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CASE REPORT

Regenerative Endodontic Procedure in Korean Children and Adolescents: A Case Report

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한국 소아청소년 근관치료 영역에서 재생치료, 근관치료재생술에 대한 증례보고

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Mineral trioxide aggregate (MTA) is widely used in endodontic therapy as a pulp-capping material, root or furcal perforation repair material, and for apexification and obturation of the root canal system. The purpose of this study was to formally document cases of MTA application in South Korean children and adolescents. Through this research, the practice of using MTA will be introduced and familiarized to the clinical practitioners. This study involved endodontic treatment using MTA for fractured crowns in 11- and 12-year-old. The children were followed up for 12 months until the pulp vitality was confirmed; in young permanent teeth with immature roots, the pulp is integral to the process of apexogenesis. These observational results regarding the use of MTA as an apexification material in non-vital immature permanent incisors appear to provide promising results in the search for new materials to meet existing endodontic needs.

Key Words: Immature permanent tooth, Mineral trioxide aggregate, Ortho mineral trioxide aggregate, Regenerative endodontic procedure

Introduction

Treatment of immature permanent teeth with pulp necrosis and apical pathosis constitutes a challenge for endodontists. Teeth with a necrotic pulp are commonly encountered in cases of trauma to the anterior teeth or untreated carious lesions. Such conditions are challenging, not only in root canal debridement and filling, but also for the thin dentinal walls increasing the risk of subsequent fracture[1)]. The standard treatment for permanent teeth with apical lesions and pulp necrosis has been apexificational. In 2009, Bose et al.[2)] proposed the term regenerative endodontic procedure (REP). In histological terms, REP refers to the treatment for the recovery of damaged dentin and root. In 2010, Lee[3)] proposed that the case of regeneration is limited at the field of endodontics. REP in immature teeth involves copious irrigation without instrumenting the root canal, followed by the application of antimicrobial agents and placement of a biocompatible filling over the initiated blood clot to preserve the remaining apical vital pulp tissue[4)].

The focus of REP is the anatomical transition of immature permanent teeth that have received some trauma. After removal of the inflammatory tissue, the live tissue is really

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live, infected pulp tissue or healthy apical tissue, which fully enables root formation to be investigated by further study. The purpose of apexification is to protect the open apex against bacterial infection, and to accelerate the formation of the apical barrier. In conventional root canal treatment of immature teeth, the thin and brittle dentin and the large, wide apical canal make the maneuvering of the instruments difficult, and the root canal is not completely sealed. Hence, for immature teeth, calcium hydroxide is used as the apexification material[5]. However, calcium hydroxide has a number of limitations, including variable treatment duration ranging from 5 to 20 months, unpredictable apical closure with respect to treatment duration, an increased risk of tooth fracture, and poor patient compliance with follow-up because of the prolonged treatment duration, all of which can adversely affect treatment outcomes[6,7]. The field of biomaterials is in the midst of the largest transition in its history in terms of the development of new and exciting technologies. Older academics and clinicians may view this change as the death of conventional dental materials, but for most others, this change signals the birth of true biomaterials[8].

The biologic principles of endodontic treatment have been well established. Ongoing efforts to improve the outcome of endodontic treatment will drive the continued development of new materials. Conversely, knowing the outcomes of the clinical use of materials can facilitate research for the development of new and better endodontic materials. Mineral trioxide aggregate (MTA) has been shown to provide superior sealing and biomineralization ability; it is used as an apical barrier for teeth with immature apices, repair of root perforations, root-end filling, pulp capping, and pulpotomy procedures[9]. Torabinejad and Chivian[10] had proposed the use of MTA to achieve apexification in a single visit, to replace calcium hydroxide apexification. Compared to calcium hydroxide, MTA has better biocompatibility, better leakage prevention ability, and requires fewer visit, at the point of increasing root fracture persistence is more compatible to apexification[11,12].

