Effect of Unintentionally Extruded Calcium Hydroxide Paste Including Barium Sulfate as a Radiopaquing Agent in Treatment of Teeth with Periapical Lesions: Report of a Case

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Abstract

Calcium hydroxide [$Ca(OH)_2$] has been widely used as short- or long-term intracanal antibacterial dressing material after endodontic treatment. In general when used in endodontics, $Ca(OH)_2$ paste is composed of the powder, a vehicle, and a radiopacifier. To provide radiopacity, barium sulfate ($BaSO_4$) powder is usually added to the paste. In this case report, $BaSO_4$:$Ca(OH)_2$ powders (ratio 1:8) and distilled water were mixed and applied as dressing material after root canals of mandibular left canine and premolar teeth with periapical lesions. However, the prepared paste was unintentionally extruded into the periapical lesion during application. The patient was seen 12 and 36 months later, at which point periapical healing was evaluated. At this time, it was observed that the periapical lesion had disappeared, but white radiopaque spots were seen at the place where calcium hydroxide remnants had originally been present. The presented case report reveals that when $Ca(OH)_2$ paste that included $BaSO_4$ was applied as an intracanal dressing and extruded through the periapical lesion associated with pulpless teeth, it had no detrimental effect. However, healing might take longer when $Ca(OH)_2$ paste including $BaSO_4$ is used, so deliberate overextension is not advocated. *(J Endod 2008; 34:888–891)*

Key Words

Barium sulphate, calcium hydroxide, periapical lesion

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0099-2399/$0 - see front matter

doi:10.1016/j.joen.2008.04.012

Calcium hydroxide [$Ca(OH)_2$] has been used in dentistry for almost a century (1). Its use in root canal treatment as an intracanal medication has been associated with periradicular healing (2). This was promoted by a series of articles (3, 4) documenting the antibacterial efficacy of $Ca(OH)_2$ in human root canals. Subsequent studies substantiated these reports (5, 6), and the routine use of $Ca(OH)_2$ as an interappointment intracanal medicament became widespread.

$Ca(OH)_2$ is an effective intracanal antibacterial dressing, mainly as a result of its high pH and its destructive effect on bacterial cell walls and protein structures (7). It has been demonstrated that treatment with $Ca(OH)_2$ as an interim dressing in the presence of large and chronic periapical lesions can create an environment more favorable to healing and encourage osseous repair (8). $Ca(OH)_2$ is a formless, thin, granular powder with strong basic properties and a density of 2.1. It can dissolve only slightly in water and is insoluble in alcohol. A $Ca(OH)_2$ paste for use in endodontics is composed of the powder, a vehicle, and a radiopacifier. $Ca(OH)_2$ mixed with any of the vehicles (aqueous, viscous, or oily) lacks radiopacity and is not easily seen radiographically. This is the main reason that radiopaque materials (barium sulfate [$BaSO_4$] and bismuth, and other compounds containing iodine and bromine) are added to the paste, thereby allowing identification of lateral and accessory canals, resorptive defects, fractures, and other structures (9, 10). Nevertheless, in apexification cases, it has been recommended that a $Ca(OH)_2$ mixture without the addition of a radiopaquer be used because $Ca(OH)_2$ washout is evaluated by its relative radiodensity in the canal in follow-up appointments (11).

Although during root canal treatment $Ca(OH)_2$ dressing material might sometimes unintentionally escape through the apex of the tooth, in the presence of large and chronic periapical lesions, the deliberate placement of $Ca(OH)_2$ beyond the confines of the root canal and into the periradicular tissues has also been advocated. Some speculate that this has a direct effect on inflamed tissue and epithelial cystic linings and that it favors periapical healing and encourages osseous repair (12). Such deliberate overextension is not, however, widely advocated because periapical extrusion of $Ca(OH)_2$ can have damaging effects. Reports dealing with bone necrosis and continuing inflammatory responses in repaired mechanical perforations (13), the neurotoxic effects of root canal sealers (14, 15), cytotoxicity on cell cultures (16), damaged epithelium with or without cellular atypical when applied on hamster cheek pouches (17), cellular damage after early $Ca(OH)_2$ dressing of avulsed teeth (18), and necrosis of buccal gingiva and mucosa after periradicular overextension caused by alkaline burn (19) have been presented.

