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PULPOTOMY TREATMENTS AND PULP PRESERVATION STRATEGIES IN IMMATURE PERMANENT TEETH: A CASE SERIES

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ABSTRACT

Pulpotomy, a vital pulp therapy, is a treatment procedure performed in immature permanent teeth with reversible or irreversible pulpitis to preserve tooth vitality and promote continued root development. This case series shares the 18-month long-term follow-up results of pulpotomy procedures involving varying depths of pulp tissue removal. Teeth with

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reversible or irreversible pulpitis and open apices in patients aged between 7 and 9 years were treated using different pulpotomy techniques as miniature, partial or copmlete. After an 18-month follow-up, it was observed that all teeth exhibited healthy continuation of root development, with no clinical or radiographic evidence of pathology. The primary factors in determining which technique to use are the characteristics of the pulpal bleeding and the results of the visual evaluation of the pulp.

KEYWORDS: Pulpotomy; Irreversible pulpitis; Reversible pulpitis; Immature teeth; Root development.

TRATAMIENTOS DE PULPOTOMÍA Y ESTRATEGIAS DE PRESERVACIÓN PULPAR EN DIENTES PERMANENTES INMADUROS: UNA SERIE DE CASOS

RESUMEN

La pulpotomía, una terapia pulpar vital, es un procedimiento de tratamiento realizado en dientes permanentes inmaduros con pulpitis reversible o irreversible, con el objetivo de preservar la vitalidad del diente y promover el desarrollo continuo de la raíz. Esta serie de casos presenta los resultados del seguimiento a largo plazo (18 meses) de procedimientos de pulpotomía que implicaron diferentes profundidades de remoción del tejido pulpar. Se trataron dientes con pulpitis reversible o irreversible y ápices abiertos en pacientes de entre

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7 y 9 años utilizando diferentes técnicas de pulpotomía: miniatura, parcial o completa. Tras 18 meses de seguimiento, se observó que todos los dientes mostraron una continuación saludable del desarrollo radicular, sin evidencia clínica ni radiográfica de patología. Los factores principales para determinar qué técnica utilizar son las características del sangrado pulpar y los resultados de la evaluación visual del tejido pulpar.

PALABRAS CLAVE: Pulpotomía; Pulpitis irreversible; Pulpitis reversible; Dientes inmaduros; Desarrollo radicular.

INTRODUCTION

Immature permanent teeth are characterized by short clinical crowns, wide pulp chambers, thin dental hard tissues, incomplete occlusal relationships, underdeveloped short roots, and open apical foramina. Typically, root development is completed within 3-5 years after eruption. However, during the immature stage, damage to the pulp caused by factors such as caries or trauma can lead to cessation of root development. Furthermore, performing root canal treatment (RCT) on these teeth is challenging due to the presence of open apical foramina. To address this, Vital Pulp Therapy (VPT) techniques have been developed to ensure both the preservation and continuity of pulp vitality in immature teeth (1). According to the American Association of Endodontists (AAE), the health status of a

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vital pulp is evaluated in three groups: normal, reversible and irreversible pulpitis (2). In reversible pulpitis, there is a history of short-duration, stimulus-induced pain that subsides once the stimulus is removed, whereas in irreversible pulpitis, there is a history of spontaneous pain occurring without any stimulus (3).

Studies have shown that the pulp tissue in immature teeth demonstrates a higher capacity for regeneration and repair compared to that in mature teeth (1). Traditionally, VPTs have been employed in teeth with deep caries and include the following procedures: indirect pulp capping, where the pulp remains unexposed, and the remaining dentin close to the pulp is covered with a biocompatible material; direct pulp capping, involving the treatment of minor pulp exposures with hemostasis followed by covering the exposed area; partial pulpotomy, where 1–3 mm of damaged coronal pulp tissue is removed and covered; and complete pulpotomy, which entails the removal of the entire coronal pulp tissue while preserving and covering the pulp tissue in the root (2, 3). The miniature pulpotomy, a recently defined procedure in the literature and incorporated into clinical practice, involves the removal of superficial pulp tissue and damaged odontoblast cells to a depth of less than 1 mm from the site of pulp exposure. Compared to direct pulp capping, the anticipated advantages of this technique include the creation of a

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cleaner surgical wound surface, improved hemostasis, increased proximity of the biocompatible material to undifferentiated mesenchymal cells, and enhanced three-dimensional coverage of the pulp tissue (4, 5). The success of VPTs depends on the health and healing capacity of the remaining pulp tissue, the achievement of effective hemostasis, the use of biocompatible materials, and the establishment of a bacteria-tight seal (5). The aim of this case series is to share the long-term outcomes of different pulpotomy techniques within VPT in immature teeth with reversible and irreversible pulpitis.

