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CASE REPORT

Nonsurgical Management of Large Periapical Lesion in Mature and Immature Teeth using Different Calcium Hydroxide Formulations: Case Series

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ABSTRACT

This case series evaluates the effectiveness of different calcium hydroxide formulations with various vehicles in management of large periapical lesion in mature and immature teeth. This will help clinicians to make informed judgments about which formulations of calcium hydroxide should be used for specific endodontic procedures.

Keywords: Immature teeth, Mature teeth, Calcium hydroxide, Vehicles, Periapical lesion.

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INTRODUCTION

Bacteria are the primary etiological agents in pulpal and periapical inflammation; successful endodontic therapy depends on their reduction or elimination.[1,2] Endodontic treatment is essentially directed toward the prevention and control of pulpal and periradicular infections. Complete chemomechanical preparation may be considered an essential step to root canal disinfection. However, bacteria may still be detected in the root canal system after biomechanical preparation. Total elimination of bacteria is difficult to accomplish. By remaining in the root canal between appointments, intracanal medicaments may help to eliminate surviving bacteria.[3]

Antibacterial intracanal medication has been advocated to eliminate remaining bacteria after canal instrumentation and irrigation. Many medicaments have been used as intracanal dressings and according to their chemical basis, generally fall into the following categories: phenolic derivatives (eugenol, camphorated parachloreophenol, camphorated phenol, metacresylacetate, beechwood creosote, aldehydes (formocresol), halides (Iodide Potassium Iodide), calcium hydroxide, antibiotics and various combinations. The most popular intracanal medicament in use currently is calcium hydroxide $Ca(OH)_2$.[4]

The antibacterial mechanism of $Ca(OH)_2$ is not completely understood but is considered to be related to induce pH elevation. Calcium hydroxide is able to maintain an increased tissue pH over a long time because of the slow release of hydroxyl ions. To produce the desired extraradicular effect, a $Ca(OH)_2$ containing intracanal medicament must diffuse from the root canal into the periapical tissues to elevate the local pH. The faster the diffusion and the higher the ultimate tissue PH produced the more efficient and effective the medicament would be. Because Ca $(OH)_2$ kills by the effect of hydroxyl ions, its efficacy depends on the availability of those ions in solution, which in turn depends on the vehicle in which the calcium hydroxide is carried. Analogously, the effectiveness of calcium hydroxide containing mixtures against microorganisms in the periapical tissues should depend on the efficiency with which the intracanal medicament is able to diffuse from the canal.[5]

Vehicles can be classified into aqueous, viscous and oily, the clinical properties of calcium hydroxide changing depending on the vehicle.[6] The aim of this case series is to evaluate the effectiveness of different calcium hydroxide formulations with various vehicles in management of large periapical lesion in mature and immature teeth. This will help clinicians to make informed judgments about which formulations of calcium hydroxide should be used for specific endodontic procedures.

CASE REPORTS

Case 1

A 22-year-old male with a noncontributing medical history reported to the department of conservative dentistry and endodontics for treatment of a diffuse swelling with the intraoral draining sinus in the maxillary anterior vestibule. The patient stated that he had lost his maxillary right central incisor due to trauma and was replaced. Clinical examination revealed crown and bridge in relation to teeth 12 and 21 (Fig. 1A). Tooth is tested sensitive to percussion and palpation. Periapical radiographs showed a diffuse radiolucent lesion around the apex of tooth 21, a presumptive diagnosis of periapical abscess was made. Root was completely formed (Fig. 1B).

PFM Bridge was removed using crown remover. After removal of previous bridge it was found that coronal tooth structure remaining was adequate. Thermal (Endo Ice, The Hygenic corporation, Akron, oh, USA) and electrical pulp testing (Parkell Farmingdale, NY, USA) is done on the teeth in the area of trauma, i.e. from maxillary left canine to maxillary right canine. All the teeth gave a positive pulpal response indicating their vitality except the involved tooth 21.

Access cavity was prepared under rubber dam isolation. Purulent hemorrhagic exudate discharged from the canal. The tooth was left open until the discharge of the exudates had stopped. Working length was determined using electronic apex locator (Root Zx, J Morita) and radiographs. Chemomechanical debridement of the root canal was performed using K-files size 20 to 80 using step back technique with copius irrigation with 2.5% sodium hypochlorite (Loba Chemie), chlorhexidine gluconate 2% (Loba Chemie) and normal saline. After drying with sterilized absorbent paper points calcium hydroxide mixed with chlorhexidine 2% (Loba Chemie) was placed inside the canal as intracanal medicament. Tooth was temporized using Cavit (3M ESPE). The intracanal dressing is changed weekly for 3 months.

