Regenerative Endodontic Treatment as a Retreatment Option for a Tooth with Open Apex - A Case Report

Maria-Elpida A. Miltiadous, Spyros G. Floratos

Treatment of non-vital immature teeth with apical periodontitis has always been a challenge in Endodontics. Regenerative endodontic treatment (RET) has been successfully used for the management of these cases. The aim of this study is to present a case of RET used for the retreatment of a previously endodontically treated permanent tooth with an open apex. A 14-year-old boy with a poor endodontic treatment done on his maxillary right central incisor developed symptomatic apical periodontitis. Radiographically, incomplete root development with thin dentinal walls and an open apex were evident. After accessing and removing previous filling materials, the canal was copiously irrigated with 2.5% sodium hypochlorite. A triple antibiotic paste was placed inside the canal and left for 15 days. After removal of the antibiotic mixture, bleeding was induced into the canal by passing a hand file out of the apex. A collagen membrane barrier was placed over the blood clot, followed by sealing with mineral trioxide aggregate. Access was sealed with permanent filling materials. Clinical examination at 12, 24 and 36 months revealed no symptoms. Radiographic examination showed resolution of the periapical lesion and apical closure. Sensitivity tests with cold and an electric pulp test elicited a negative response at all recall periods. On the basis of long-term results, RET may be an effective option for the retreatment of an immature permanent tooth with a failed previous treatment and periapical periodontitis.

Introduction

Endodontic treatment of necrotic immature teeth has always been significantly challenging due to the disrupted development of root canal walls and open apices. The traditional treatment of choice in these cases includes a multiple-visit, long-term application of calcium hydroxide to promote the formation of an apical calcified barrier (1,2). Another treatment of necrotic teeth with open apices is the placement of an artificial apical barrier using mineral trioxide aggregate (MTA). These techniques have been proven to be highly successful however both apexification and artificial apical barriers prevent the continuation of root development and thickening of dentinal walls, thus making teeth susceptible to root fractures (3,4).

Regenerative endodontic treatment (RET) is a biologically based alternative method of treating necrotic immature teeth and allowing for continuation of root development (5). The term "revascularization" was introduced to describe a treatment protocol for necrotic immature permanent teeth with apical periodontitis. Revascularization consists of three basic steps. Primarily, the root canal is disinfected without mechanical instrumentation with the use of copious sodium hypochlorite (NaOCl) irrigation followed by the filling of the canal with a mixture of ciprofloxacin, metronidazole and minocycline (6). After successful disinfection during which clinical signs and symptoms of infection subside, the antibiotic paste is removed and a blood clot is produced. Finally, MTA is used to seal the root canal to the level of the cementoenamel junction and a coronal restoration is placed. This technique has demonstrated its therapeutic value by promoting varying degrees of root elongation, thickening of root canal walls, apical closure and periradicular healing (7,8).

The survival rate of immature teeth treated with RET (100%) and MTA apexification (95%) were significantly greater than the survival rates of the calcium hydroxide-treated teeth (77.2 %) (9). Furthermore, with regard to the increase of root length and width, the percentages observed in the RET group (14.9% and 28.2%) were significantly greater than those reported in the MTA apexification group (6.1% and 0.0%) and calcium hydroxide apexification group (0.4% and 1.5%) (9). Based on these encouraging results, RET consists a successful treatment option for non-vital immature teeth.

There are several studies and numerous case reports supporting the use of RET as the treatment of choice in cases of necrotic immature teeth with periapical periodontitis (6,7). Nevertheless, a case of using RET as a retreatment option has not been reported up to the present time. The aim of this study is to present a case report with the use...
of RET as a retreatment option of an immature tooth with
previous failed endodontic treatment and symptomatic
apical periodontitis.

