Pulp Revascularization of an Immature Permanent Tooth with Apical Periodontitis – A Case Report

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SUMMARY
The present case report analyzes the outcome of revascularization treatment of an immature permanent tooth with necrotic pulp and apical periodontitis. The canal was disinfected with copious irrigation and application of triple antibiotic paste. After the disinfection protocol was completed, apical bleeding was induced in the canal resulting in the formation of a blood clot. An absorbable scaffold was placed over it followed by an adequate triple coronal seal. After nine months follow-up, increased thickening of dentinal walls with intact lamina dura and complete apical closure was reported radiographically. Therefore, revascularization therapy could be recommended as an alternative treatment option.

Keywords: apexification; artificial barrier technique; revascularization; stem cells; triple antibiotic paste

INTRODUCTION
Endodontic therapy is one of the most progressive aspects in modern dentistry. Significant advancements in debridement and obturation techniques have occurred in recent years. Consequently, successful treatment rates of 95% for teeth with irreversible pulpitis and 85% for necrotic teeth have been reported [1].

However, the treatment of an immature tooth with necrotic pulp has always been a challenge in endodontics. It is difficult to obtain an appropriate apical seal in teeth with open apices using conventional endodontic treatment methods. Discontinued development of dentinal walls after pulp necrosis can also lead to weak root canal structure with thin dentinal walls which makes the tooth susceptible to future fracture. Conventional technique such as multiple-visit apexification with calcium hydroxide and artificial barrier technique performed by placing Mineral Trioxide Aggregate (MTA) in the apical portion of the canal share the same disadvantage of not providing continuous root development which leads to fragile root structure [2].

Recently, there have been introduced better alternatives to conventional treatment of immature permanent teeth with periapical pathology. Procedures attempting to preserve remained dental pulp and mesenchymal stem cells of apical papilla can result in canal revascularization and completion of root maturation [3, 4].

Revascularization is regenerative treatment and biologically based alternative approach to treat necrotic immature teeth that in contrast to apexification and artificial barrier technique allows continuation of root development [5]. It is based on the concept that vital stem cells can differentiate into secondary odontoblasts, ultimately allowing dentin deposition [3]. Survival of stem cells is aided by abundant blood supply to apical papilla, contributing to pulp revascularization [4]. Even in luxated and avulsed tooth, revascularization is possible [6, 7]. Iwaya et al. [8] showed that a human immature permanent tooth with necrotic pulp and apical periodontitis/abscess after revascularization procedure can induce increased thickness of the canal walls and continuous root development. Others have also reported similar cases [6, 9, 10].

The current case report describes successful revascularization treatment outcome of an immature permanent right maxillary central incisor with clinical and radiographic signs of necrotic pulp and apical periodontitis.

CASE REPORT
A 17-year-old boy was referred to the Department of Conservative Dentistry and Endodontics of the National Dental College and Hospital, Dera Bassi for the evaluation of right maxillary central incisor with a history of trauma 8 years ago. Clinical examination revealed extensively carious right maxillary central incisor sensitive to percussion. Cold test and electric pulp test elicited no response (Figure 1). Periodontal status was normal (i.e probing depth < 3 mm) and the tooth showed no mobility. Radiographic evaluation revealed an immature open apex associated with radiolucent periapical lesion (Figure 2). Right maxillary lateral incisor was clinically sound and responded normally to cold and electric pulp test. No significant medical history was reported. Concluding diagnosis was pulpal necrosis with symptomatic chronic apical periodontitis and revascularization was chosen as optimal treatment.

After obtaining an informed consent, a rubber dam was applied, remaining carious tooth structure removed and access cavity prepared. No purulent exudates or hemorrhage was observed in the pulp chamber. The working length was...
determined. The canal was passively irrigated with 20 ml of 5.25 % NaOCl (Prime Dental Products Pvt. Ltd India). The apical opening was enlarged to 1.1 mm using 110 K instrument (Mani K­Files, Japan). After copious irrigation, the canal was dried with paper points and a creamy paste of equal proportion of ciprofloxacin, metronidazole and minocycline was prepared using sterile water as described by Windley et al. [11] and placed inside the canal with K-file in anticlockwise motion. The access cavity was cleaned with sterile cotton pellet and restored temporarily with Cavit (3M ESPE, Deutschland GmbH, Germany) for a period of 2 weeks. The triple antibiotic paste was replaced again after 2 weeks for additional 2 weeks.

