined with a RomiApex A-15 apex locator (Romidan Ltd., Kyriat Ono, Israel) and #15 K-file in all root canals. Biomechanical instrumentations were performed 1 mm short of the root canal length using the Twisted File (TF) Adaptive system up to the SM3 (#35/.04) file (SybronEndo, Orange, CA) adapted to the Elements motor (SybronEndo, Glendora, CA) in adaptive motion, according to the manufacturer’s protocol, under abundant irrigation with 2.5% NaOCl.

The final irrigation of all canals was carried out with 5 mL of 17% ethylenediaminetetraacetic acid (EDTA) for 3 minutes followed by 5 mL of 2.5% NaOCl agitated by XP-Clean instruments (MK Life, Porto Alegre, RS, Brazil) in continuous rotation, according to the manufacturer´s recommendations (900 rpm and 1 Ncm-1 torque). However, during the agitation technique, the XP-Clean instruments fractured within the mesiobuccal (Figure 1b) and distal (Figure 2b) canals of teeth 37 (case 1) and 47 (case 2), respectively. The patients were informed about the fractured instruments and attempts were made to bypass and remove the fragments from the root canals with the help of the E5 ultrasonic insert (Helse Dental Technology, São Paulo, SP, Brazil) coupled to the EMS Piezon Master 200 Ultrasound (EMS, São Bernardo do Campo, SP, Brazil) at a power setting of 20%. In both cases, the fragment was only bypassed and not removed, but in tooth 37 (case 1) it moved apically beyond the apical foramen (Figure 1c). Final irrigation was performed again in each canal using the E1-Irrisonic tip (Helse Dental Technology) at a power of 10% to activate ultrasonically the solutions for 30 seconds. During this procedure, new fractures occurred in the apical third of the ultrasonic insert within the mesiobuccal and distal canals (Figure 2b) of tooth 47 (case 2), and only the fragment within the distal canal was removed.

In both cases, the fragments within the canals were maintained and surgical removal was not indicated due to the proximity of the roots to the mandibular canal. Intracanal medication with calcium hydroxide paste (UltraCal™ XS, Ultradent Products Inc., South Jordan, UT, USA) was used for 14 days. In a second visit, as the teeth were asymptomatic, the roots were obturated with the lateral condensation technique using gutta-percha cones (Dentsply Maillefer, Ballaigues, Switzerland) and Sealapex sealer (SybronEndo, Orange, CA) (Figure 1c and 2c). The coronal accesses were sealed with resin-modified glass ionomer (Riva SDI, São Paulo, SP, Brazil) and restored with a light-cured composite resin (Opus bulk fill APS, FGM, Joinville, SC, Brazil). The patients did not present any painful symptoms and did not need analgesics during and after treatment.

Clinical and radiographic follow-up sessions were carried out at 6 (Figures 1d and 2d), 12 (Figures 1e and 2e), and 18 (Figures 1f and 2f) months after the treatment. The patients reported no signs and symptoms related to the respective teeth. Radiographic images showed bone neoformation in the periradicular area suggestive of successful endodontic treatment despite the complications.

3. Results and Discussion

Case reports are still a great contribution to the endodontic literature, especially when involving techniques and instruments used extensively today, in which potential usage complications have not yet been reported, as in the two cases presented. This is the first clinical report showing the fracture of an anatomic finishing file and ultrasonic tip used in passive ultrasonic irrigation and explaining the management of such complication.

New concepts of anatomic finishing files (XP-Endo Finisher and XP-Clean) were introduced for the final cleaning of root canals after any instrumentation technique to remove debris and microorganisms in untouched areas (Vaz-Garcia et al., 2018). Specifically in the cases reported, the XP-Clean file was chosen as a strategy for finishing the root canal preparation due to the large apical foramen of young patients, whose final apical SM3 (#35/.04) file would not be able to touch associated with the presence of radiolucent periapical lesions. According to the manufacturer, XP-Clean are NiTi instruments (#25/.02) developed to work as finishing files after the biomechanical preparation, increasing the cleaning power of the irrigating solution by mechanical agitation ("whipping" action), eliminating debris and remaining microorganisms due to the mechanical contact with the inner walls of the canals. However, unlike the XP-Endo Finisher, which is supported by current scientific literature (De-Deus et al., 2019; Reis et al., 2020), the XP-Clean was recently launched in the market. A previous in vitro study (Vaz-Garcia et al., 2018), comparing the mechanical properties of these two anatomic finishing files showed no difference in microhardness, although the XP-Endo Finisher showed higher resistance to cyclic fatigue than XP-Clean. Therefore, the fracture of XP-Clean files observed in both clinical cases could be attributed to torsional stress and cyclic fatigue. Additionally, the presence of defects on the surface of the instruments could also work as stress-concentration points, making these regions highly vulnerable to nucleation and crack propagation (Lopes et al., 2016; Vaz-Garcia et al., 2018).