Because of the favorable clinical properties of MTA, recently various MTA products have been developed and

Fig. 1. Clinical photograph and periapical radiograph of Case 1. (A) Intra-oral photograph showing a fractured tooth of permanent maxillary left incisor at first visit, (B) radiographic image showing an open apex associated with widespread periapical radiolucent lesion of tooth #21, (C, D) endodontic procedure using gutta percha cone with OrthoMTA on tooth #21, (E) intra-oral photograph after treatment, (F~H) periapical view at after treatment, 6- and 12-month follow-up.

are commercially available. These include MTA-angelus (Angelus, Londrina, Brazil), Bioaggregate (Innovative Bioceramics, Vancouver, BC, Canada), Micromega MTA (Micromega, Besanchon, France), and Biodentine (Septodont, Saint-Maur-Des-Fosses, France). MTA products such as OrthoMTA (BioMTA, Seoul, Korea) and Endo CEM (Maruchi, Wonju, Korea) are available in the domestic market. OrthoMTA is a newly developed MTA cement for root canal obturation, composed mainly of tricalcium silicate and containing less heavy metal than the original ProRoot MTA (Dentsply, Tulsa, OK, USA).

There have been several reports of REP in children and adolescents. In this report, we present a case of successful continuous root development achieved by the use of a revascularization protocol in an immature permanent incisor with necrotic pulp.

The study was approved by the College of Dentistry, Wonkwang University Hospital Authority Bioethics Committee (W1511/004-001).

Case Report

1. Case 1

In October 2012, a 12-year-old boy suffered crown fracture when he bumped into a pillar while playing with his friends at school. The patient's medical history was noncontributory. The fractured segment was reattached with resin. To avoid occlusal contact between incisors, resin was applied to the posterior teeth to raise the bite. For the next 2 months, pulp vitality was tested using the electric pulp test. As pulp death was suspected, it was decided to commence endodontic treatment.

In December 2012, we informed the patient and his guardians that the prognosis was not favorable. A detailed explanation about the treatment plan, which included root canal treatment, was provided to the patient and his parents. Access opening and working length were measured with an electric apex locator and confirmed by radiography. Initially, a #35 K-file (Dentsply) was used as the apical file, and a working length of 23 mm was used. The root canal was filled with gutta percha and MTA. After the

