



Universidade Federal de Uberlândia
Faculdade de Odontologia



ANAHI DE PAULA MELO

**REGENERATIVE ENDODONTIC TREATMENT
OF NECROTIC MOLARS ON YOUNG
PATIENTS: A SERIE OF CASES**

UBERLÂNDIA

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Trabalho de conclusão de curso apresentado
à Faculdade de Odontologia da UFU, como
requisito parcial para obtenção do diploma
de Odontologia.

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ABSTRACT

Regenerative endodontic procedures have been performed on traumatized anterior teeth as an alternative to conventional endodontic treatment. However, there are few reports of this therapy in molars. This case series describes the use of revascularization technique in molars in six young patients, performed at the Hebiatric Extension Clinic, which takes place at the Dental Hospital of the Federal University of Uberlândia. All patients received the same treatment protocol, which was performed in three appointments. In the first appointment, chemical and mechanical preparation was performed using saline and 2.5% sodium hypochlorite as irrigating solutions. For mechanical preparation, light manual instrumentation was performed in the first session. The intracanal medication of choice was the ready-to-use calcium hydroxide formulation - Ultracal. In the second appointment, the medication was removed, mechanic preparation was performed with rotary files followed by final irrigation with EDTA under ultrasonic agitation and clot promotion. After filling the root canal with the clot, the entrande of the canals were sealed with trioxide aggregate material (MTA) and provisionally restored with light-cured glass ionomer. In the last appointment, the patients received definitive restoration and were followed, performing clinical evaluation through the pain scale and clinical examination to check for pain, edema and fistula, and radiographic examination to assess apical repair every three months. It was possible to observe success in five of the six cases presented. Thus, it is possible to perform regenerative procedures in molars, even with the anatomical difficulties presented by this tooth.

Key words: regenerative endodontic treatment; immature permanent molar; pulp regeneration.

INTRODUCTION

Immature permanent teeth with pulp necrosis represent a challenge for endodontics, since occurs disruption of root development, resulting in open apices and thin root dentine walls, which make them fragile and more susceptible to fractures (1,2). In addition, teeth with incomplete root formation present difficulties in biomechanical preparation, since vigorous instrumentation may further weaken dentinal walls and adequate root canal filling is difficult to be performed (3). For many years, immature teeth were submitted to apexification with successive changes of calcium hydroxide ($\text{Ca}(\text{OH})_2$) in order to induce the formation of an mineralized apical barrier (4, 5, 6). Alternatively, artificial apical barrier created with mineral trioxide aggregate (MTA) plug had also been used in teeth with immature apices (3). This treatment modality shortens the time required for mineralized barrier formation and promotes the healing of periapical tissues (5,7). However, both techniques cited above do not provide the root development in length or thickness. In face of those limitations, revascularization have been emerged as an alternative therapy to conventional endodontic treatment (8,9,10) mainly for immature teeth.

Revascularization is a modality of regenerative endodontic therapy that allows the filling of the root canal by a new connective tissue, and induce the formation of mineralized tissue, providing apical root closure (apexification) and could also induce continuation of root growth (maturogenesis) (9,11). The procedure often begins with abundant chemical disinfection using sodium hypochlorite (NaOCl), slight instrumentation and use of intracanal medication to reduce the number of microorganisms. In a second appointment bleeding is induced within the canal, promoting the formation of the blood clot by means of which stem cells of the apical papilla migrate (12). Most studies demonstrate the success of revascularization in permanent incisors by increasing root length and dentin thickness in necrotic teeth (9, 13,14).

Initially, revascularization was indicated only for teeth with incomplete root development (9,15). However, several studies have demonstrated the efficiency of this technique in mature permanent teeth (16,17). However, there are few reports in the literature of treatment of immature permanent molars with regenerative therapy

(18,19,20,21,22). This fact is probably related to the anatomical difficulties of disinfection and difficulty in filling the canal with an adequate volume of blood. Therefore, the objective of this study is to report the follow-up of a series of clinical cases of revascularization in severely compromised young permanent molars with open apex, performed at the Hebiatric clinic of the Federal University of Uberlândia, Uberlândia, Brazil.