Considering this complication, potential solutions would be trying to remove the XP-Clean fragment or bypass the fragments retained within the canal. Both alternatives may be difficult and time-consuming, with an overall clinical success rate ranging from 53% to 87% (Shen et al., 2004; Suter et al., 2005). The success of the non-surgical removal of fractured instruments from root canals depends on factors such as length and location of the fragment in the canal, instrument cross-sectional design, and diameter and degree of curvature of the root and the canal (Shen et al., 2004). When the position of the fragment prevents its conventional removal, with evidence of a negative impact on the

treatment outcome due to its maintenance within the canal, a surgical approach may be considered the best option. However, in cases in which the surgical area is near vital anatomical structures at risk of damaging them, surgical removal is not indicated (Madarati et al., 2013; Wang et al., 2010). Ultrasonics under the visualization of an operating microscope has been considered the most effective method of removing intracanal instrument fragments (Gencoglu & Helvacioglu, 2009). However, the use of ultrasound for removing broken rotary nickel-titanium files may result in some procedural errors such as transportation, perforation, and root fracture (Shahabinejad et al., 2013) or create a secondary fracture of separated file fragments (Arslan et al., 2020; Terauchi et al., 2013). In the two cases reported, the attempt to remove the fragments with ultrasonic tips was partially unsuccessful, which led to their maintenance within the root canals due to the proximity to the mandibular canal, rendering surgical removal impossible. A very undesirable event observed after the removal attempt was the displacement of the fractured fragment beyond the apex, in proximity to the alveolar nerve (Gandevivala et al., 2014; Singh et al., 2017; Wang et al., 2016).

Unfortunately, in case 2, in addition to the primary file fracture, there was also a fracture of the E1-Irrisonic tip during the final irrigation of the root canal. Studies have shown that the acoustic flow and cavitation produced by ultrasound contribute to the cleaning capacity of the root canal irrigation (Jiang et al., 2010). This also makes them effective in several applications including root canal preparation, removal of pulp nodules and fractured instruments, and condensation of endodontic filling materials (Wan et al., 2014). However, regardless of the technique used, endodontic instruments might fracture within the root canal by improper use or pre-existing factors such as anatomical complications and weak points of the instrument itself related to the manufacturing process (Lopes et al., 2016). The fracture of ultrasonic inserts during endodontic procedures is rarely reported in the literature, but some studies correlate it with weak points such as the angle and the diameter of the tips (Walmsley et al., 1996). The acoustic streaming generated by ultrasound varies according to the tip size, in which instruments with smaller diameters have greater displacement amplitude (Ahmad et al., 1987; Lin et al., 2006). This may have favoured the fracture of the ultrasonic inserts in the roots of case 2. Additionally, the previous use of ultrasonic tips without controlling the number of times used and associated with the potential damage caused by the endodontic autoclave sterilization process may have contributed to the fracture (Dioguardi et al., 2019). Further studies evaluating the number of times ultrasonic

inserts for endodontics can be used and sterilized are required to bring more safety to clinicians (Kirsch et al., 2019).

Overall, the occurrence of retained instrument fragment may affect the outcome of the endodontic treatment, transforming a common endodontic procedure into a complication that could result in tooth extraction (Madarati et al., 2013; McGuigan et al., 2013). The degree of canal infection should be considered when determining the potential effect of instrument fracture on the treatment outcome, as the healing rates of teeth with periapical lesions and retained instrument fragment are around 86.7% compared with 92.9% for cases without retained fragment, after a 1-year follow-up (Spili et al., 2005). In both cases reported, the evidence of tissue repair characterized by bone neoformation and absence of clinical symptoms show the success of endodontic therapy although the maintenance of intracanal fragments has limited the access to the apical third of root canals. The stage and degree of root canal preparation and disinfection at the time of instrument fracture, fragment position, use of sterile instruments and antimicrobial solutions, and intracanal medication may have favoured the treatment prognosis (McGuigan et al., 2013). Generally, the cases presented reinforce the assumption that the success rate of endodontic treatment is related to the efficiency in disinfecting the root canal system, even in the presence of a fractured instrument (Nevares et al., 2012; Parashos & Messer, 2006; Simon et al., 2008). It is also necessary to be aware of the use of XP-Endo files, which even in single use seem to have a high potential for fractures.

4. Conclusions

Non-surgical management and bypassing retained fragments of anatomic finishing files (XP-Clean) and ultrasonic inserts (E1-Irrisonic) were successful in both cases and they may be considered adequate approaches. Clinical investigations are required to validate our results and to investigate the effectiveness of different protocols for the removal of fractured endodontic instruments from root canal systems.