Case Report

A 14-year-old Caucasian male was referred to the private
office by an oral surgeon for evaluation and treatment of
tooth #11 (maxillary right central incisor). He complained
of an intermittent pain upon biting on the tooth. Patient’s
medical history revealed no significant medical pathosis.
The dental history revealed trauma on tooth #11 five years
before, which resulted, according to his mother’s statement
in a crown fracture with pulp exposure. The tooth was
immediately treated by his general practitioner with an
endodontic treatment and a composite resin restoration.
Clinical examination revealed moderate palpatory pain,
severe percussion pain and intraoral swelling at the buccal
alveolar mucosa of the right maxillary incisor. Crown
discoloration of tooth #11 was also apparent (Fig. 1A).
Periodontal probing were within normal limits and there
was no mobility of the tooth. Radiographic examination
revealed a previous endodontic treatment, open apex and
thin dentinal walls and an apparent radiolucency around
the apex of tooth #11. Noticeably, a radiopaque mass in
the vicinity of the root apex could be observed in the
preoperative radiograph (Fig. 1B). Based on the history,
clinical tests and radiographs, a diagnosis of previous root
canal treatment of an immature permanent tooth with
symptomatic periapical periodontitis was established.
Regenerative endodontic treatment (RET) was determined
as a retreatment option for tooth #11. Written consent
was obtained for the treatment plan which was signed by
the patient’s parent.

After local anesthesia (Ubistesin 4%, 3M ESPE, Germany)
and rubber dam isolation, the tooth was accessed and
gutta-percha points were removed by using an 80K file
(Dentsply Maillefer, Ballaigues, Switzerland). Working
length was determined radiographically (Fig. 1C). The
root canal was gently irrigated with 24 ml of 2.5% NaOCl,
without any instrumentation. NaOCl was delivered via a
30-gauge closed end, side vent needle (Canal Clean, Biodent
Co., Ltd., Paju-city Guynghi-do, Korea), positioned 1 mm
short of working length. NaOCl was activated for 60 s by
use of ultrasonics (25K, CK tip, B&L Biotech, Philadelphia,
PA). After the canal was dried with paper points, a triple
antibiotic paste consisting of 500 mg ciprofloxacin powder,
500 mg metronidazole powder and 500 mg amoxicillin
powder was introduced in the canal with a lentulo spiral
and filled the canal up to the level of the cementoenamel
junction (CEJ). The access cavity was sealed with 4 mm of
Cavit (ESPE, Seefeld, Germany).

The patient returned 15 days later, reporting that clinical
symptoms had subsided. Clinical examination revealed no
palpation or percussion pain and there was no intraoral
swelling. After local anesthesia with 3% mepivacaine with
no vasoconstrictor, the tooth was isolated using a rubber
dam and accessed. The tri-antibiotic paste was removed
with irrigation with 12 ml of 2.5% NaOCl followed by 12ml
of 17% EDTA solution and dried with sterile paper points.
After the root canal appeared to be clean and dry, a sterile
20 K-File was passed 2 mm out of the apex and gently
irritated the periapical tissues to induce blood flow in the
canal. The intracanal bleeding was controlled at a level of
3 mm below the CEJ by placement of a sterile cotton pellet
for 3 minutes (Fig. 1D). Following that, a sterile collagen
membrane barrier (Collacote, Zimmer Dental, Carlsbad, CA,
USA) was placed on the blood clot by use of new sterile
pliers. Mineral trioxide aggregate (MTA, Dentsply, Tulsa,
OK, USA) was mixed and placed on the collagen membrane
forming a 3mm layer (Fig.1E). A moist cotton pellet was
placed on top of the MTA and glass ionomer cement was
used to seal the access. Two days later the tooth was
re-accessed, MTA set was confirmed and the access was
sealed with composite resin. A postoperative radiograph
was taken (Fig. 1F).

The patient was recalled yearly for clinical and
radiographic follow-ups. At two-year follow-up a complete
healing of the radiolucent lesion was evident (Fig. 1G). At
three-year follow-up session the tooth was asymptomatic
and functional (Fig. 1H). The patient reported no recurrence
of swelling. The response to the cold test was negative
in all follow-up sessions. In radiographic examination at
three years apical closure was visible. However, there was
no increase in the length and thickness of the canal walls.
Cone-beam computed tomography (CBCT) was taken to
evaluate the accurate position of the calcification present
at the periapical area. The result indicated the radiopaque
image was attached with dentin wall in buccolingual
direction like a bridge (Fig.1I,1J).

Discussion

RET is a biologically based alternative approach to treat
necrotic immature teeth that, unlike apexification and
artificial apical barrier techniques, allows continuation
of root development (10). The endodontic treatment
of permanent teeth with open apex has been a clinical
challenge as (11): 1. Mechanical instrumentation of the
root canal is difficult because of the anatomy of the
immature tooth; 2. An apical seal of the root canal by
using traditional filling methods is difficult because of
the absence of an apical stop; 3. Thin root canal walls of
immature teeth are susceptible to fracture (4).