At the 5th week follow-up, the patient was asymptomatic, and no sensitivity to percussion and palpation was reported (Figure 3). The tooth was anesthetized with 2% lignocaine hydrochloride containing 1:200,000 adrenaline (Astra Zeneca Pvt. Ltd. Bangalore, India). After rubber dam isolation, temporary restoration was removed. The canal was flushed with 10 ml of 5.25 % NaOCl and dried with paper points. K­files were used to induce bleeding in the canal by irritating periapical tissue. Bleeding was stopped at the level of 3 mm below cement­enamel junction (CEJ) by applying pressure with a sterile saline soaked cotton pellet for 15 minutes so that the blood would clot at that level. After 15 minutes, an absorbable scaffold (Gel­spon, Eucare Pharmaceuticals Pvt. Ltd. India) was gently placed over the blood clot. MTA (MTA- Angelus Reparative Cement, Angelus Ind. de. Prod. Odontologicos S/A, Brasil) was carefully placed against the scaffold followed by a wet cotton pellet and Cavit (Figure 4).

At the 6th week follow-up, the patient was asymptomatic, temporary restoration was removed and the tooth was restored with a glass ionomer base (GC Gold Label Glass...
Figure 6. Radiograph showing effective triple coronal seal of MTA, glass ionomer cement and bonded-resin restoration with respect to maxillary right central incisor.

Figure 7. Postoperative radiograph after 3 months. Decreased size of periapical radiolucency and thickening of the root canal walls was observed.

Figure 8. Postoperative radiograph after 6 months. Complete resolution of periapical radiolucency was noted.

Figure 9. Postoperative radiograph after 9 months. Increased thickening of dentinal walls with intact lamina dura and complete apical closure was observed.

DISCUSSION

The benefits of revascularization technique over conventional methods include continuation of root development and strengthening of the remaining root structure. With an attempt to gain these benefits, in the present case revascularization was chosen as a treatment option over other alternatives. Elimination of microorganisms and necrotic tissue from the root canal system is the key factor in successful revascularization. Studies have revealed that chlorhexidine irrigation might have cytotoxic effects on human cells [12] and interfere with the attachment of dental papilla stem cells to the root canal walls [13]. Thus, in this case 5.25% sodium hypochlorite was used as irrigant.

Previous studies have pointed out different methods for disinfecting necrotic immature teeth in revascularization treatment including the use of triple antibiotic paste [6], calcium hydroxide [14] and formocresol [15]. Hoshino et al. [16] and Sato et al. [17] in two separate in vitro studies used a mixture of metronidazole, ciprofloxacin and minocycline against endodontic pathogens and were able to disinfect even deeper layers of dentin in infected teeth. An animal study done by Windley et al. [11] in 2005 revealed that triple antibiotic dressing placed in infected canals for 2 weeks resulted in bacteria free culture in 70% of cases. Based on these observations, triple antibiotic dressing was placed for 4 weeks in the root canal to achieve disinfection and encouraging results were obtained.

Instrumentation is contraindicated in revascularization treatment because root dentin walls are extremely thin and any further instrumentation would make them weaker and more susceptible to future fractures. Also, the formation of smear layer could occlude dentinal tubules. The notion that successful regeneration depends on the race between new tissue and bacteria populating the pulp chamber is strengthened by the fact that the incidence of revascularization is enhanced if the apex shows radiographic opening of more than 1.1 mm [6]. Taking this into consideration, in the present case, apical opening was enlarged to more than 1.1 mm using 110 K instrument with the tip diameter of 1.1 mm to provide easy access of new tissue into the root canal system.