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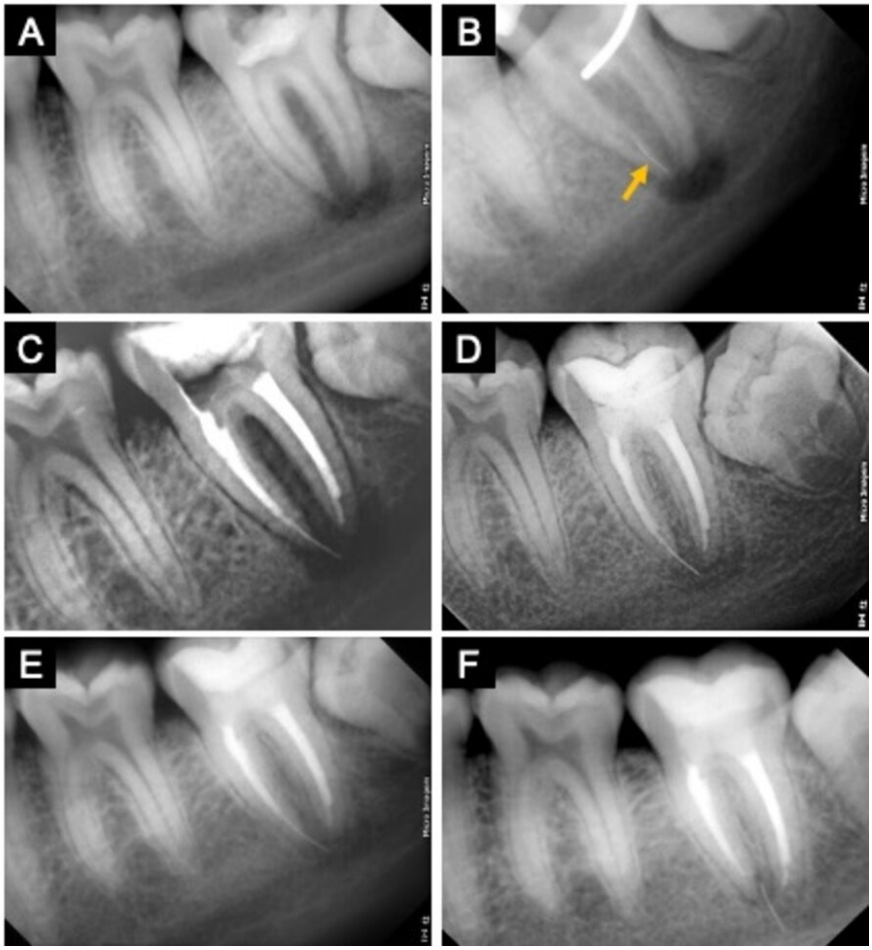

Figure 1. Radiographic images of case 1: A) Preoperative radiograph of the left mandibular second molar (tooth 37) showing periapical radiolucent lesion; B) Radiograph after biomechanical instrumentation showing a fragment of the XP-Clean instrument (yellow arrow) within the mesiobuccal canal; C) Radiograph after endodontic root canal filling; D) 6-month follow-up; E) 12-month follow-up; F) 18-month follow-up showing bone neoformation in the periradicular area.

