Case Report

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Regenerative Endodontic Management of Immature Mandibular Premolar Using Novel Bioceramic Sealer – A Case Report

Abstract:

Aim : This case report aims to describe the treatment approach for immature permanent teeth with necrotic pulp by inducing revascularization and using a bioceramic sealer.

Case description : An 11-year-old boy reported pain in the lower right posterior tooth region in the Department of Pediatric and Preventive Dentistry, People's Dental Academy, Bhopal. Upon clinical and radiographic examination, the mandibular right first premolar was found to have a necrotic pulp and an immature root. The patient's mother was informed about the diagnosis, and consent was obtained to proceed with a regenerative endodontic treatment. Local anesthesia was administered. Access opening was done. The root canal disinfection was done using sodium hypochlorite and EDTA. A triple antibiotic paste was placed as an intracanal medicament, and after two weeks, canal was filled with a bioceramic sealer.

Results : At the four-month follow-up, the periapical radiograph revealed complete root formation, thickening of the dentinal walls, and apical closure of the root canal.

Conclusion : The results indicate that the regenerative endodontic protocol employed was effective and may serve as a viable treatment option for immature teeth with pulp necrosis.

Key-words: revascularization, bioceramic sealer, immature teeth, intracanal medicament, apical closure

Introduction:

One of the biggest challenges faced by dental practitioners is the treatment of permanent teeth with incompletely formed apices.[1] Immature permanent teeth are the teeth having inadequate root growth, no cement-coated apical dentin, and not reaching Nolla stage 10 (full apex formation) on radiographs.

For circumstances like such, two treatment modalities are considered. The first is apexogenesis, which applies to cases of incomplete root formation where the pulp remains vital and not fully inflamed. In such cases, preserving the pulp allows for the continued development of the root along its entire length.[1] The second treatment option is apexification, a widely recognized approach for pulp necrosis, in which calcium hydroxide is used to stimulate the formation of an apical barrier. However, this method has the drawback of requiring multiple clinical sessions over an extended period. Additionally, calcium hydroxide can weaken the dentinal walls by dissolving certain components of the organic matrix, potentially leading to fractures in the future.[1-3] Using mineral trioxide aggregate (MTA), which is the preferred material for the technique, aims to create a mineralized apical barrier (apical plug). While MTA offers advantages such as improved sealing, shorter clinical time, biocompatibility, and better consistency in periapical tissue compared to calcium

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[1]SATISHMARAN, [2]NAINA GUPTA, [3]ANAYA KULKARNI KALE, [4]SAARIKA SURESH

[1-4]Department Of Pediatric and Preventive Dentistry, People's Dental Academy, Bhopal

Address for Correspondence: Dr. Naina K. Gupta
Postgraduate Student,
Department of Pedodontics
Institutional Affiliation: People's Dental Academy, Bhopal
People's Dental Academy, People's University,
Ayodhya Bypass Road, Bhopal, M.P. - 462037
Email: naina.gupta7808@gmail.com

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hydroxide, both techniques do not promote the formation of dentin walls in terms of thickness or length, which increases the risk of root fractures.[4]

Regenerative endodontic treatments (REP) were developed as biologically based approaches to restore affected dentin and root structures, as well as pulp-dentin complex cells. This can cause further root lengthening, wall thickening, and apical closure.[5] REP is an innovative, results-oriented, and rapidly advancing treatment approach for managing immature teeth with open apices, infected canals, and halted root development. The term "pulp revascularization" gained widespread recognition when it was introduced to describe a new procedure for treating permanent teeth with incomplete root formation. A key benefit is that it allows for continued root development and dentinal wall strengthening through tissue deposition, reducing the risk of root fractures, unlike apexification[6, 7]

Regenerative endodontics, driven by advances in tissue engineering, relies on a triad of foundational components: growth factors, scaffolds/matrices, and stem cells.The American Association of Endodontists (2013)[8] states that although stem cells can be found in a variety of places, the apical papilla cells (SCAPS, or stem cells from apical papilla) at the apex of teeth with incomplete root formation have the most potential for regenerative endodontics. These cells can differentiate into odontoblasts.Although there are several scaffolds, the primary one is the blood clot, which can be recruited using a file outside the apical foramen. These scaffolds offer the three-dimensional support and framework for the organisation, proliferation, differentiation, and vascularization of the new tissue that will form inside the root canal. Additionally, growth factors—proteins that signal and promote cell division and proliferation—are mostly held in dentin and may be liberated with 17% ethylenediaminet etraacetic acid. They are also present in blood clots.

Another study added a new term for regenerative endodontics: disinfection. As a fundamental component, it interacts with scaffolds, growth factors, and stem cells, making it crucial to use as an effective canal disinfection protocol that uses intracanal medications like calcium hydroxide or triantibiotic paste (ciprofloxacin, metronidazole, and minocycline), such as sodium hypochlorite.[9]

Thus, the purpose of this study was to present a case study of a regenerative endodontic treatment using a bioceramic sealer in a permanent mandibular right second premolar that had a severely carious lesion with a 4-monthfollow–up.