It is assumed that blood clot formed inside the disinfected empty space that contains platelet-rich scaffold might be crucial for successful population and differentiation of stem cells and ultimately root development [18]. Thibodeau and Trope [19] demonstrated that root canals that had blood clot formation inside them after disinfection had better radiographic outcomes compared with those without blood clot. Therefore, in the present study, a blood clot was created in the canal after disinfection. One might assume that blood clot may break down and leave root canal space without scaffold where new tissue
should grow for regeneration [20]. Therefore to avoid this loss of scaffold, an absorbable collagen scaffold was placed over the formed blood clot. This also provided a barrier against which MTA plug was condensed resulting in an effective triple coronal seal.

The importance of bacteria-tight coronal seal for successful revascularization is well-documented [6]. Majority of reported studies have used double seal over the blood clot formed inside the canal, MTA and resin-bonded restoration [6, 19]. Wang et al. [21] in an animal study on revascularization showed that a cemental bridge is formed beneath MTA in most cases, which might be the result of cementogenetic and osteogenetic properties of MTA. In addition, in the present case, glass ionomer base was placed as a second sealing agent over MTA, followed by a permanent coronal resin-bonded restoration. Hence, successful outcome may also be attributed to this effective coronal seal.

An interesting question is the nature of new tissue produced in the root canal space after this procedure. It has been shown that three types of tissue i.e. cementum like tissue along dentinal walls responsible for root cancel wall thickening, bone like tissue and periodontal ligament like tissue were generated after the treatment [21]. We must acknowledge that vitality of pulp tissue was not known. In the present case blood supply was required for the root canal wall to become thicker and apex to close. New tissue within pulp space although not necessarily pulp, comprises not only blood vessels but also vital cells required to lay down new tissue. Since vital tissue inside the canal is not necessarily pulp tissue, the term regeneration may not be appropriate, therefore, preferred term is revascularization suggesting that blood supply in previously necrotic pulp space has been restored.

There has been a tremendous increase in our clinical tools (i.e. materials, instruments and medications) and knowledge in tissue engineering fields during the last decade. The question is no longer “Is regenerative endodontic procedure successful?” Instead, the important question we are facing is “What are the issues that must be addressed to develop safe and effective method to regenerate functional pulp-dentin complex?” Future research should focus on translational research models that emphasize keeping the tissue in its natural state instead of doing conventional endodontic treatment. However, more studies with long follow-ups on this proposed technique will be valuable in finding reliable ways to successful treatment outcomes.

REFERENCES

Revascularizacija pulpe stalnih zuba sa nezavršenim rastom korena i apikalnim periodontitisom – prikaz slučaja

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KRATAK SADRŽAJ
U ovom prikazu analizirana je metoda revascularizacije u lečenju stalnih zuba sa nezavršenim rastom korena i apikalnim periodontitisom. Dezinfekcija kanala postignuta je obilnim irigacijom i primenom intrakanalne pastes sa tri antibiotika. Nakon dezinfekcije izazvano je apikalno krvenje koje je dovelo do stvaranja krvnog ugruška u kanalu. Potom je postavljena resorptivna mrežica preko ugruška, kao i troslojni ispun. Nakon devet meseća na rendgenskom snimku uočeni su zadebljanje dentinskih zidova s intimnom laminom durom i kompletno zatvaranje apleksa. Terapija revascularizacije može se preporučiti kao alternativno rešenje u lečenju stalnih zuba sa nezavršenim rastom korena i apikalnim periodontitisom.

Kljучне реци: apleksifikacija; tehnika veštačke barijere; revascularizacija; matične čelije; pasta sa tri antibiotika

UVOD
Endodontsko lečenje je jedno od najnaprednijih aspekata savremenih stomatologije. Poslednjih nekoliko godina došlo je do značajnog napretka u dezinfekciji i optuštanju kanala korena zuba. Tako je sada procenat uspeha endodontskog lečenja oko 95% za zube sa irreverzibilnim pulpitisom i 85% za zube sa nekrotičnom pulpm [1].

Terapija stalnih zuba sa nezavršenim rastom korena i nekrotičnom pulpm je odveću bila izazov u endodontiji. Kod zuba s otvorenim apleksom ne dolazi uvek do uspešnog zatvaranja apleksa konvencionalnim metodama lečenja. Prekinut rast korena nakon nekroze pulpe može dovesti do slabljenja strukture zida kanala korena, gde tanki dentinski zidovi čine zub podložan lomljenju. Konvencionalne tehnike, kao što su apleksifikacija korena, pulpe kalcijum-hidrosida ili tehnika veštačke barijere pomoću mineralnog trioksida (MTA), ne podstiču nastavak rasta korena, što dovodi do slabljenja njegove strukture [2].