Radiographs taken periodically at the end of third month revealed resolution of periapical radiolucency (Fig. 1C). Calcium hydroxide was removed using EDTA and obturation was performed with gutta-percha and Zoe sealer. The

Figs 1A to E: (A) Preoperative photograph, (B) preoperative radiograph, (C) radiograph at 3 months (D) 6-month follow-up and (E) 1 year follow-up

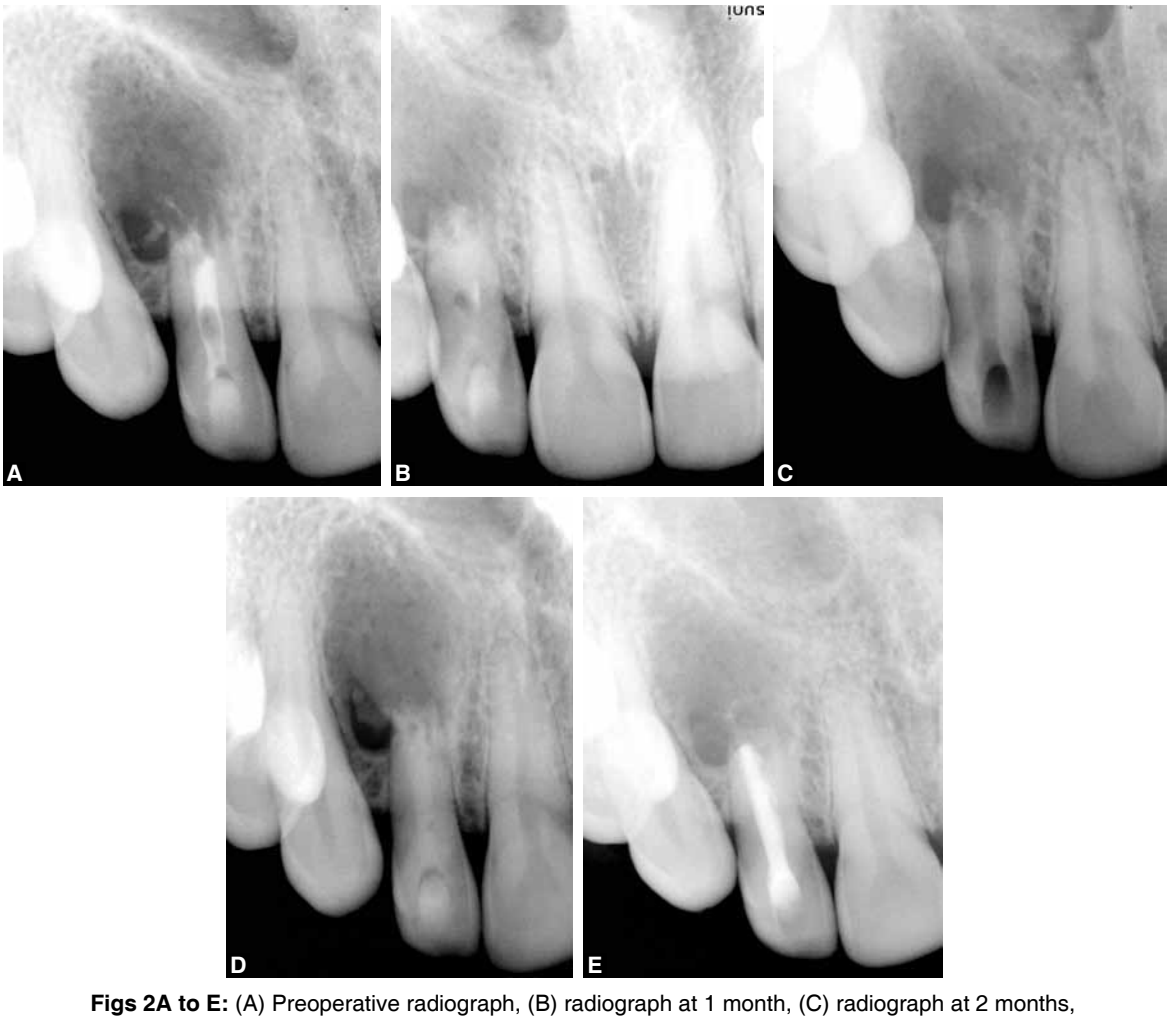
6 months and 1 year follow-up revealed asymptomatic and adequately functioning teeth with radiographic signs of healing (Figs 1D and E).