Case Description:

A 11-year-old male patient visited the Department of Pediatric and Preventive Dentistry, People's Dental Academy, Bhopal, for a dental assessment. He reported experiencing spontaneous pain in the mandibular right permanent first premolar #44, which had been exacerbated by chewing for 10 days.

The pain was intermittent, and the patient was unable to recall any specific incident or trauma that may have triggered the onset of symptoms. The pain was localized to the affected tooth and has not radiated to other areas.

The patient had no significant past medical or dental history. The clinical examination showed a deep carious lesion. There was no mobility observed, and the gingival tissues appeared normal around the other affected teeth.

On radiographic examination, a periapical radiograph revealed incomplete root development in #44, thin root dentinal walls, a wide open apex, along with caries approaching the pulp (Figure 1). Based on the patient's history, clinical evaluation, and periapical radiograph, a diagnosis of an immature permanent tooth with a necrotic pulp and stage 4 of Cvek's root classification established. The diagnosis and treatment plan had been explained to the patient and his mother. Their consent was acquired for the same.

In the first session, the tooth was anesthetized with Lidocaine 1:200000. An appropriate access cavity was created, and the root canal was accessed under complete isolation. Initial exploration was conducted using a K10/0.02 instrument. The working length was determined by inserting a K-file into the canal, and a periapical radiograph was taken, as seen in Figure 2. The root canal preparation was performed 1 mm short of the apical foramen using a K #40/0.02 file. Over-instrumentation was avoided due to the large size of the apex.

Throughout the instrumentation, irrigation was done 3 mm short of the apparent working length to prevent the extrusion of irrigation solutions. The root canal was irrigated with 20 mL of 1.5% sodium hypochlorite and saline solution and then dried using absorbent paper points.

An intracanal medicament, triple antibiotic paste (metronidazole, ciprofloxacin and clindamycin), was placed in the canal, and the tooth was sealed with Cavit.

The second session was held after 15 days. The access cavity was reopened, and the triple antibiotic paste was removed by irrigating with 20 mL of 1.5% sodium hypochlorite solution

and saline. The canal was subsequently irrigated with 20 mL of 17% EDTA and dried using absorbent paper points.

Next, a K 25/0.02 instrument was inserted 2mm beyond the apical third of the tooth to induce apical bleeding. The blood filled the entire root canal up to the cervical third, and the clotting process was allowed to occur. The bioceramic sealer was then placed into the canal. Once set, the final restoration was placed using composite resin.

The patient was recalled after one month, where he was asymptomatic, and a follow-up radiograph was taken, revealing an increase in the dentinal root thickness. Clinically, no signs of inflammation or infection were observed. The case remained under follow – up. Radiographic evaluation with periapical radiographs (IOPA) after 4 months revealed complete healing with increased root length and thickness, along with apical closure resembling stage 5 of Cvek's root classification.

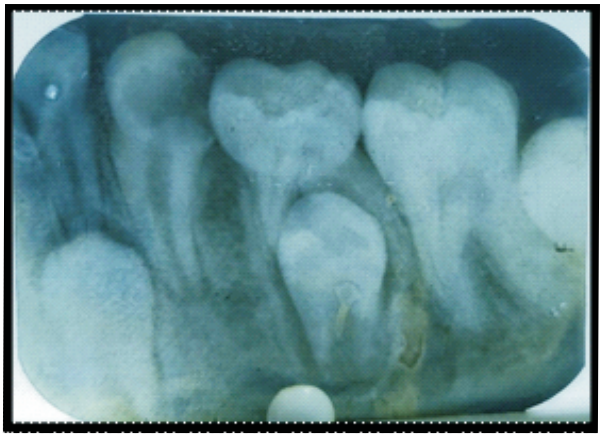

Figure 1: Periapical radiograph of mandibular right first premolar showing incomplete root development and caries approaching pulp.

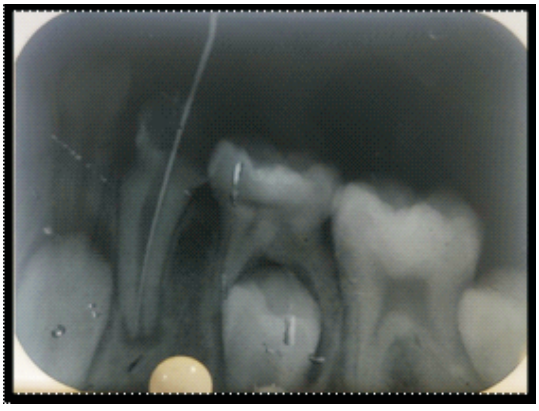

Figure 2: Periapical radiograph showing access cavity and determination of working length in the first visit

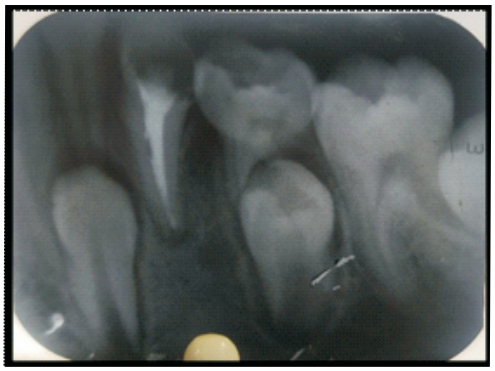

Figure 3: Periapical radiograph showing #44 after the placement of Bioceramic sealer into the canals.