Nedavno su uvedene nove metode kao alternative konvencionalnom lečenju stalnih zuba sa nezavršenim rastom korena i periapikalnom patologijom. Ove metode, čiji je cilj očuvanje preostale zubne pulpe i mezenhimalnih matičnih čelija iz apleksne pastes, mogu dovesti do revascularizacije kanala i završetka rasta korena zuba [3, 4].

Revascularizacija je regenerativna metoda koja ima biološki pristup u lečenju stalnih zuba sa nezavršenim rastom korena i nekrotičnom pulpm i, za razliku od apleksifikacije korena i tehnike veštačke barijere, omogućava završetak rasta korena [5]. Ona se temelji na konceptu da se vitalne matične čelije mogu transformisati u sekundarne odontoblaste i sintetisati dentin [3]. Opstanak matičnih čelija potpomognut je dobrom vaskularizacijom apikalne pulpke koja doprinosi revascularizaciji pulpe [4]. Revascularizacija je moguća čak i kod lukuisanih ili avulziranih zuba [6, 7]. Ivaja (Iwaya) i saradnici [8] su pokazali da je kod stalnih zuba sa nezavršenim rastom korena i nekrotičnom pulpm apikalnim periodontitisom apsescom nakon postupka revascularizacije došlo do povećanja debljine zida kanala i završetka rasta korena. Drugi autori su takođe došli do sličnih zaključaka [6, 9, 10].

Ovaj prikaz slučaja opisuje uspešan ishod revascularizacije stalnog desnog maksiarnog centralnog sektića sa nezavršenim rastom korena i kliničkim i radiološkim znacima nekrotične pulpe i apikalnog periodontitisisa.

PRIKAZ SLUČAJA
Sedamnaestogodišnji mladić je upućen na Kliniku za konzervativnu stomatologiju i endodonciju Nacionalnog stomatološkog fakulteta i bolnice u Dera Basi zbog desnog maksiarnog centralnog sektića koji je bio povređen osam godina ranije. Kliničkim pregledom je utvrđena velika karijesna ležija na tom zubu. Zub je bio osjetljiv na perkuziju, dok na hladno i na električni test vitaliteta nije reagovao (Slika 1). Periodontalni status zuba bio je normalan (dubina gingivalnog sulksa je bila manja od 3 mm) i zub nije bio pokretljiv. Rendgenski snimak je pokazao otvoreni vrh korena povezan sa radioluscentnom periapikalnom ležijom (Slika 2). Desni lateralni sektić je bio zdrav i pokazao je normalnu reakciju na hladno i električni test vitaliteta. U opštoj anamnezi nije bilo značajnih podataka. Konačna dijagnoza je glasila „nekroza pulpe sa simptomatskim hroničnim apikalnim periodontitisom”, a metoda revascularizacije je izabrana kao optimalan način terapije.


Na pregledu posle pet nedelja pacijent je bio bez simptoma, a zub neosjetljiv na palpaciju i perkusiju (Slika 3). Nakon primene anestezijske dvuprocentne lignokain-hidrohloridom s adrenalinoj u dosnu u 1:200.000 (Astra Zeneca Pvt. Ltd., Bangkok, Indija), postavljen je koferdam i uklonjen privremeni ispun. Kanal je ispran sa 10 ml 5,25% NaOCl i osušen papirnim poenima. Kerovim instrumentima je iziritiran periapex, koji je doveo do krvarenja u kanalu. Krvenje je zaustavljeno 3 mm ispod gleđno-cementne granice britskom pomoću ste-
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Prednosti metode revaskularizacije nad konvencionalnim metoda-


Mehanička obrada kanala je kontraindikovana tokom primene metode revaskularizacije, jer su dentinski zidovi kanala korena izuzetno tanki, tako da bi dodatno mehaničko uklanja-