Case 2

A 20-year-old female reported to department of conservative dentistry and endodontics with fractured, discolored tooth 12 compromising esthetics as well as function. The patient stated that her tooth 12 had fractured when she was 8 years old, and she had undergone root canal treatment 3 years back from a local dentist. Clinical examination revealed fractured and discolored maxillary right lateral incisor with incomplete root canal treatment. Tooth is tested sensitive to percussion and palpation. Thermal (Endo Ice, The Hygenic corporation, Akron, oh, USA) and electrical pulp testing (Parkell Farmingdale, NY, USA) is done on the teeth in the area of trauma, i.e. form tooth 13 to tooth 23, all teeth gave a positive pulpal response indicating their vitality except the involved tooth 12.

The radiographic examination of tooth showed incompletely formed root, characterized by wide root canal space, thin and fragile dentinal wall and increased foraminal opening associated with large periapical radiolucency approximately measuring 2 × 2 cm (Fig. 2A). Presumptive diagnosis of periapical cyst was made.

Access cavity was prepared under isolation with rubber dam. Copious, clear, straw-colored fluid flowed from the canals. Working length is established coinciding with root apex. When the drainage ceased, the canals were prepared using K-files no. 60 to 120, with copious irrigation with 1% sodium hypochlorite, 2% chlorhexidine gluconate and normal saline. Viscous calcium hydroxide paste composed of calcium di hydroxide, glycerol, zinc oxide and barium sulfate (Apexcal, Ivoclar Vivadent) was placed as an intracanal medicament for canal disinfection and tooth is temporized with cavit. The intracanal dressing is changed monthly during four consecutive appointments and the patient was evaluated. Radiographic examination taken at the end of first, second and third month revealed significant decrease in size of the periapical radiolucency, thickening of root canal wall, closure of foraminal opening with periapical barrier formation and additional root development



Figs 2A to E: (A) Preoperative radiograph, (B) radiograph at 1 month, (C) radiograph at 2 months, (D) radiograph at 3 months and (E) 6 months follow-up

(Figs 2B to D). Calcium hydroxide dressing was removed using 17% EDTA. After apical barrier formation was confirmed by using K-files, obturation was performed with rolled cone technique using gutta-percha and zinc oxide eugenol sealer. The 6 months follow-up revealed asymptomatic teeth with radiographic signs of healing (Fig. 2E).

Case 3

A 35 years female patient reported to department of conservative dentistry and endodontics with pain in relation teeth 11, 12 and 22. Her dental history revealed traumatic injury to the teeth 2 years back due to fall from stairs.

Clinically, there was edema in the anterior facial region and alveolar mucosa associated with sensitivity to palpation. Thermal (Endo Ice, The hygienic corporation, Akron, Oh, USA) and electronic pulp testing (Parkell Farmingdale, NY, USA) were negative for tooth 11, 12, 13 whilst adjacent teeth gave normal response.

Radiographically teeth 11, 12, 22 exhibited wide canal with an open apex and a large periapical lesion approximately 3 × 3 cm in diameter with a well defined margin in relation to 11, 12 and 22. Presumptive diagnosis of periapical cyst in relation to teeth 11, 12, 22 was made (Fig. 3A).

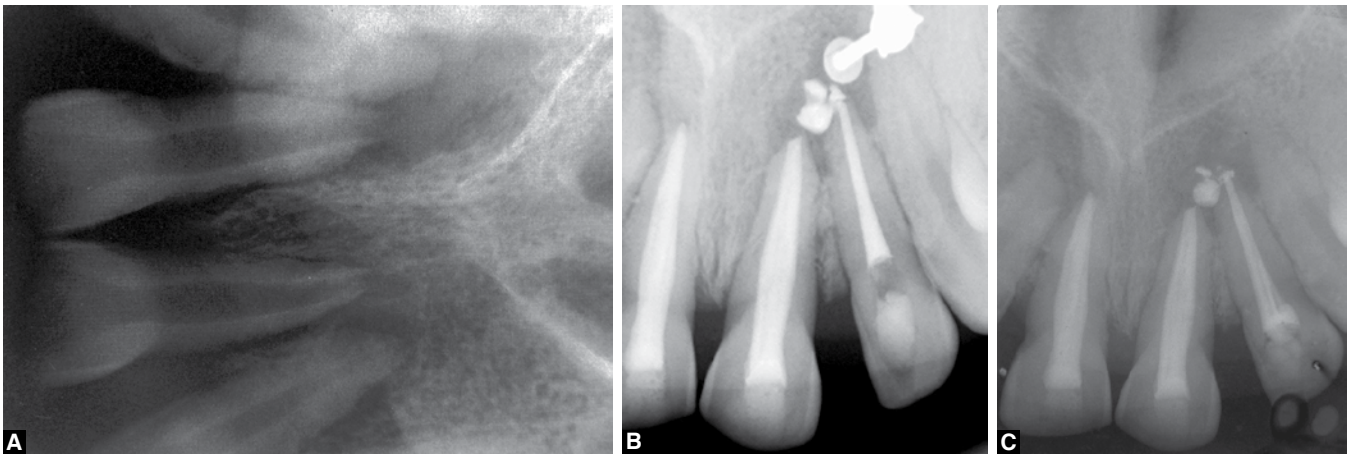
Access cavity was prepared under isolation with rubber dam copious drainage of purulent exudates is observed. The tooth was left open until the discharge of purulent exudates had stopped. Working length was established coinciding with root apex. Chemomechanical debridement of the root canal was performed using K-files 40 to 80 with copious irrigation with chlorhexidine gluconate 2% (Loba Chemie), sodium hypochlorite 1% (Loba Chemie) and normal saline. Root canal is temporarily sealed with Cavit (3M Espee, Seefield, Germany). Canals were dried with sterilized absorbent paper points then oil based calcium hydroxide paste Metapex (META Biomed co., Ltd Korea) was placed. Provisional protection was performed with GIC.