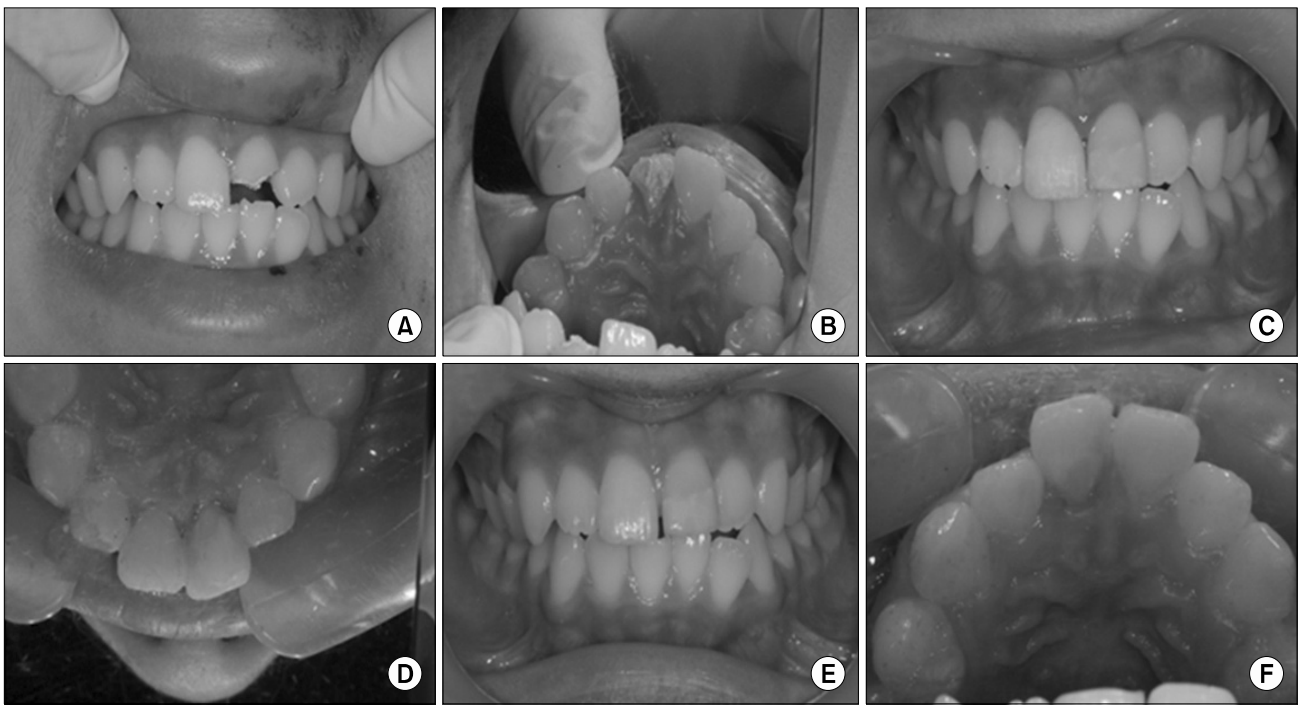

Fig. 2. Clinical photograph and periapical radiograph of Case 2 at first visit. (A) Intra-oral photograph of frontal view, (B) intra-oral photograph of occlusal view of tooth #21, preoperative, (C, D) postperative, (E, F) 10-month follow-up on tooth #11 and 12-month follow-up on tooth #21.

apical portion had been filled, a fiber-reinforced composite (FRC) post was inserted and the core was built up with Luxacore (DMG, Englewood, NJ, USA) and Contax (DMG). Currently, the patient is under regular follow up (Fig. 1).

2. Case 2

In July 2012, an 11-year-old boy suffered crown fracture, leading to the exposure of the pulp of the upper left central incisor. On clinical examination, the fracture lines were found to be extended obliquely, in the labiolingual direction. The patient told us that he fell off a bike while riding downhill the previous day; his medical history was noncontributory. We informed the patient and his guardians that the prognosis was not favorable. A detailed explanation about the treatment plan was provided, which included root canal treatment and the use of FRC posts in the upper left central incisors. Two months later, the patient was admitted for a check-up, whereupon pain and discoloration in the upper right central incisor were observed. Hence, we performed endodontic treatment using OrthoMTA (Fig. 2, 3).

Discussion

MTA was developed at Loma Linda University in the 1990s as a root-end filling material. It was approved by the US Federal Drug Administration, and became commercially available as ProRoot MTA. Recently, MTA has been successfully used as a biomaterial in both surgical and

Fig. 3. Intraoral radiographs. (A) Preoperative, (B) working length measurement of tooth #21, (C) postoperative, (D) radiographic image showing an open apex associated with widespread periapical radiolucent lesion of tooth #11, (E) working length measurement of tooth #11 and 2-month follow-up on of tooth #21, (F) 10-month follow-up on tooth #11 and 12-month follow-up on tooth #21.

nonsurgical endodontics.

The use of MTA is associated with several safety concerns related to the procedure, materials used, and risks posed by failure. There is very little information available regarding these aspects. Efficacy is concerned with the comparative longevity. True long-term estimates of efficacy are obtained from longitudinal clinical trial information[8]. The primary objective of pulp therapy is to maintain the integrity and health of teeth and their supporting tissues. It is a treatment objective to maintain the vitality of the pulp of a tooth affected by caries, traumatic injury, or other causes. Particularly in young permanent teeth with immature roots, the pulp is integral to the process of apexogenesis.