CASE SERIES

Six patients, one children under 10 years, two pre-adolescents and three adolescents with teeth presented extensive coronary destruction due to caries participated of this case series. The patients were referred to the Hebiatric clinic of the Federal University of Uberlândia, Uberlândia, Brazil, which performs endodontic and restorative treatments in decayed molars of patients aged 6 to 18 years. All teeth had been submitted to emergency treatment for pain relief in the emergency service and had already been submitted to coronary opening. The cases were performed by signing Informed Consent Form by parents or guardians.

ANAMNESIS AND CLINICAL EXAMINATION

The patient's complaints, medical and dental histories were recorded on the anamnesis form. Extraoral and intraoral examinations were conducted. Swelling, presence of sinus tract, vertical percussion and palpation sensitivity were recorded. Preoperative digital periapical radiographs were taken (FIT T2 Microimage, Indaiatuba, SP, Brazil). Based on these data, a pulpal-periapical diagnosis was established. The data collected from the patients are summarized in Table 1. Of the seven treated teeth, six were mandibular molars. Of these, one had incomplete root development and six had at least the distal canal with an open apex. The only treated maxillary molar had root development almost complete, which showed slightly open foramina in palatal root canal.

SUMMARY OF PROCEDURES

First Visit

With the exception of the Patient 1, tooth 18, in which was performed surgery to restore the biological space and reconstruction of the crown using resin in the first treatment visit, in all other patients the following procedures were conducted: local anesthesia with 2% lidocaine containing 1: 100000 epinephrine (DFL, Rio de Janeiro, RJ, Brazil), rubber dam isolation, removal of temporary restorative material and improvement of the access cavity using carbide round burs and Endo Z (Malleifer, Dentsply, Petrópolis, RJ, Brazil).

After gaining access to the pulp chamber, the canals were passively irrigated with approximately 10 ml of 2.5% sodium hypochlorite (NaOCl) and explored with a #10-15 hand K-files. In order to facilitate the procedure and avoid the stress to rotatory files during the prepare of the root canals, the coronal part was widened with #15-25 H-files and Gattes Glidden drill sizes #2 and #3. A working length 1 mm short of the radiographic apex was determined with periapical radiographs. Then, the canals were prepared with Protaper Next rotary files (Dentsply) X1-X4 under copious amounts NaOCl. The final irrigation was performed with 5 ml of saline solution, the canals were dried with sterile paper points and dressed with Ultracal (Calcium hydroxide; Ultradent, Southern Jordan, UT, USA). The pulp chamber was closed with a sterile cotton pellet and Maxxion glass ionomer (FGM, Joinville, SC, Brazil).

Second Visit

At least two weeks after the first treatment visit the asymptomatic teeth were submitted to the revascularization procedure. It was performed local infiltrative anesthesia with 2% lidocaine containing 1: 100000 epinephrine (DFL, Brazil) without vasoconstrictor followed by rubber dam isolation and removal of the glass ionomer and cotton pellet from the access cavity. Ultracal was removed from the canals by using K-files and 20 ml irrigation of 2.5% NaOCl, followed by 5 ml of sterile saline solution and dried with sterile paper points. Then, which canal was irrigated with 3 ml of 17% EDTA (1 ml for min) under ultrasonic stirring and dried with paper points.

Apical bleeding was induced by passing with K-file size #15 (for mandibular mesial or maxillary buccal canals) or # 20-25 (for mandibular distal or maxillary palatal canals) approximately 2 mm past the apex. The filling of the canals by the clot were accompanied by magnification of 3x using surgical microscope (DFV, Valença, RJ, Brazil). After approximately 10 minutes, when the blood became semi coagulated, mineral trioxide aggregate (MTA, Angleus, Londrina, PR, Brazil), was introduced into the coronal part of each canal using an appropriate device similar to a miniature amalgam carrier (MTA Applicator, Angelus, Londrina, PR, Brazil) and was vertically condensed. The collagen matrix was not used because the space inside the canal was insufficient. In the same session the pulp chamber was filled with resin-modified glass ionomer (Riva, SDI, São Paulo, SP, Brazil). Postoperative radiograph was taken using fit4.