Case Presentation

This study was prepared following the Preferred Reporting Items for Case Reports in Endodontics (PRICE) 2020 guidelines (Figure 1) (6). None of the patients had any systemic diseases. All treatments were performed by the same clinician under proper isolation conditions. During the procedures, 5% sodium hypochlorite solution (Microvem, Istanbul, Türkiye) was used to control pulpal bleeding. Mineral trioxide aggregate (Nexobio MTA CEM, Chungcheongbuk-do, Korea) was applied as a biomaterial for pulp sealing. Glass ionomer cements (Imicryl, Istanbul, Türkiye) and stainless steel crowns (SSC) (Shinhung Kids Crown, Namdong, Korea) were utilized for restorations.

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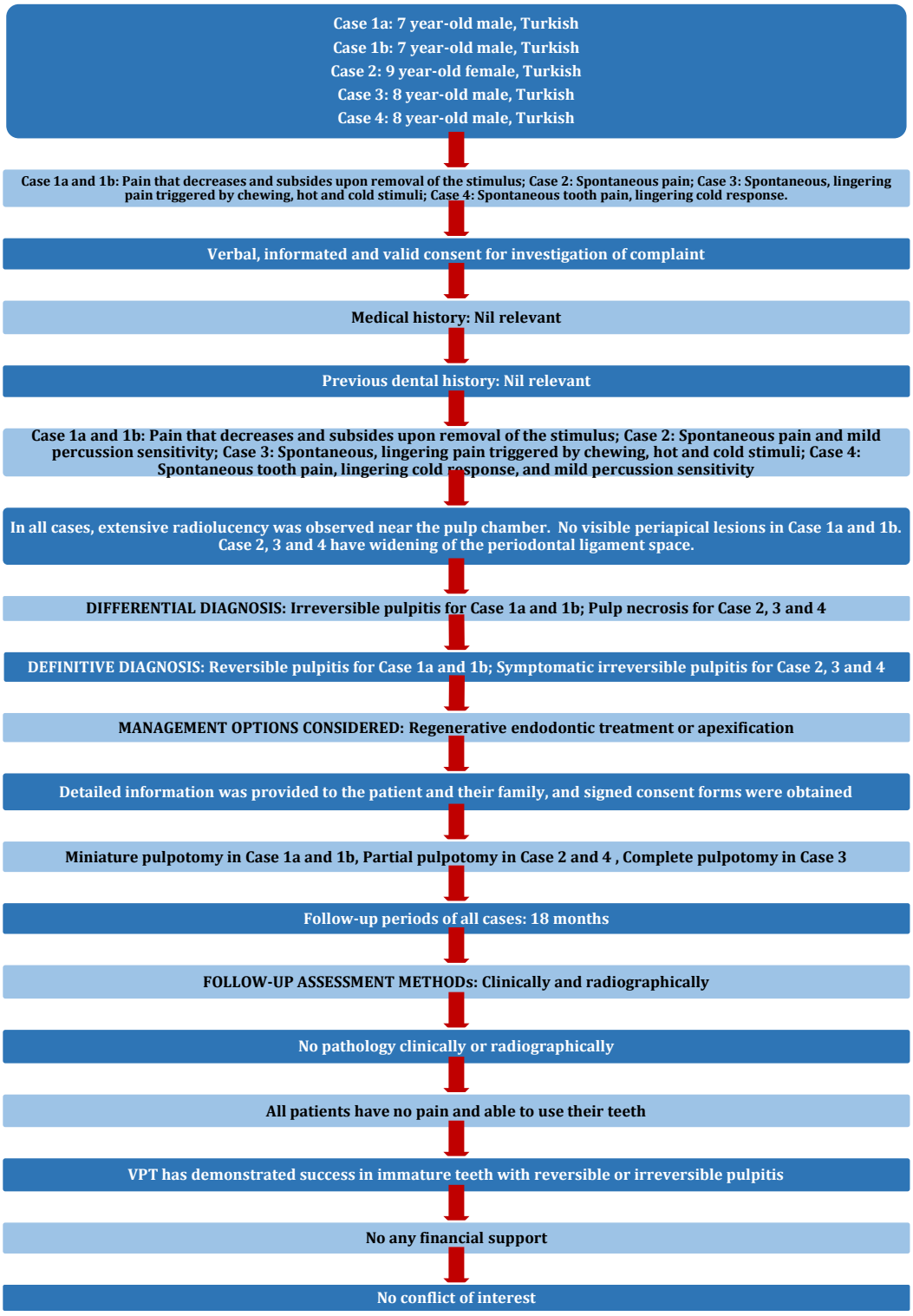