In endodontics, $BaSO_4$ is often used as a radiopaquing agent in $Ca(OH)_2$ pastes. Insoluble $BaSO_4$ is inexpensive and nontoxic. But when $Ca(OH)_2$ paste including $BaSO_4$ is extruded beyond the apex, the $BaSO_4$ can obscure the apex and is not readily resorbed over time. Therefore, healing after the use of $Ca(OH)_2$ paste might take longer, or this situation might make a radiographic interpretation of osseous healing more difficult (9). Furthermore, the effect of overflow of $Ca(OH)_2$ paste including a $BaSO_4$ and/or another radiopaque agent into the periradicular tissues on the healing of periapical lesions is not completely understood. Therefore, most clinicians prefer to use pure

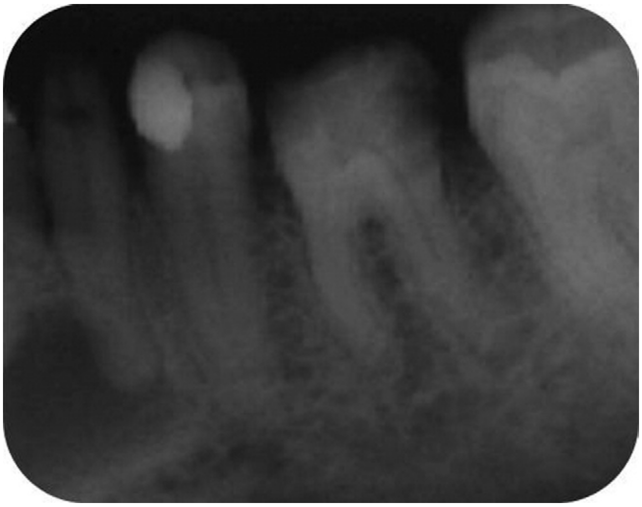

Figure 1. Radiograph of the left mandibular canine and premolar teeth with periapical radiolucency.

$Ca(OH)_2$ because they believe that the ingredients of commercial preparations might retard or delay the reparative processes they seek (9).

Also, in orthopedic surgery, $BaSO_4$ is commonly added to bone cement, resulting in radiopacity and aiding with radiologic assessment (20). But there is evidence that $BaSO_4$ causes a significant pathologic response in the tissue surrounding the injection area. Intradermal injection of $BaSO_4$ into animals is known to cause a foreign-body inflammatory reaction (21). $BaSO_4$ has also been shown to intensify the release of inflammatory mediators in response to polymethylmethacrylate (PMMA) particles (22). A study done by Sabokbar et al. (20) suggested that radiopaque agents in bone cement might contribute to the resorption of aseptic loosening by enhancing macrophage-osteoclast differentiation. Research done by Ingham et al. (23) suggested that the addition of radiopaque additives to bone cement might increase the capacity of the debris to induce osteolysis. In another study, Wimhurst et al. (24) found that particles of bone cement appear to promote osteolysis at the bone-implant interface, and that this effect is most marked when $BaSO_4$ is used as the radiopaque agent. Acarturk et al. (25) studied the impact of $BaSO_4$ on remodeling and regeneration in rabbits with tibial defects that were treated with the Norian skeletal repair system (SRS). The study found that standard SRS and SRS with $BaSO_4$ appeared to be biocompatible and osteoconductive. There was no evidence of either inflammation or fibrous tissue around the implant materials or at the bone-material interfaces. But in SRS with $BaSO_4$, the residual $BaSO_4$ was localized to the intramedullary canal of the tibia.

In this case report, the effect of accidental and voluminous $Ca(OH)_2$ with $BaSO_4$ overextensions into periradicular lesions and tissues on the prognosis of periapical healing in the mandibular left canine and premolar teeth with periapical lesions was evaluated.

Case Report

A 42-year-old man was referred to our clinic for endodontic treatment of his mandibular left canine and premolar teeth with a history of trauma. The teeth were clinically asymptomatic. There was no intraoral sinus tract related to teeth. A routine periapical radiograph revealed the presence of a periradicular lesion in association with the teeth. Thermal and electric pulp tests confirmed that the teeth were nonvital. The patient reported that 2 or 3 months before this appointment, he had experienced swelling and pain in the left mandible after having suffered a blow to the area. He was taking penicillin prescribed by his referring dentist. There was no evidence of current swelling or tooth mobility. No signs of an active sinus tract were seen.

Endodontic treatment was initiated in both teeth. The teeth were opened without anesthesia. Root canals were dry, and there was no apical exudation. The root canals were cleaned and shaped up to a master apical file #55 (Kerr, Romulus, MI), according to the step-back technique, by using 2 mL 5.25% sodium hypochlorite (NaOCl) solution between each file. Afterwards, the root canals were dried with sterile paper points (SPI Dental Mfg, Inc, Inchon, Korea), and $Ca(OH)_2$ powder was mixed with $BaSO_4$ powder (ratio 1:8) and distilled water and placed into root canals of both teeth by using a lentulo spiral (Fig. 1). During this procedure, the mixture was accidentally extruded into the periapical lesion (Fig. 2). No pain was reported during the placement of the $Ca(OH)_2$ paste.