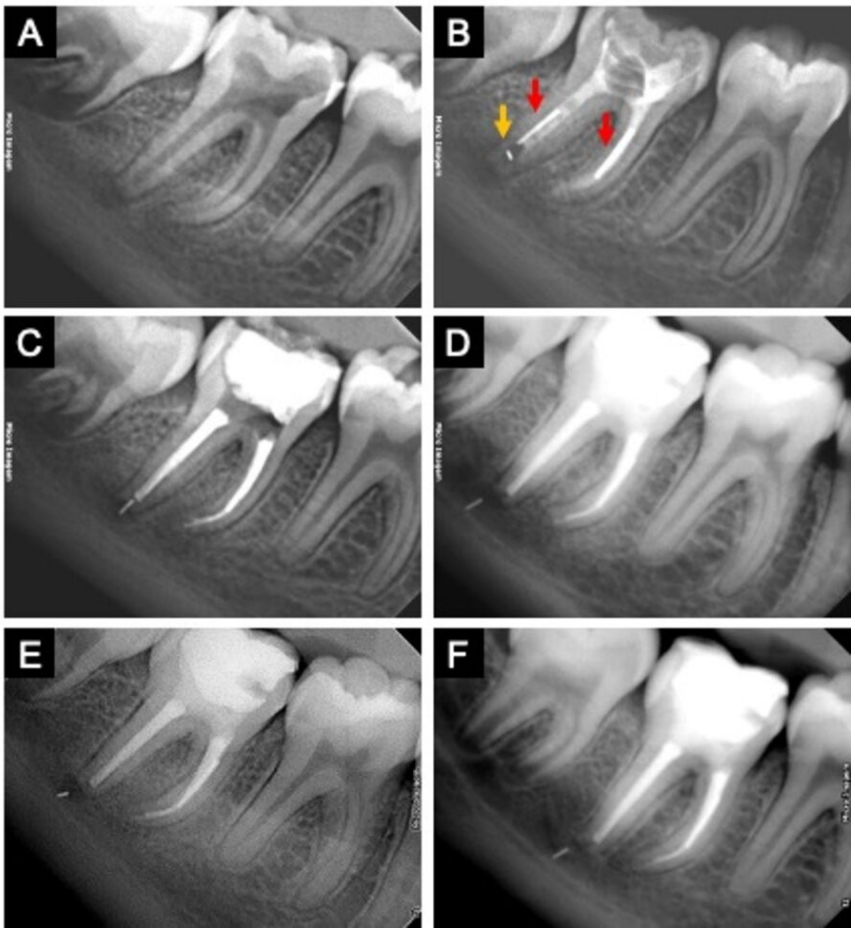

Figure 2. Radiographic images of case 2: A) Preoperative radiograph of the right mandibular second molar (tooth 47) showing periapical radiolucent lesion; B) Radiograph after biomechanical instrumentation showing a fragment of the XP-Clean instrument (yellow arrow) within the distal canal and fragments of ultrasonic inserts (red arrows) within the mesiobuccal and distal canals; C) Radiograph after endodontic root canal filling; D) 6-month follow-up; E) 12-month follow-up; F) 18-month follow-up showing bone repair in the periradicular area.

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Abordagem interdisciplinar em molares de pacientes jovens, o desafio para evitar a extração prematura: Relato de Casos

Interdisciplinary procedures on molars of young patients, the challenge to avoid premature extraction: Case Reports.

Thaís Christina Cunha, Carlos José Soares, Priscilla Barbosa Ferreira Soares, Marco Aurélio Gagliardi Borges, Camilla Christian Gomes Moura

RESUMO

O tratamento reabilitador de molares jovens severamente destruídos por cárie, pode ser extremamente desafiador mesmo para profissionais mais experientes, necessitando de atendimento integrado que envolva intervenção endodôntica, periodontal e restauradora. Este artigo apresenta relato de dois casos clínicos que envolveram condução clínica bem-sucedida em molares de adolescentes, severamente destruídos por cárie com lesão periapical, enfatizando protocolos interdisciplinares com acompanhamento de 1 ano. Dois pacientes do sexo masculino, 14 e 17 anos, foram atendidos no projeto de extensão de intervenção integrada na hebiatria sendo submetidos ao tratamento endodôntico dos dentes 46 e 36. Após preparo biomecânico realizado com sistema automatizado TF Adaptive (SybronEndo, Orange, CA, EUA), a limpeza e desinfecção foi completada com limas XP Endo Finisher (FKG Dentaire SA, Suiça) e irrigação final com pontas de ultrassom. Após 14 dias de curativo de demora com hidróxido de cálcio, os canais foram obturados e os dentes restaurados com restauração direta em resina composta bulk-fill (Opus Bulk Fill APS, FGM). Reparo ósseo periapical e ausência de sinais e sintomas foram observados após 6 meses e 1 ano. O protocolo apresentado favoreceu a manutenção de molares jovens após um ano de proservação.

Palavras-Chave: Endodontia, preparo do canal radicular, resina composta, resultados clínicos.

ABSTRACT

The rehabilitation of young molars teeth severely affected by caries is great challenging even for experienced professionals, requiring integrated endodontics, periodontal and restorative procedures. This paper presents two clinical cases of successful protocols for treating molar of adolescents, severely compromised by caries with periapical lesions,

emphasizing interdisciplinary procedures with 6 months and 1 year follow-up. Two male patients, 14 and 17 years old, underwent root canal treatment of teeth right mandibular molar and left mandibular molar. After carrying out the biomechanical preparation with the automated TF Adaptive system (SybronEndo, Orange, CA, EUA), the cleaning and disinfection process was complemented with the XP Endo Finisher files (FKG Dentaire SA, Switzerland) and final irrigation protocols with the aid of ultrasound tips. After 14 days of calcium hydroxide dressing, the root canals were filled with sealer and gutta-percha, than the teeth were restored with bulk-fill composite resin (Opus Bulk Fill APS, FGM) restorations. Bone periapical neoformation and no signs and symptoms were observed after 6 months and 1 year of follow-up. The presented protocols resulted in properly maintenance of the structural compromised molar teeth in after one year of observation.

Keywords: Endodontics, root canal preparation, synthetic resin, treatment outcome.