Figure 1. This flow chart follows the PRICE 2020 guidelines for the case series in endodontics. (http://pride-endodonticguidelines.org/price/).

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Case 1

A 7-year-old male patient presenting with pain relieved upon removal of cold and hot stimuli in both #36 and #46, was diagnosed with reversible pulpitis. A miniature pulpotomy procedure was performed in both teeth, and the restorations were completed in the same session.

Case 2

A 9-year-old female patient presented with spontaneous pain and mild percussion sensitivity in #36, which was diagnosed as symptomatic irreversible pulpitis. Following a partial pulpotomy, the restoration was completed in the same session.

Case 3

An 8-year-old male patient reported pain that is spontaneous, lingering provoked by chewing, and triggered by hot and cold stimuli and severe enough to disturb sleep at night in #36. The tooth was diagnosed with symptomatic irreversible pulpitis. A complete pulpotomy procedure was performed, and the restoration was completed in the same session.

Case 4

An 8-year-old male patient presented with spontaneous tooth pain, a lingering response to cold stimulus, and mild percussion sensitivity in #46, which was diagnosed as symptomatic irreversible pulpitis. An increase in the periodontal ligament space is observed on the radiograph. A partial pulpotomy

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procedure was performed, and the restoration was completed in the same session.

At the 18-month follow-up, no intraoral or extraoral pathology was observed in any of the teeth, and complete root development was confirmed. The cases' details are provided in Table 1, and the initial and follow-up radiographs are displayed in Figure 2.

Table 1. Details of the cases.

Case	Gender	Age	Tooth	Syptoms	Pulp status	Treatment
Case 1a	Male	7	#46	Pain that decreases and subsides upon removal of the stimulus	Reversible pulpitis	Miniature pulpotomy
Case 1b	Male	7	#36	Pain that decreases and subsides upon removal of the stimulus	Reversible pulpitis	Miniature pulpotomy
Case 2	Female	9	#36	Spontaneous pain and mild percussion sensitivity	Irreversible pulpitis	Partial pulpotomy
Case 3	Male	8	#36	Spontaneous, lingering pain triggered by chewing, hot and cold stimuli	Irreversible pulpitis	Complete pulpotomy
Case 4	Male	8	#46	Spontaneous tooth pain, lingering cold response, and mild percussion sensitivity	Irreversible pulpitis	Partial pulpotomy

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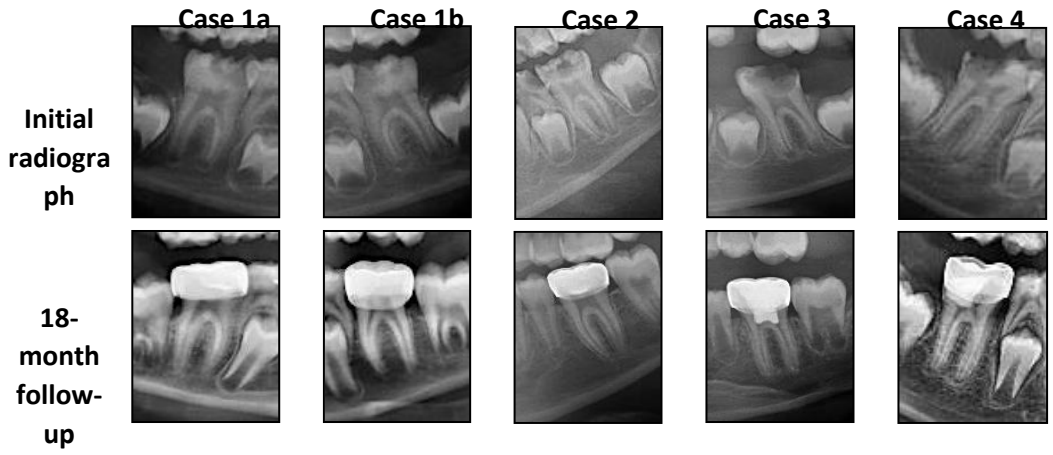

Figure 2. The initial and 18-month follow-up radiographs.