Radiographs taken periodically at the end of 6 months revealed resolution of periapical radiolucency, evidence of closure of foraminal opening and associated additional root development (Fig. 3B). Metapex was removed using 10% citric acid. Root canal obturation was performed with apically molded and heated gutta-percha technique. Radiographs taken at the end of 1 year reveal healthy periapical area with additional root development (Fig. 3C).

DISCUSSION

The studies have evaluated the strong correlation between apical periodontitis and the presence of bacteria in canals. Cleaning, shaping and irrigation greatly reduce the cultivable number of bacteria, typically by 99 to 99.9%. However, studies have shown that it is impossible to achieve a sterile root canal system in all cases by cleaning and shaping alone (62% remaining positive) in agreement with Bystorm and Sundqvist.[7,8] Residual bacterial are most often located in inaccessible areas such as isthmuses, ramifications, deltas, accessory and lateral canals and dentinal tubules. If bacteria persist in the root canal system at the time of obturation, there is a higher risk of failure. So, it is essential to reduce the microbial flora to as low level as possible to ensure a successful outcome. Hence, attempts of eliminate remaining bacteria involve the use of an antibacterial dressing. Calcium hydroxide currently remains the best medicament available. Therefore, to maximize reduction of bacteria in the root canal before root canal filling, calcium hydroxide should be used as an inter appointment dressing for minimum 7 days.[4] So calcium hydroxide is selected as intracanal medicament in the cases treated.

According to Tronstad et al[9] and Soares and Santos,[10] the favorable clinical, radiographic and histological responses obtained with calcium hydroxide are related to the participation of Ca^{++} and OH^{-} ions in several mechanisms which would provide: (i) control of the inflammatory reaction (by hygroscopic action: formation of calcium



Figs 3A to C: (A) Preoperative radiograph, (B) radiograph taken at 6 months and (C) 1 year follow-up radiograph

proteniate bridges and inhibition of phospholipase); (ii) the neutralization of acidic products of osteoclasts (acid hydrolases and lactic acid) (iii) the induction of mineralization (activation of alkaline phosphatase and calcium-dependent ATP ases); (iv) the induction of cell differentiation ; (v) the depolymerization of endotoxins; and (vi) antibacterial action by means of irreversible damage to DNA, proteins, enzymes and bacterial lipids.[9,11-15] The vehicle plays an important role in the overall process because it determines the velocity of ionic dissociation causing the paste to be solubilized and resorbed at various rates by the periapical tissues and from within the root canal.

The differences in the velocity of ionic dissociation are related directly to the vehicle employed to obtain the paste. In general, three types of vehicles are used: aqueous, viscous and oily.[6]

This case series describes the outcomes of 3 patients who presented with mature and immature permanent teeth with large periapical lesion. In case-1 patient is young 20 years old male with a diffuse swelling with mature root formation in relation to tooth 21. Calcium hydroxide mixed with chlorhexidine 2% is used as intracanal medicament. Differences in the velocity of hydroxylion dissociation are seen when various vehicles are employed to produce the calcium hydroxide paste. The lower the viscosity of the paste, the higher will be the ionic dissociation.[6] Since aqueous vehicles promote a rapid release of hydroxyl ions it is used in this patient. The antimicrobial action of calcium hydroxide is related to the release of hydroxyl ions in an aqueous environment and therefore depends on the ability of these ions to diffuse through dentin and periapical tissue remnants to reach sequestered bacteria. To do so, the ionic diffusion of calcium hydroxide should exceed the buffering ability of the dentin. Calcium hydroxide owes its biocompatibility to its low water solubility, but this low solubility and diffusibility mediates against its ability to produce the rapid increase in pH necessary to eliminate bacteria from the dentinal tubules and root canal intricacies.[1]