INTRODUÇÃO

A despeito da considerável redução dos índices de cárie observados em vários países[1,2,3], essa é ainda uma realidade que acomete de forma marcante a população de baixa renda, sobretudo em países subdesenvolvidos[4,5,6]. Se não tratada precocemente, a cárie dental poderá gerar grande comprometimento estrutural, atingindo a polpa e consequentemente os tecidos perirradiculares[7]. Devido a fatores socioeconômico e culturais, os responsáveis, muitas vezes, negligenciam o tratamento de cáries em crianças e adolescentes, levando a perda prematura dos primeiros molares, e consequentemente a problemas oclusais, de desenvolvimento do aparelho estomatognático e de eficiência mastigatória[8].

O fato de a família geralmente procurar tratamento apenas quando o dente apresenta comprometimento pulpar, resultando em dor espontânea e elevada destruição torna necessário a realização de tratamento endodôntico radical[7]. A reabilitação da função mastigatória desses dentes com pouca estrutura coronária dental remanescente, representa desafio operacional com prognóstico incerto [7]. As dificuldades técnicas para realização do tratamento endodôntico, na fase hebiátrica, vão desde a complexidade na instalação do isolamento absoluto, instrumentação e obturação de canais geralmente amplos, além da baixa colaboração do paciente[9].

Atualmente o uso de instrumentos rotatórios de níquel titânio domina a prática endodôntica. Porém, estes instrumentos não foram desenvolvidos para canais amplos, pois apresentam diâmetro apical inferior a 0.5 mm, limitando o preparo em molares jovens. Dessa forma, a lima apical final de diferentes sistemas não trabalha adequadamente as paredes dentinárias na região próxima ao ápice em dentes jovens, necessitando complementação do preparo biomecânico. Recentemente, uma nova lima, XP-Endo Finisher (# 25 /.00, XPF, FKG Dentaire, La Chaux de Fonds, Suíça), foi introduzida como instrumento universal complementar ao preparo radicular, completando a limpeza de canais com morfologias complexas em regiões de difícil acesso[10,11].

Dessa forma, o objetivo desse artigo foi apresentar dois casos de gerenciamento de protocolo integrado bem-sucedido de dentes molares permanentes de pacientes jovens, severamente destruídos por cárie com lesão periapical em que se utilizou a lima XP Endo Finisher como recurso auxiliar, seguida da restauração direta com resina composta bulk fill para reabilitação da função mastigatória com recuperação biomecânica satisfatória imediata.

RELATO DE CASOS

Este relato de caso foi construído de acordo com as diretrizes da CARE 2013[12]. Os pais dos pacientes assinaram termo de consentimento livre e esclarecido, autorizando a realização do tratamento e a publicação do caso e de quaisquer imagens que os acompanhem. Dois pacientes do sexo masculino de 14 e 17 anos foram submetidos a tratamento endodôntico nos molares inferiores direito (dentes 46, caso 1) e esquerdo (dentes 36, caso 2). A análise detalhada do histórico médico e odontológico dos pacientes não revelou doença sistêmica e condições bucais contributivas. Os exames intra-orais mostraram presença de cárie com extensa perda de estrutura dentária, e ausência completa de pelo menos duas paredes coronárias (Figura 1A). Os testes diagnósticos revelaram respostas negativas aos testes de sensibilidade pulpar e palpação na região apical, ausência de mobilidade patológica, mas ambos relataram respostas ligeiramente exacerbadas à percussão. O exame radiográfico revelou lesões radiolucentes periapicais (Figuras 2A e 1B), estado pulpar e perirradicular com necrose pulpar e periodontite apical assintomática, respectivamente.

No caso 2 (dente 46), após avaliação integrada das áreas de periodontia, endodontia e restauradora, foi verificada necessidade de restabelecimento do espaço biológico e reconstrução coronária para permitir isolamento absoluto adequado. Dessa forma, primeiramente foi realizada remoção do tecido cariado com instrumento manual e broca carbide esférica n° 3 de baixa rotação (KG Sorensen, Barueri, SP, Brasil) de haste longa, compatível com a anatomia da câmara pulpar. Após refinamento da abertura coronária a neutralização dos condutos foi realizada com NaOCl 2,5% (Rioquímica Ltda., São José do Rio Preto, SP, Brasil) sob isolamento relativo. A entrada dos condutos foi preenchida com pasta de hidróxido de cálcio (UltraCalTM XS, Ultradent Products Inc., South Jordan, UT, EUA), inserção de bolinha de algodão estéril, e selamento provisório com ionômero químico Vidrion R (SS White, Rio de Janeiro, Brasil). Tal procedimento é recomendado previamente a realização de cirurgias periodontais e restaurações transcirúrgicas a fim de se evitar a agudização do quadro clínico após a intervenção. Devido à extensa perda de estrutura dentinária na região lingual com invasão das distâncias biológicas, foi realizada cirurgia à retalho para aumento de coroa clínica e reconstrução coronária imediata com resina composta em restauração transcirúrgica (Figura 2B). Foi realizado condicionamento ácido seletivo com ácido fosfórico a 37% (Condac 37, FGM, Joinville, SC, Brasil) por 30 segundos, seguido da lavagem com jato de ar água e secagem com papel absorvente. O sistema adesivo autocondicionante de frasco único (Ambar Universal APS, FGM) foi aplicado em duas camadas, seguido de leve jato de ar e fotoativação por 20 segundos com fonte de luz multi espectro VALO GRAND (Ultradent, South South Jordan, UT, EUA) que apresenta irradiância de 1200mW/cm2, checada com sistema MARC Resin Calibrator (BlueLight, Halifax, Canada). A resina bulk fill (Opus Bulk Fill APS, FGM) foi inserida em incremento único e fotoativada com 40 segundos. Em sessão clínica posterior, houve continuidade do tratamento endodôntico.