The patient was seen again after 1 week. During the second appointment, he reported that he had experienced slight sensitivity on the day after the placement of $Ca(OH)_2$, and that it had disappeared the next day. During this second appointment, root canals were reirrigated with 5.25% NaOCl and dried with paper points. A new $Ca(OH)_2$ dressing was not put in place. The root canals were finally obturated with AH Plus (Dentsply DeTrey GmbH, Konstanz, Germany) + gutta-percha (Diadent Group International, Inc, ChongJu City, Korea) by using the cold lateral condensation technique.

After root canal treatment, the patient was seen again 12 and then 36 months later. During these appointments, the control radiograph revealed remnants of the calcium hydroxide dressing in the periradicular region; in addition, the periapical lesion was seen to have healed (Fig. 3).

Discussion

The presented case report showed that when a $Ca(OH)_2$ paste including $BaSO_4$ was applied as an intracanal dressing and extruded through the periapical lesion associated with pulpless teeth, there was no detrimental effect; throughout the period after the $Ca(OH)_2$ paste

Figure 2. Radiograph after placement of an intracanal $Ca(OH)_2$ paste dressing with unintentional periapical overextension.

Figure 3. The 36-month control radiograph showing healing of the apical lesion and the presence of a white radiopaque spot at the place where calcium hydroxide remnants were originally present.

was extruded, the teeth were continuously free of symptoms. But in the present case, complete resorption of the paste did not occur, although the periradicular and periextrusion radiolucency disappeared. A possible explanation for the incomplete resorption of paste might be that the paste contains $BaSO_4$. When $Ca(OH)_2$ is extruded beyond the apex, the $BaSO_4$ can obscure the apex and is not readily resorbed over time (9). Therefore, the healing property of $Ca(OH)_2$ paste might take longer to work effectively (9). In addition, $BaSO_4$ demonstrates a residual radiopacity (9). A study by Webber et al. (26) suggested that a reduction of the usual ratio of $BaSO_4$:$Ca(OH)_2$ to 1:8 will reduce the problem of residual radiopacity at the root apex. However, in one case, radiopaque remnants of the paste were still obscuring the apex of a treated tooth after 21 months. This made a radiographic interpretation of osseous healing more difficult. Residual radiopacity is due to the inability of the body to resorb insoluble $BaSO_4$. Consequently, the paste with $BaSO_4$ might cause problems with the radiographic interpretation of the healing process because of its unresorbable properties. Only 0.02 g of $BaSO_4$ can be dissolved in 100 mL of water. Although it has also been proposed that practitioners use resorbable iodine compounds like diatrizoate or iothalamate instead of $BaSO_4$, these do not have a significant effect on the length of the healing period (9).

Vernieks and Messer (27) suggested that extrusion of $Ca(OH)_2$ beyond the apex might be a cause of the lack of early healing of periapical lesions. De Moor and De Witte (8) evaluated the effect of accidental and voluminous $Ca(OH)_2$ overextensions into periradicular lesions and tissues on the prognosis of periapical healing. They also reported that in the cases of extensive $Ca(OH)_2$ overextension, repair took more than 6 months to be complete. Also, researchers observed that complete resorption of the paste including $BaSO_4$ did not occur, although the periradicular and periextrusion radiolucency disappeared. In the present case, it took approximately 36 months for periradicular radiolucency to disappear. Therefore, our finding confirms the findings of those researchers.

In orthopedic surgery, several studies reported that the presence of $BaSO_4$ can negatively influence the mechanical properties of the bone cement. Research by Ginebra et al. (28) showed that the presence of $BaSO_4$ particles results in a decrease of the tensile strength when compared with the use of radiolucent cement. The work of Haas et al. (29) showed that cement containing $BaSO_4$ possesses lower tensile and transverse strength and a lower modulus of rupture compared with radiolucent counterparts. For this reason, $BaSO_4$, radiopaque agent used in endodontics, might also cause problems by altering the manipulative properties of $Ca(OH)_2$. Alacam et al. (9) suggested that some deviations in the paste consistency might form when powders of $Ca(OH)_2$ and $BaSO_4$ were mixed with pure water. According to the researchers, because the water affinity of $BaSO_4$ and $Ca(OH)_2$ powders in different concentrations differed, the amount of water that was sufficient to make the ideal paste would also be different. To establish an ideal paste consistency, the water affinity of each powder should be determined and the concentrations prepared (9). Therefore, in the presented case, the long healing period might also be related to the consistency of paste together with the amount of extruded paste and the dimension of the lesion.

Consequently, although extensive extrusion of $Ca(OH)_2$ paste including $BaSO_4$ through the periapical lesion associated with pulpless teeth has no detrimental effect, deliberate overextension is not advocated because $BaSO_4$ has unknown effects on the healing process.

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