Case Report

Hardened exogenous material after extrusion of calcium hydroxide with barium sulfate

Case study and histopathologic and laboratory analyses

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ABSTRACT

Background and Overview. Although calcium hydroxide ($Ca[OH]_2$) paste associated with barium sulfate ($BaSO_4$) is considered a safe agent, there is a lack of clinical research on its effects on periodontal and submucosal tissues. The aim of the authors was to report the effects of extrusion of Ultracal XS paste (Ultradent Products) in 2 cases. The authors also analyzed the paste constituents and compared them with the proportion reported by the manufacturer and the material extruded.

Case Description. The authors present 2 cases in which root canals were restored with Ultracal XS paste after cleaning and shaping, and there was unintentional overextension of the paste into periradicular tissues, with a hardened exogenous material observed associated with inflammatory signs and symptoms. A biopsy was performed, and the material was subjected to histopathologic analysis and characterization through scanning electron microscopy, energy dispersive x-ray spectroscopy, Fourier transform infrared spectroscopy, and x-ray diffraction.

Conclusions. $BaSO_4$ and calcium carbonate ($CaCO_3$) were associated with a hardened material after Ultracal XS paste extrusion. The $Ca(OH)_2$ percentage on the Ultracal XS paste was approximately 2 times greater than the proportion reported by the manufacturer.

Practical Implications. $Ca(OH)_2$ with $BaSO_4$ paste application should be performed carefully, and its extrusion to periradicular and submucosal tissues should not occur. Its extrusion may result in the formation of a persistent exogenous material of hardened consistency associated with inflammatory signs and symptoms.

Key Words. Biopsy; dental materials; endodontic therapy; foreign bodies; root canal.

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Calcium hydroxide ($Ca[OH]_2$) intracanal medicament is widely used for its inhibitory properties on clastic activity through the formation of an alkaline environment, in addition to its biological activities as a mineralizer, anti-inflammatory, tissue-dissolution, and antimicrobial agent.[1-3] The antimicrobial activity of $Ca(OH)_2$ is achieved through the release of highly reactive hydroxyl ions in an aqueous environment, which primarily affects cytoplasmic membranes, proteins, and DNA.[4] Moreover, the effectiveness of chemomechanical preparation against endotoxins is clinically improved with the use of root-canal medicament.[5] In endodontic retreatment, its use has been associated with relief of postoperative pain in patients with previously symptomatic teeth as well as with a reduced frequency of flare-ups.[6]

The placement of $Ca(OH)_2$ paste should be limited to within the root canal, but unintentional overextension of $Ca(OH)_2$ paste into periradicular tissues is more likely to occur in canals with large and open apexes.[7] Overextension of the $Ca(OH)_2$-based medicament was previously supported because it is thought to have beneficial properties for promoting healing.[8] Once in contact with tissues, $Ca(OH)_2$ triggers superficial necrosis and subsequent inflammation, which encourages repair

and active calcification.[4] Although $Ca(OH)_2$ paste is considered a safe agent,[9,10] adverse effects such as nerve and tissue lesions have been reported as a result of its extrusion.[11] The effect of $Ca(OH)_2$ paste on periodontal tissue is a controversial issue.[4]

$Ca(OH)_2$ paste is a mixture composed of the powder and a vehicle (aqueous, viscous, or oily). Radiopacifiers can be included to aid in radiologic assessment.[7] Commercial $Ca(OH)_2$ formulations are ready-to-use products and may also include radiopacifiers (for example, Vitapex, Neo Dental Chemical Products; Pulpdent Multi-Cal, Pulpdent; and Ultracal XS, Ultradent Products). According to the manufacturer, Ultracal XS consists of an aqueous solution of 30 through 35 percentage by weight $Ca(OH)_2$, 20 wt% barium sulfate ($BaSO_4$) or less, and an unidentified vehicle with a high pH (12.0-13.0). $BaSO_4$ is commonly used as a radiopacifier agent,[12] and its effects on tissues are questionable.[13-16] The overflow of $Ca(OH)_2$ powder mixed with $BaSO_4$ powder (ratio, 1:8) applied to periradicular tissues was previously associated with retardation and hindering of $Ca(OH)_2$ paste resorption.[7] Extrusion of this mix may cause several reactions, and to our knowledge, no researchers have reported on the effects of Ultracal XS paste extrusion on periradicular and submucosal tissues.