This type of vehicle promotes a high degree of solubility when the paste remains in direct contact with the tissue and tissues fluids, causing it to be rapidly solubilized and resorbed by macrophages. The root canal may become empty in short period, delaying the healing process.[6] So the intracanal dressing is changed every week for 3 months in this case, which resulted in uneventful healing of the periapical lesion.

In case 2, patient is 20-year-old female presented with a large periapical lesion with well defined margins associated with wide canal and an open apex in relation tooth 12. Endodontic treatment with calcium hydroxide has been demonstrated to be successful method in periradicular healing and apical root closure even in mature tooth with cyst like large periapical lesion.[16] Viscous calcium hydroxide paste composed of calcium dihydroxide, glycerol, zinc oxide and barium sulfate (Apex Cal, Ivoclar Vivadent) is used as intracanal medicament. As this was a case of large periapical lesion with open apex viscous vehicle is used to promote healing of periapical lesion, closure of apex and to promote undisturbed apical root development. Viscous vehicles are utilized because these substances release Ca^{++} and OH^{-} ions more slowly for extended periods which resulted in significant decrease in size of the periapical lesion, thickening of root canal wall and closure of foraminal opening. They promote lower solubility of paste when compared to aqueous vehicles, probably because of their high molecular weights. The high molecular weight of these vehicles minimizes the dispersion of calcium hydroxide into the tissue and maintains the paste in the desired area for longer intervals; this factor prolongs the action of the paste, and Ca^{++} and OH^{-} ions will be given off at lower velocity.

And also viscous vehicle containing calcium hydroxide may remain within the root canal for 2 to 4 months interval, the number of appointments and redressing of the root canal is drastically reduced.[6]

In case 3, 35 years old female patient reported with large cyst like periapical lesion with incompletely formed root, characterized by wide root canal space, increased foraminal opening in relation to tooth number 11, 12, 13. Oil based formulation of calcium hydroxide paste Metapex (META BIOMED) containing calcium hydroxide with silicon oil and iodoform is used as intracanal medicament. Since this patient had large cyst like lesion involving multiple teeth characterized by wide root canal space and increased foraminal opening oily vehicle was used because oily vehicles are nonwater soluble substances that promote the lowest solubility and diffusion of the paste within the tissues. Pastes containing this kind of vehicle may remain within the root canal for longer than pastes containing aqueous or viscous vehicles and this paste was most frequently indicated for apexification procedures.[6]

At present the only agent that dissolves pulp tissue is sodium hypochlorite. This explains its continued popularity among clinicians. 2.5 and 1% solutions both are suitable for clinical endodontic use.[17] 2.5% solution of sodium hypochlorite is used as irrigant in Case-1 since the root was completely formed, chances of extrusion in the periapical area was minimal. In cases 2 and 3, 1% of sodium hypochlorite is selected for irrigation as it was an open apex case.

It is known that residual $Ca(OH)_2$ influences the setting mechanism of zinc oxide-eugenol-type endodontic sealers.[18] The vehicle used to prepare calcium hydroxide paste is

important for its retrieval. Oil based $Ca(OH)_2$ is more difficult to remove than powder form $Ca(OH)_2$ mixed with distilled water. Both 17% EDTA and 10% citric acid were found to remove the powder form of $Ca(OH)_2$ in distilled water efficiently, whereas 10% citric acid was found to perform better than EDTA in removing oil based $Ca(OH)_2$. This probably could be because of reason that EDTA chelates calcium ions in water but citric acid is able to penetrate the silicon oil better in comparison to EDTA and chelates Ca ions.[19,20] Hence citric acid is used in case 3 for removal of Metapex and 17% EDTA and sodium hypochlorite is used in case 1 and 2 for removal of aqueous and viscous based $Ca(OH)_2$.

CONCLUSION

To date, no clinical case series has been reported for nonsurgical management of large periapical lesion with immature and mature root using different calcium hydroxide formulations. The value of case reports is the demonstration of what is possible in our patients. Importantly, the value of prospective randomized clinical trials is their ability to provide strong quantitative evidence for both treatment efficacy and the potential for adverse effects. This case series provides impetus for developing prospective randomized controlled trials evaluating these methods.

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