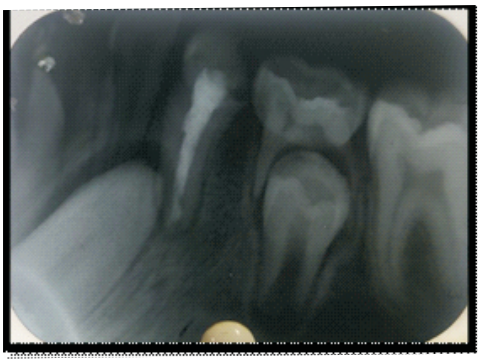

Figure 4: Periapical radiograph of #44 post-operative after one–month follow-upshowing an increase in dentinal root thickness.

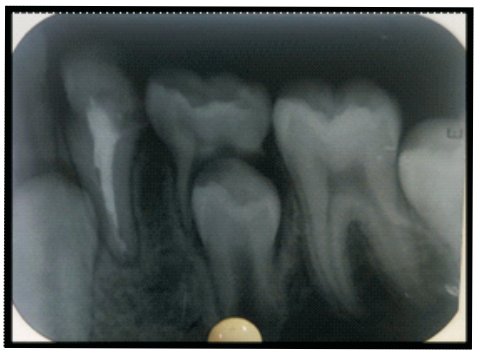

Figure 5: Periapical radiograph showing #44 post-operative after 4 – month follow-up. Complete apical closure, root development and thick dentinal walls can be seen.

Discussion:

Regenerative Endodontic Procedures (REPs) represent a groundbreaking approach for treating immature necrotic teeth, enabling continued root growth and apical closure, a significant improvement over traditional methods such as apexification and apexogenesis. The main goal of REPs is (i) elimination of symptoms and evidence of bone healing, (ii) increasing root wall thickness and increased root length and (iii) positive response to vitality testing.[10] Irrigants and

medications used within the root canal play a crucial role in disinfecting the canal system, serving as the primary means of eliminating infection. Despite numerous studies and protocols aimed at optimizing root canal cleaning and disinfection, sodium hypochlorite has consistently emerged as the most effective irrigating solution.[11, 12]

In this study, the root canal was initially irrigated with 1.5% sodium hypochlorite to remove necrotic tissue and debris. At the subsequent appointment, 17% EDTA was used to clean the dentinal walls, a step particularly beneficial in treating immature teeth with open apices, as EDTA facilitates the adhesion, migration, and differentiation of stem cells from the apical papilla, promoting regeneration towards the dentin followed by normal saline 20ml/canal.[13]

Following thorough cleaning and disinfection of the root canal system, bleeding was intentionally induced in the apical region by over-instrumenting 2 mm beyond the apex, thereby triggering the influx of stem cells from the apical papilla, periodontal ligament, and bone marrow into the affected area, facilitating regeneration.These cells play a crucial role in facilitating pulpal regeneration, promoting dentinal wall thickening, and supporting continued root development.[14, 15] The blood clot scaffold, enriched with stem cells and growth factors, provides a conducive environment for the epithelial cell rests of Malassez and remnants of Hertwig's epithelial root sheath to facilitate radicular development and continued root formation.[16, 17]

Although various medicaments, including mineral trioxide aggregate, Biodentine, and triple antibiotic paste (TAP), have been explored for Regenerative Endodontic Procedures, Bioceramic Sealer was the material of choice in this particular case.

The bioceramic material (Bioaggregate) was selected for its composition of tricalcium silicate, tantalum oxide, calcium phosphate, and silicon dioxide and notably, its absence of aluminum and zirconium oxide.[18]Bioceramic sealers without aluminum and zirconium oxide have several advantages such as improved biocompatibility, enhanced osteogenesis, reduced risk of corrosion, improved sealing ability and increased bioactivity.[19,20] Bioceramic materials also exhibit optimal biological and physicochemical properties, making them conducive to the revascularization process in immature teeth with necrotic pulp.

This case report demonstrates that effective microbial control, combined with proper technique and the use of a bioceramic sealer, can facilitate successful Regenerative Endodontic Management of an immature mandibular premolar, while employing a conservative approach that preserves tooth function, as evident at follow-up.

Conclusion:

The long-term outcomes of this regenerative endodontic protocol, which incorporated microbial control measures including sodium hypochlorite gel irrigation, calcium hydroxide intracanal dressing, revascularization through blood clot formation, and bioceramic material placement, demonstrate its efficacy and potential as a viable therapeutic approach for treating immature teeth with necrotic pulps.

Limitations:

The case report presents a shorter follow–up period. It is limited to a single case report, which limits the generalizability of the findings to a broader population.Regenerative endodontic procedures can vary significantly in terms of protocols, materials, and techniques, which may affect the reproducibility of the results.More extensive studies with longer follow-up periods and larger sample sizes are necessary to confirm the efficacy and safety of using bioceramic sealers in regenerative endodontic treatments.

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