For these reasons, disinfection of the canal system
relies solely on irrigants and intracanal medications. In
our case report, 2.5% NaOCl and 17% EDTA were used as chemical irrigants at the second appointment. EDTA has been suggested to be a single irrigant for pulp regeneration in immature necrotic teeth at the second appointment because EDTA was shown to promote stem cells of apical papilla (SCAP) survival (89% viability) (12). Lower cell viability (74%) was observed when both sodium hypochlorite and EDTA were used (12). A combination of sodium hypochlorite and EDTA was used in this case, although a significant decrease in viability of stem cells was expected.

SCAP are considered to be a main cell source for pulp regeneration in immature teeth (13). SCAP are defined as mesenchymal stem cell populations residing at the apical papilla around the root apices of immature permanent teeth (13,14). Periodontal ligament stem cells (15,16), bone marrow mesenchymal stem cells (16,17), and some surviving dental pulp stem cells around the root apex may participate in pulp regeneration. It is necessary that all these cells be stimulated to migrate into root canal space. Bleeding induced by passing files beyond the apex was thought to stimulate the migration of adult stem/progenitor cells into the root canal (18). In the case report presented, no thickening of the dentinal walls occurred and further root development was not evident. This can probably be explained by the fact that copious irrigation with a high concentration of sodium hypochlorite close to the apex done at the previous endodontic treatment may have damaged the SCAP, other progenitor/stem cells or apical vital tissue (19). Another possibility is the fact that persistent canal wall debridement during the primary treatment did not allow for hard tissue deposition and further thickening of dentinal walls. When bleeding was induced in immature teeth, there was up to 600-fold increase in stem cell markers in canal blood compared with the level in systemic blood (18). Probably the blood that filled the canal space in the case reported here might have been poor in stem cells as SCAP were damaged by the cytotoxic effect of the sodium hypochlorite used during the primary treatment.

In the case presented, although no increase in root length and no increase in root wall thickness was observed, these aspects may not always be achievable, nor are they essential for treatment success after RET is implemented (20). It has to be noted that at the 36-month recall examination, patient did not present any clinical signal or symptom after treatment completion and follow-up that would indicate regenerative endodontic retreatment fail. Therefore, conclusions related to regenerative endodontic retreatment should be drawn based not only on X-ray and computed tomography images, but on clinical signals and symptoms as well (21).

Five types of response of immature permanent teeth with infected necrotic pulp tissue and apical periodontitis were observed when revascularization procedures were implemented: type 1, increased thickening of canal walls and continued root maturation; type 2, no significant continuation of root development and the root apex became blunt and closed; type 3, continued root development and the apical foramen remained open; type 4, severe canal calcification; type 5, hard tissue barrier between the coronal MTA plug and the root apex (22). Following this classification, the case presented was a type 2 tissue response as root formation did not continue and the apex was closed.

The presence of a radiopaque mass in the vicinity of the root apex could be observed in the preoperative radiograph. Similar radiopaque entities were found by other investigators either at the periapical tissues or close to the apex (7,8), or in the canal space shortly after RET was initiated (11). This entity was speculated to be either bone-like tissue and/or cementum-like tissue (11). This calcific tissue in our case gradually approached the apex as healing of the periapical pathology was progressing. Probably this mineral deposition was formed as a reactionary response to the irritation of vital progenitor cells of the apical papilla during the previous endodontic treatment. The three-year periapical radiography showed this tissue was in continuation with the dentinal walls forming an apical barrier whereas the coronal view of the CBCT indicated the radiopaque image was right at the apical point attached with the dentin walls.

RET has been proven to be a better choice for the treatment of a nonvital immature permanent tooth, as opposed to apexification, because of the thickening of dentin wall and continuation of root development. Based on these advantages we selected this procedure as a retreatment option for the case reported. However, the 36-month follow up of the case showed that RET as a retreatment option for immature teeth with a persistent periapical lesion has no clearly favorable results over apexification. Further clinical studies are needed to support this finding.

This case shows that RET could be used as a retreatment option in the case of a failed endodontic treatment on an immature permanent tooth with apical periodontitis.

References
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