The long-term retention of a permanent tooth requires a root with a favorable crown/root ratio and dentinal walls that are thick enough to withstand normal tooth functioning. Therefore, pulp preservation is the primary goal in the treatment of permanent dentition in young patients. A tooth without a vital pulp, however, can remain clinically functional. The indications, objectives, and type of pulpal therapy depend on whether the pulp is vital or non-vital, based on the clinical diagnosis of normal pulp (symptom-free and normally responsive to vitality testing), reversible pulpitis (pulp capable of healing), symptomatic or asymptomatic irreversible pulpitis (vital inflamed pulp incapable of healing), or necrotic pulp[13,14]. Apexification is a method to induce root end closure in an incompletely formed non-vital permanent tooth by removing the coronal and non-vital radicular tissue just short of the root end, and placing a biocompatible agent such as calcium hydroxide in the canals for 2～4 weeks to disinfect the canal space. Root end closure is accomplished with an apical barrier such as MTA[10]. The developmental mechanism of root formation is very complex. Thorough cleaning of the canal system to render it as free as possible of tissue, bacteria, and bacterial products, followed by complete obturation of the canal system to prevent apical or coronal leakage is essential to create an environment that promotes periradicular healing. Different materials are available to achieve this objective, some having been used for over 100 years. The endodontic materials in use currently include those that have been thoroughly tested by scientific investigation, clinical usage, and time, as well as others that are the result of new developments in the field of dental materials. Knowing the specific qualities of different materials can aid the clinician in selecting those that are appropriate for a given situation.

On the basis of current evidence, MTA seems to be biocompatible. Meticulous studies need to be performed to adopt new endodontic materials into clinical practice. In future reports, we will be describing the clinical and radiographic outcomes of a series of cases involving the use of OrthoMTA in root canal treatment of traumatized teeth with pulp exposure and pulp necrosis. These observational results of the use of MTA as an apexification material in non-vital immature permanent incisors appear promising in the search of new materials to meet existing endodontic needs.

요 약

최근 성장 중인 아동에서 치근의 성장이 계속됨에 따라 치수가 괴사되어 치근의 병변이 있는 미성숙 영구치에서도 치수의 재혈관화(revascularization)가 실제로 일어날 수 있다는 가능성이 제시되고 있다. 소아치과영역에서 자주 접하게 되는 미성숙 영구치의 치근단 형성술의 목적은 열린 치근단에서 세균 침입을 제한하고 치근단 장벽 형성을 촉진하는 것이다. 미성숙 치아의 근관 치료에서 기존의 수산화칼슘을 이용한 치근단 형성술은 빈번한 내원과 장기간 소요되는 치료 기간, 환자협조 요구, 최종 처치의 지연, 장기간의 수산화칼슘 적용 이후 치아 파절 가능성의 증가 등의 단점이 보고되었다. 기존의 수산화칼슘 치근단형성술의 대체방법으로 MTA를 이용한 1-visit 치근단형성술을 시행하고 있다. MTA는 1990년대 초반 근관치료 분야에서 다양한 적용을 위해 개발되었다. MTA의 우수한 임상적 성질에 힘입어 국내에서도 OrthoMTA 및 Endo CEM 등의 mineral aggregate 제품이 출시되어 있다. 따라서 본 증례에서는 우리나라의 청소년에서 MTA 적용한 사례를 보고하는 데 있다. 이 연구를 통해 MTA를 이용하여 진료하는 임상가에게 소개하고자 한다. 이 연구는 11～12세의 파절이 된 치아에 MTA를 적용하여 근관 치료를 하였다. 치료 받은 환자의 치아 상태를 12개월 동안 추적 관찰하였고, 국내에서 개발된 OrthoMTA를 이용한 치근단형성술을 시행한 후 임상적 및 방사선학적 관찰 결과를 통해 근관치료재생술(REP)에 관한 만족할 만한 결과를 얻었으며, 치수괴사가 생긴 경우에

서도 성공적으로 치수재생술을 적용할 수 있다는 정보를 제공하고 그 결과를 공유하기 위함이다.

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