Os tratamentos dos canais radiculares dos dois casos foram executados por um único e experiente operador, utilizando anestesia local com lidocaína a 2% com epinefrina 1: 100.000 (Alphacaine; DFL Indústria e Comércio Ltda, Rio de Janeiro, Brasil) e isolamento absoluto. Primeiramente, foi realizado "Glide path" com limas manuais tipo Kerr 10 e 15 (Dentsply Maillefer, Ballaigues, Suíça) e NaOCl a 2,5% (Rioquímica Ltda., São José do Rio Preto, SP, Brasil). Os comprimentos de trabalho foram determinados com o localizador foraminal RomiApex A-15 (Romidan Ltd.,

Kyriat Ono, Israel) e lima K nº 15 em todos os canais radiculares. A instrumentação foi realizada a 1 mm do comprimento estimado do canal radicular, usando o sistema Twisted File Adaptive (TF) até a lima SM3 (#35/.04, SybronEndo, Orange, CA, EUA) acoplada ao motor Elements (SybronEndo) em movimento adaptativo, de acordo com o protocolo do fabricante, sob irrigação abundante com NaOCl a 2,5% (Rioquímica Ltda., São José do Rio Preto, SP, Brasil). Finalizada a instrumentação, a lima XP Endo Finisher (FKG Dentaire SA, Suiça) foi utilizada por 1 minuto, em contínuo movimento de rotação de acordo com as recomendações do fabricante (900 rpm e torque de 1 Ncm), sob irrigação abundante com NaOCl a 2,5%.

A irrigação final de todos os canais foi realizada com 3 mL de ácido etilenodiaminotetracético (EDTA a 17%, Biodinâmica, Ibiporã, PR, Brasil) por 3 minutos, seguido por 6 mL de NaOCl a 2,5% agitados com ponta E1-Irrisonic (Helse Dental Technology, São Paulo, SP, Brasil) em potência mínima, acoplada ao aparelho ultrassom (EMS Piezon Master 200 Ultrassom, EMS, São Bernardo do Campo, SP, Brasil). Posteriormente, realizou-se irrigação com 5 mL de solução de cloreto de sódio a 0,9% (Fresenius Kabi Brasil Ltda, Barueri, SP, Brasil), e secagem dos condutos com pontas de papel absorventes (Dentsply Maillefer, Ballaigues, Suíça) esterilizadas.

A medicação intracanal, pasta pré-fabricada a base de hidróxido de cálcio (UltraCalTM XS, Ultradent Prod, Inc., South South Jordan, UT, EUA), foi inserida em todo comprimento de trabalho permanecendo por 14 dias. Na sessão seguinte, como os dentes estavam assintomáticos, a medicação foi removida por meio de irrigação abundante associada a limas manuais. As raízes foram obturadas por meio da técnica de condensação lateral, utilizando cones de guta-percha (#35/.04, Dentsply Maillefer, Ballaigues, Suíça) e cimento obturador Sealapex (SybronEndo) (Figuras 1C e 2C). Os acessos dos canais radiculares na câmera pulpar foram selados com ionômero de vidro modificado por resina (Riva SDI, São Paulo, SP, Brasil) e então reabilitados com resina composta bulk fill (Opus Bulk Fill APS, FGM) utilizando protocolo descrito anteriormente e limitando os incrementos a 5.0 mm de espessura (Figuras 1D e 2D). Os pacientes não apresentaram sintomas dolorosos e não foi necessário o uso de analgésicos durante e após o tratamento. As sessões de acompanhamento clínico e radiográfico foram realizadas aos 6 meses (Figuras 1E e 2E) e 1 ano após o tratamento (Figuras 1F e 2F). Não foram relatados pelos pacientes sinais e sintomas relacionados

aos respectivos dentes. Imagens radiográficas mostraram neoformação óssea na área perirradicular sugestiva de sucesso do tratamento endodôntico.