Discussion

Pulpitis refers to the inflammation of the pulp tissue caused by factors such as caries, trauma, and other insults. Historically, RCT was considered the sole therapeutic option for pulpitis. However, in cases of partial pulp inflammation, particularly in immature teeth, VPT was developed to preserve pulp vitality and allow for continued root development. Traditionally, VPT techniques have been classified based on the extent of pulp intervention and tissue removal into indirect or direct pulp capping, partial pulpotomy, and complete pulpotomy (1, 2, 7). Recently, a novel technique termed miniature pulpotomy, positioned between direct pulp capping and partial pulpotomy, has been introduced in the literatüre (4, 5). In this case series, we

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aim to contribute to the existing body of knowledge by presenting various pulpotomy techniques described in the literature along with their long-term follow-up outcomes.

Studies have shown that VPT have higher success rates compared to root canal treatment and can even be applied to mature teeth with irreversible pulpitis. However, evidence regarding which VPT technique yields the best results remains insufficient. It has been suggested that factors such as the severity of pulp damage, spontaneous pain, the intensity of pain on percussion, the type of pulp dressing materials used, and the integrity of the final restoration can influence the treatment outcome. It is emphasized that complete pulpotomy may provide a more definitive solution depending on the severity of pulp damage. Although the presence of periapical lesions is traditionally viewed as a contraindication for VPT, evidence supporting this claim is also inadequate (7). Inflammation in the pulp can affect the periapical tissues, leading to widening of the periodontal ligament space and the formation of lesions. Changes in the periapical region represent a local immune response of the pulp. Neurogenic inflammation, associated with increased osteoclast activity, can result in bone destruction and widening of the periapical ligament space before total pulp necrosis occurs. In such cases, vital pulp tissue may still be present in the tooth (8). In the initial radiographs of Case 2, Case 3, and Case 4

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in this case series, widening of the periapical ligament space at the apical regions of the roots was observed. However, the differential diagnosis also considered the possibility of open apex. Due to the presence of percussion sensitivity, it was concluded that the teeth had apical periodontitis. Long-term follow-up revealed no lesions or pathology in these teeth.

The VPT is heavily influenced by clinical diagnosis, the condition and severity of pulp inflammation, the extent of caries in the tooth, a detailed visual examination of the pulp, the pulp dressing material used, and the restoration performed (7, 9). Although it has been stated that the duration of bleeding control and the color of the blood are important in determining the health of the pulp, there is insufficient evidence in the literature to suggest that these factors affect the treatment outcome and more research is needed (10). In this case series, in Case 1a and 1b, miniature pulpotomy was preferred over direct pulp capping to create a clean surgical wound surface and achieve better healing. In Case 2 and Case 4, after caries removal, pulp exposure occurred, and as bleeding could not be controlled, a portion of the coronal pulp was removed to achieve hemostasis, followed by partial pulpotomy. In Case 3, after complete removal of the coronal pulp tissue, bleeding was controlled and complete pulpotomy was performed. Additionally, a detailed visual examination of the pulp was conducted in all teeth to determine

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the appropriate treatment type. Due to significant substance loss in the teeth, SSC were chosen to ensure better sealing of the restoration.

Conclusions

Pulpotomy treatments performed on immature permanent teeth with reversible or irreversible pulpitis, involving the removal of affected pulp tissue, are VPT procedures that help preserve pulp vitality and ensure continued root development.

Declarations

Ethics and integrity statement

All the clinical examinations described in the manuscript have been carried out in compliance with the principles outlined in the Declaration of Helsinki and its subsequent revisions, or equivalent ethical guidelines.

Patient consent statement

In this case report, detailed information was provided to the patient and their family, and signed consent forms were obtained before the treatment.

Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Authors contributions

M.K. and B.K.–investigation; M.K. and B.K.–methodology; M.K. and B.K.–visualization; M.K. and B.K. writing original draft; M.K. and B.K.-conceptualization; M.K-project administration; M.K-drafting and critical revision of the manuscript. All listed authors have approved the manuscript before submission, including the names and order of authors.

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