Third Visit

The restoration of resin-modified glass ionomer was lowered and Opus bulk fill resin (FGM, Joinville, SC, Brazil) was inserted on the cavity. All procedures were performed under rubber dam isolation. The time between the conclusion of endodontic treatment and definitive restoration with bulk fill resin ranged from 7 days to 6 months.. Five teeth were completed in three sessions and only one tooth (Patient 1, tooth 18) was submitted to four sessions due the fact that the first session was exclusively devoted to periodontal surgery and reconstruction of the crown.

FOLLOW-UP EXAMINATION

The present study evaluated the results of the treatments based on ØRSTAVIK *et al.* 1986 and Saoud *et al.* 2016 (14,23) which classified the outcome as: healed, healing and disease, adding some modifications on original criteria. Healed was defined as a tooth without clinical signs and symptoms and periapical radiography with normal appearance. Healing as tooth with reduction of the periapical lesion, without clinical signs and symptoms. Diseased has new development or persistence of periapical lesion associated or not with the presence of clinical signs and symptoms. In addition, apical closure or reduction of canal lumen by deposition of mineralized tissue were also evaluated. The clinical and radiographic data obtained from each

patient are summarized in Table 1. The follow-up occurred 1 month after the conclusion of the endodontic treatment and afterwards every 3 months, totaling 15 months of follow-up, although all patients were missing at least one appointment.

Patient 1 (Fig 1A-C) attended the first consultation with extensive coronary loss being submitted to periodontal surgery and coronary reconstruction previously to regenerative endodontic treatment. On radiographic examination it was possible to observe that the tooth presented open apex in the mesial and distal roots. After three months of follow-up, signs of failure were identified in patient 1 (tooth 18), which preserved the dimensions of the apical radiolucent area but developed reabsorption lacunae on the inner walls of the distal canal (Figure 1, arrow). It was immediately considered as an alternative treatment option the use of apical plug of MTA. In the referred case the coronary restoration with resin modified glass ionomer was removed and gained access to the MTA, which was removed with the aid of ultrasonic tips and abundant irrigation with 2.5% NaOCl. Root canals were reinstrumented manually with K-files and nearly 20 ml of 2.5% NaOCl. $\text{Ca}(\text{OH})_2$ intracanal dressing (Ultracal, Ultradent, Southern Jordan, UT, USA) was maintained for a period of 2 weeks. The medication was removed by copious irrigation with NaOCl and sterile saline solution. After dried with sterile paper points, complete obturation of the distal canal was done with MTA (Angelus, Brazil), while in mesial canals were performed apical plug with MTA followed by obturation with gutta-percha and endodontic sealer containing MTA (MTA Fillapex Angelus, Angelus, Londrina, PR, Brazil).

Patient 2 (Fig 1 D-F) was the oldest of all (16 years old) and the unique whose endodontic treatment was performed in the upper molar. At the initial appointment, only the palatine canal had a slightly open apex. The other canals were not large and periodontal ligament space was thickened, although not presented radiographic periapical lesion. After the treatment the tooth was classified as cured at 12 months after endodontic treatment, with a reduction in the space of the periodontal ligament for normal parameters. A reduction of the canals lumen were observed, indicating possible obliteration.

Patients 3, 4 and 5 (Fig 1 G-O) presented open apex in the distal root. All received the same treatment protocol. Twelve months after the completion of regenerative

endodontic therapy, we observed that the apex of the distal roots was closed and the teeth were classified as healed, reducing the periodontal ligament space to normal parameters. In cases 3 and 4, a reduction in the lumen of the root canals were observed, indicating possible obliteration.

Patient 6 (Fig 1 P-R) was the youngest of all (9 years old) and at the initial appointment was verified a wide distal canal with open apex, increased periodontal ligament space and initial signs of apical radiolucent development. After treatment, in follow-up visits, it was verified a reduction in canal lumen and apical repair, classifying the tooth as healing up to 6 months.

DISCUSSION

Although there are a large number of case reports of regenerative endodontic treatments published, few describe this procedure performed on immature permanent molars (19,20,21,22). In addition, there is no standardized clinical protocol established for this treatment (24). Some authors report performing the procedure in a single appointment (22), while others use two or more appointments (19,20,21). In the present cases, the regenerative endodontic procedures were completed in two appointments, since most of them had periapical radiolucency and they were open previously to the beginning of treatment. The third appointment was reserved for the definitive restorative treatment using bulk fill resin.