DISCUSSÃO

Os relatos de casos ainda apresentam grande relevância na literatura endodôntica, especialmente quando envolvem problemas clínicos com impacto social significante. Por meio desse tipo de relato, há a possibilidade de translação de evidências científicas que suportam tomadas de decisão de clínicos. O tratamento endodôntico-reabilitador de molares jovens, em faixa etária não mais considerada pediátrica e nem incorporada a clínica integrada de adultos é frequentemente negligenciada e pouco discutido na literatura, seja por meio de estudos laboratoriais ou clínicos[7].

Reabilitar dentes de pacientes jovens com lesões periapicais e grande perda de estrutura dentária, com prognóstico incerto, se caracteriza como grande desafio ao cirurgião-dentista. Além das dificuldades técnicas relacionadas ao tratamento endodôntico de molares jovens, as quais são pouco discutidas na literatura[8], tem-se também o desafio restaurador, que deve sempre buscar simplificação técnica e baixo custo[13]. No caso clínico 2, foi também necessária a realização de cirurgia periodontal a fim de restabelecer o espaço biológico, permitir reconstrução coronária e realização de adequado isolamento absoluto. A realização de restaurações transcirúrgicas por vezes é necessária nesses pacientes hebiátricos, como verifica-se na prática clínica do programa de extensão em Hebiatria da FOUFU, fazendo com o atendimento tenha que ser realizado de forma integrada e multidisciplinar.

Na prática endodôntica, com o uso cada vez mais frequente de sistemas automatizados, os quais não foram desenvolvidos com a especificidade para tratamentos de canais amplos, a instrumentação rotatória em molares jovens pode ser ineficiente, pois a lima pode não atuar adequadamente no terço apical. Considerando que a seleção das limas deve ser baseada na escolha da lima apical inicial, com posterior ampliação de pelo menos três instrumentos de numeração acima dessa[14,15]. Verificamos na rotina de nosso programa de extensão em Hebiatria que a execução de tal conceito é por muitas vez impraticável em molares jovens. Nos dois casos apresentados, a última lima do sistema TF adaptive com diâmetro apical 0.35 mm não trabalhou de forma suficiente no terço apical. Assim, empregamos como alternativa para limpeza dos canais as limas de acabamento anatômico (XP-Endo Finisher e XP-Clean). Estas foram desenvolvidas para

serem utilizados na limpeza final dos canais radiculares após qualquer técnica de instrumentação, a fim de remover detritos e microrganismos em áreas inacessíveis aos instrumentos convencionais[11]. Especificamente, nos casos relatados, a lima XP-Endo Finisher foi escolhida como estratégia para finalizar o preparo do sistema de canais radiculares, objetivando o acesso e limpeza das regiões não tocadas e que poderiam estar associadas à presença e/ou manutenção das lesões periapicais.

XP-Endo Finisher (# 25/.00) são instrumentos fabricados com a liga NiTi (MaxWire®) e que, segundo o fabricante, é um material altamente flexível e que reage a diferentes níveis de temperatura. Essas limas aumentam o poder de limpeza da solução de irrigação por agitação mecânica, por meio de ação de "chicotear", eliminando detritos e microrganismos remanescentes devido ao contato mecânico com as paredes internas dos canais[16,17,18]. Além disso, elas também possuem a capacidade de remover medicação intracanal[19,20,21], biofilme[22], bem como evitar extrusão apical de NaOCl[23]. Seu uso nos casos clínicos descritos parece ter impactado positivamente no resultado do tratamento endodôntico, uma vez que em ambos os casos, as lesões regrediram completamente. Outro fator de relevância atualmente é a agitação de soluções irrigadoras por meio da oscilação livre de pontas ultrassônicas com frequência de 25-30 kHz, capaz de gerar cavitação e fluxo acústico que contribuem para a eficiência da limpeza durante a irrigação do canal radicular[24,25].

Em relação a medicação intracanal, optou-se pelo $Ca(OH)_2$, o qual ainda é considerado padrão ouro pela literatura em casos de dentes com lesão periapical associada[26,27]. É importante notar na imagem radiográfica do caso 1, que após toda remoção do tecido cariado, a espessura dentinária no assoalho ficou bastante reduzida e com sugestão do comprometimento da furca. Porém aos 6 meses de acompanhamento, a imagem já aponta o completo reparo nessa região, demonstrando que o tratamento empregado foi extremamente efetivo e confirmando que a associação das tecnologias atualmente disponíveis na endodontia promove descontaminação adequada sem necessidade de várias trocas de medicação intracanal[28]. Embora pesquisas clínicas indiquem ausência de diferenças significativas quanto ao índice de sucesso de dentes com lesões periapicais obturados em sessão única ou duas sessões, esse é ainda um tema controverso na endodontia[29,30].