Our purpose in this study was to report the effects of unintentional extrusion of Ultracal XS paste on periradicular and submucosal tissue in 2 clinical cases in which signs and symptoms persisted. We also analyzed Ultracal XS paste constituents. We compared the results with the paste composition stated by the manufacturer and to the extruded material.

CASE 1

A 50-year-old man visited an endodontic specialist at a private dental office with the symptom of purulent exudate. His medical history was noncontributory, and he had no history of trauma. The intraoral examination revealed a sinus tract associated with the left maxillary central incisor (tooth no. 9) and extensive restoration and the presence of a carious lesion on the same tooth (Figure 1A). The tooth was tender to vertical percussion and palpation testing. A periapical radiograph revealed a J-shaped radiolucency surrounding the apex of tooth no. 9 and radiopaque structures consistent with a post and a previously treated root canal (Figure 1B). No deep periodontal pockets were present. On the basis of American Association of Endodontists terminology,[17] the specialist clinically diagnosed tooth no. 9 with a previously treated root canal (pulpal condition) and chronic apical abscess (apical condition). The specialist conducted nonsurgical endodontic retreatment. The specialist removed the post and the restoration material with the aid of a dental operating microscope and ultrasonic instruments. No crack was detected. The specialist completed the apical preparation with a no. 50 K-type hand file. After chemomechanical preparation, the specialist positioned a 29-gauge needle at 2 millimeters of its working length and slowly restored the canal with Ultracal XS paste up to the cementoenamel junction (Figure 1C). The access cavity was then sealed with composite resin (CR). At the next visit 15 days later, the specialist observed persistence of the sinus tract in association with a hardened material. Apical palpation provoked drainage of the exogenous material (Figures 1D and 1E). The interappointment medicament was removed. The specialist instrumented the canal again and restored it with $Ca(OH)_2$ powder mixed with a saline solution. The specialist resealed the access cavity with CR.

After 7 days, complete remission of the sinus tract was observed, and the patient reported no symptoms (Figure 1F). After removal of the $Ca(OH)_2$ paste, the specialist completed repreparation and performed obturation with gutta-percha and sealer using a continuous wave technique (Figure 1G).[18] The specialist then restored the crown with CR. The patient continued to be free of signs and symptoms after 8 months of follow-up (Figure 1H).

CASE 2

A 74-year-old woman reported a traumatic injury with extrusion of teeth nos. 9 and 10 (left maxillary central and lateral incisor, respectively), which she immediately repositioned herself. After cone-beam computed tomography (CBCT), a general dentist at a hospital dental clinic detected a maxillary alveolar fracture involving the buccal cortical portions of the left maxillary anterior teeth at the level of the apexes (Figure 2A). The dentist applied a semirigid splint and referred the patient to an endodontic specialist at a private dental office. The patient's medical history was noncontributory. At the intraoral examination, teeth nos. 9 and 10 were found to be misaligned. The crowns presented no signs of change in morphology and color. Mild swelling of the

ABBREVIATION KEY

Au:	Gold.
Ba:	Barium.
$BaSO_4$:	Barium sulfate.
C:	Carbon.
$CaCO_3$:	Calcium carbonate.
$Ca(OH)_2$:	Calcium hydroxide.
CBCT:	Cone-beam computed tomography.
CR:	Composite resin.
EDS:	Energy dispersive x-ray spectroscopy.
FTIR:	Fourier transform infrared.
IR:	Infrared.
La:	Lanthanum.
mag:	Magnification.
Na:	Sodium.
Nb:	Niobium.
O:	Oxygen.
S:	Sulfur.
SEM:	Scanning electron microscopy.
Ti:	Titanium.
XRD:	X-ray powder diffraction.