Of the six treatments performed, five were considered healed after 15 months of evaluation. The literature brings several factors responsible for the success of regenerative endodontic treatments, among which we can mention root canal disinfection and apical papilla stem cell survival (SCAP). Previous studies have shown that SCAPs are responsible for tissue repair (25,26), thus their survival directly influences the potential for cell repair and differentiation. SCAPs have high proliferative potential and are able to differentiate in several cell subtypes, such as osteogenic, odontogenic and neurogenic cells (27). SCAP induces tissue repair by depositing a continuous layer of dentin-like tissue (25), promoting additional development in thickness and length (12,13). Such development was observed in

case 6 when analyzing the apical third of the distal root. However, the fact that the teeth were previously opened in emergency service and the lack of information about how the procedure was performed may have compromised the viability of the SCAPs, influencing the prognosis of case 1. Another factor that may also influence the viability of the SCAPs is the concentration of NaOCl used (11,28). Although this is commonly the most used irrigating solution in regenerative endodontic treatments, the concentration used is variable (11,24). In the present study, we chose 2.5% NaOCl, which is a potent antimicrobial agent (29), capable of dissolving organic matter (30,31). *In vitro* studies demonstrated that 2.5 % NaOCl do not compromise the survival of SCAP, though higher concentrations are not recommended due to their cytotoxicity (28,32). The use of EDTA 17% in final irrigation in cases of revascularization is supported by the literature (24,33). Its use is recommended because it is a chelating agent capable of promoting the release of growth factors trapped in dentin, favoring the adhesion of SCAPs in dentine walls, without interfering with their survival (34).

The use of intracanal medication in teeth undergoing revascularization is practically peaceful point in injured teeth, since most randomized clinical studies and case series perform the procedure in at least two appointments (19,20,21). However, there is no consensus on the best intracanal medication to be used in regenerative endodontic procedures (35). While some authors use triantibiotic paste (TAP), others use calcium hydroxide ($\text{Ca}(\text{OH})_2$). Ready-to-use $\text{Ca}(\text{OH})_2$ (Ultracal) was the intracanal medication used in the reported cases. Previous studies have shown that $\text{Ca}(\text{OH})_2$ -based paste is less cytotoxic than TAP to cells in periapical tissues (36,37). In addition, $\text{Ca}(\text{OH})_2$ -based paste is easier to remove than triantibiotic paste (38). However, it has been suggested that root canal obliterations are more related to the use of $\text{Ca}(\text{OH})_2$ (39). Although we cannot make such statement, it is possible to observe that cases 2, 3, 4 and 6 showed a significant reduction in canal volume in the first 12 months which could be related to it.

Another important factor for the success of regenerative endodontic treatment is the promotion of the clot, which is performed by the induced bleeding technique. It is from the clot that SCAPs migrate to provide repair (12). To confirm that there was adequate canal filling by the clot, all cases were performed using a 3x magnification microscope. However, we know that molars have canals with smaller diameter and

greater anatomical complexity than incisors, teeth usually submitted to regenerative procedures (20). This fact makes it difficult to induce clot (20), as found by the operators in this series of cases. Among the six reported cases one had failed as demonstrated by radiographic examination which suggested root resorption inside the distal canal. Among the factors that may be related to the failure of case 1, we can mention the difficulty of promoting the clot in the mesial canals, since they have a smaller diameter when compared to the distal canal. The possible failure to induce mesial canal bleeding may have been masked by distal canal bleeding. The deficiency in the promotion of clot in the mesial canals may have compromised the amount and viability of SCAP in these canals, reducing the potential for differentiation and consequent repair. In addition, we should take into account the fact that the permanent restoration had not been performed until the 3-month follow-up, which may have led to contamination and consequent failure. Proper coronal sealing to seal the clot and prevent bacterial contamination is another key factor for successful revascularization (40). The MTA was used to seal the canals because it has good sealing properties and excellent biocompatibility (41), followed by the insertion of modified glass ionomer (RIVA). However, restorations in composite resin over the inomer took a long time to perform. Such variability of time is due to the fact that the patients lacked in the appointment with the specialist responsible for the resin restoration. This situation in most cases was due to the fact that RIVA provides a restoration with good aesthetic quality and masticatory efficiency, which made the mothers unchecked or missed consultation with the specialist responsible for restoring the tooth.