Em relação a alternativa reabilitadora, coroas totais apresentam baixa indicação nessa faixa etária, uma vez que o indivíduo ainda apresenta crescimento facial. No entanto, as resina híbridas convencionais demandam maior tempo pela inserção em vários incrementos, com isso, resinas bulk fill surgiram como alternativa para esses casos[13,31,32,33] mostrando desempenho mecânico e estético satisfatório[34,] sendo executadas em uma única sessão, com menor custo que as restaurações indiretas.

CONCLUSÃO

Os dois casos apresentados mostraram que é possível tratar de forma adequada e conservadora molares de pacientes hebiátricos com extrema destruição coronária, mantendo o dente em função na cavidade oral, e que as tecnologias atualmente disponíveis na endodontia associadas a restaurações diretas bulk fill favorecem estes tratamentos.

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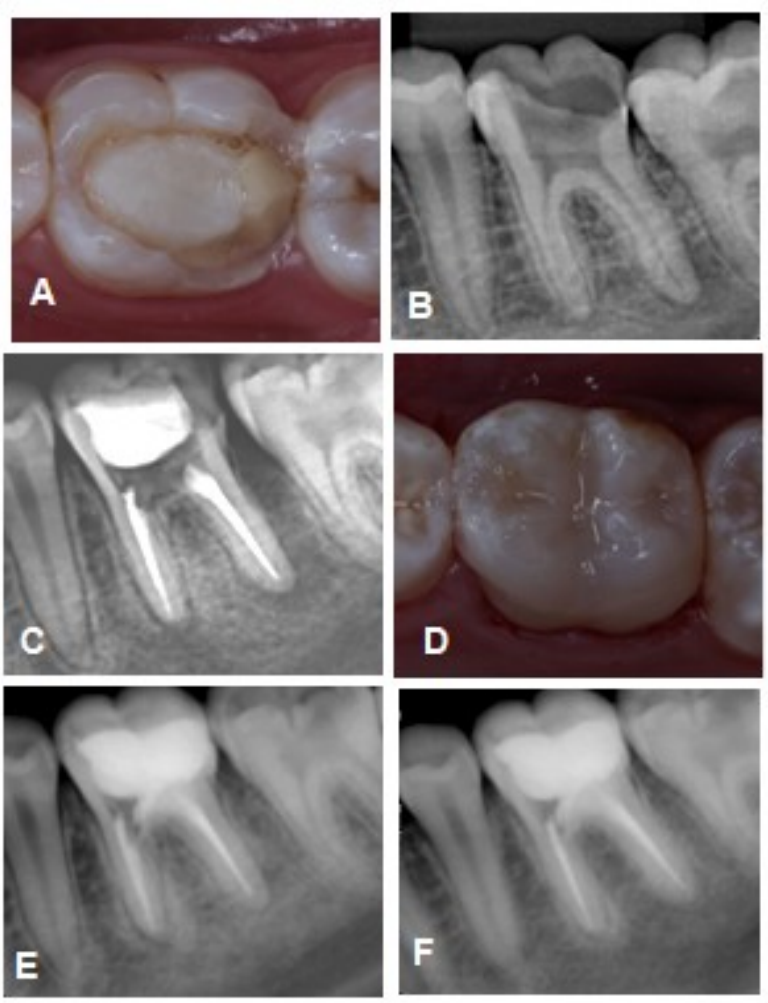

Figura 1: Caso clínico 1; A. Imagem inicial do dente com cárie extensa resultando em comprometimento estrutural; B. Radiografia Inicial evidenciando área radiolúcida periapical na raiz distal; C. Radiografia final evidenciando área radiolúcida apical nas duas raízes e reduzida espessura dentinária no assoalho da cavidade; D. Dente reconstruído com resina composta bulk fill após tratamento endodôntico; E. Radiografia de controle após 6 meses, evidenciando reparo completo da lesão na raiz distal; F. Radiografia de controle após 1 ano mostrando dente completamente reparado.

Figura 2. Caso Clínico 2: A. Radiografia Inicial evidenciando área radiolúcida na região de furca e periápice da raiz mesial; B. Radiografia após realização de restauração transcirúrgica e reconstrução do dente em resina composta bulk fill; C. Radiografia final demonstrando ligeira extrusão de cimento obturador; D. Dente reconstruído após tratamento endodôntico; E. Radiografia de controle após 6 meses mostrando completo reparo em ambas as raízes; F. Radiografia de controle após 1 ano, material extravasado permanece próximo ao periápice com manutenção do reparo apical e na região de furca.

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