Regarding the biomechanical preparation of the canals, although mild instrumentation is recommended (20), we opted for rotary instrumentation using NITI files. We considered that a more effective biomechanical preparation would be necessary to reduce contamination, and also the fact that the instrumentation would enlarge the mesial canals of the lower molars, subsequently allowing more effective induction of the clot. This fact does not seem to have affected the prognosis of the treatments performed. In general, we can state that even in the adverse conditions found, we were successful in 5 cases considered healed which were largely destroyed by caries and previously exposed to the oral environment. Moreover, in cases 3, 4, 5 and 6 we can observe that the apex closure of the distal roots occurred.

However, even in successful cases sensitivity tests were negative during follow-up appointments. The lack of response to the pulp sensitivity test does not necessarily mean that the tooth has no vitality (42) once the thickness of sealing material present on the tooth may affect the response to cold sensitivity test (43).

CONCLUSION

Although molar teeth have a more complex anatomy, it is possible to perform regenerative endodontic procedures in severely compromised teeth by caries and obtain success. Although root formation is incomplete, rotational instrumentation does not appear to have negatively affected treatment prognosis. Therefore, it is possible to perform this type of treatment using rotary instrumentation as a method of mechanical disinfection of root canals. Another important point is the careful selection of cases, as the success of this therapy depends on the patient's collaboration.

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ANEXO 1

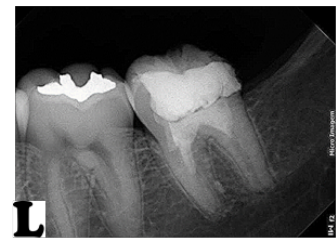
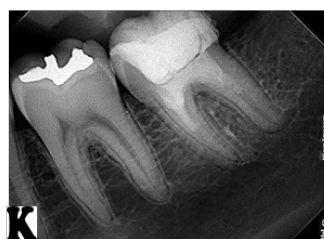
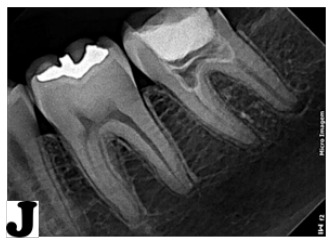
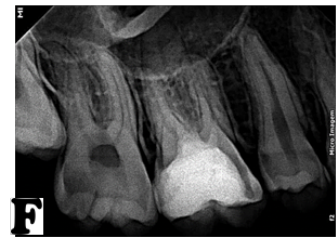


Figure 1. (A) initial radiography. (B) Three-month follow-up radiograph with radiolucent area at distal root apex suggestive of resorption. (C) Final radiograph after new intervention and conventional endodontic treatment. (D) Initial radiography. (E) Six month follow up. (F) After a fifteen month follow up, a reduction in the canal volume is observed. (G) Initial radiography. (H) Six month follow up. (I) After a fifteen month follow up, a reduction in the canal volume is observed and the apex closed. (J) Initial radiography. (K) Six month follow up. (L) Fifteen month follow up. (M) Initial radiography. (N) Six month follow up. (O) Fifteen month follow up. (P) Initial radiography. (Q) Three month follow up. (R) After a fifteen month follow up, a reduction in the canal volume is observed and the apex closed.

ANEXO 2

TABELA 1 – *Clinical and Radiographic findings: outcomes.*

Patient n°	Sex	Age	Tooth n°	Clinical diagnosis	Time final restoration	Last Control (month)	Periapical status after endodontic regenerative treatment	Root canal
1	F	12	18	Irreversible pulpitis	After 5 months	12	disease	normal
2	M	16	3	Irreversible pulpitis	After 2 weeks	15	healed	reduced
3	F	15	31	Pulp necrosis	After 1 month	15	healed	reduced
4	M	14	18	Pulp necrosis	After 6 months	15	healed	reduced
5	F	13	31	Irreversible pulpitis	After 4 months	15	healing	normal
6	M	9	30	Irreversible pulpitis	After 1 week	15	healed	reduced

F, female; M, male