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Practice Limited to Endodontics



A Comparison of Calcium Hydroxide and Mineral Trioxide Aggregate for Pulp Capping

After trauma or an injury to a tooth that creates pulp exposure, pulp capping is usually indicated. By promoting the dentinogenic potential of pulpal cells, pulp capping offers a more conservative approach to root canal therapy when the vital pulp is exposed with reversible injury or without signs of inflammation.

The success of pulp-capping materials can be determined by the thickness of the dentinal bridge, the morphology of the dentinal bridge, the intensity of pulpal

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inflammation, the presence of odontoblasts and biocompatibility. Although calcium hydroxide ($\text{Ca}[\text{OH}]_2$) has long been considered the gold standard for pulp-capping procedures, studies conducted in the past 2 decades

have suggested that mineral trioxide aggregate (MTA) may be a better alternative.

Use of MTA has demonstrated a significantly greater frequency of dentin bridge formation, thicker and less porous dentin, and less pulp inflammation than has use of $\text{Ca}(\text{OH})_2$ (Figure 1). MTA has also been shown to induce the recruitment and proliferation of undifferentiated cells to form a dentinal bridge while reducing inflammation better than $\text{Ca}(\text{OH})_2$. Moreover, researchers have found that, when placed in direct contact with them, MTA differentiates human dental pulp cells (DPCs) into odontoblast-like cells. However, little is known about the importance of this direct interaction with the cells. It has been unclear whether MTA needs to be in direct contact with the pulp cells or whether it secretes soluble substances that could exert the same effects on the pulp.

To resolve the question of whether direct MTA/pulp cell contact is a prerequisite for differentiating DPCs, Paranjpe et al from the University of Washington compared the effectiveness of MTA when placed in direct contact with DPCs and the effectiveness of MTA when placed in indirect contact with DPCs using a cell culture insert as a barrier.

Human DPCs, derived from extracted third molars, were divided into 3 groups:

- **Group 1:** DPCs grown on a culture dish (control)
- **Group 2:** DPCs cultured directly beneath ProRoot Grey MTA (Tulsa Dental, Tulsa, OK)
- **Group 3:** DPCs cultured beneath a cell culture insert containing ProRoot Grey MTA

The authors measured the levels of gene expression, secretion of vascular endothelial growth factor (VEGF) and the rates of cell proliferation for 7 days. Cells in direct contact with MTA expressed significantly more important odontoblastic genes, such as osteocalcin and dentin sialoprotein, on day 7 than did cells in indirect contact with MTA. MTA placed in direct contact with DPCs also induced a significant increase in the secretion of VEGF compared with the other groups.

Conclusion

Direct contact of DPCs with MTA promoted differentiation of the pulp cells into odontoblast-like cells, the cells responsible for dentin bridge formation. DPCs placed in direct contact with MTA showed higher levels

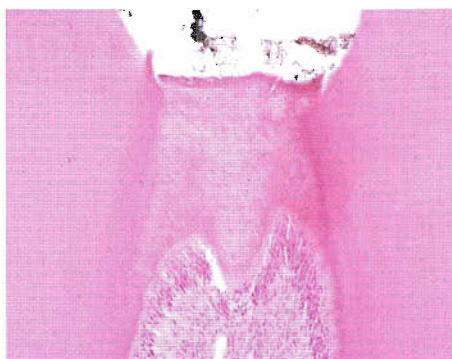


Figure 1. Dentin bridge following MTA pulp-capping procedure. (Photograph courtesy of Dr. Frederic Barnett.)

of activation, which in turn could translate into more effective pulpal repair and faster and more predictable formation of reparative dentin. The authors believed that this aspect of MTA is particularly important during the process of direct pulp capping. Overall, the data presented in this study underscore the significance of placing MTA in direct contact with cells and will help practitioners to use this material in the optimal manner, which in turn can lead to more successful treatment outcomes.

Paranjpe A, Smoot T, Zhang H, Johnson JD. Direct contact with mineral trioxide aggregate activates and differentiates human dental pulp cells. J Endod 2011;37:1691-1695.

Postoperative Pain In Symptomatic Patients with Pulp Necrosis

The endodontist frequently treats symptomatic teeth with a pulpal diagnosis of necrosis. Although thorough debridement of the root canal system by way of cleaning and shaping procedures should minimize posttreatment discomfort by reducing bacteria and inflammatory mediators, moderate to severe postoperative symptoms can persist after the first visit, requiring the use of pain medication (non-steroidal anti-inflammatory drugs [NSAIDs] and/or narcotics) to help reduce postoperative pain.

Many studies have undertaken the evaluation of various analgesics on postoperative pain. However, these studies diverged greatly in their

methods of pain assessment. Some studies evaluated the occurrence of interappointment emergencies, use of analgesics and effect of drainage on postoperative pain but failed to separate the diagnosis of various pulpal conditions (vital vs necrotic) and/or evaluated postoperative pain only during short time intervals.

Wells et al from The Ohio State University performed a study of symptomatic patients diagnosed with pulpal necrosis with periapical radiolucency who were experiencing moderate to severe preoperative pain. The authors compared the efficacy of ibuprofen use with ibuprofen/acetaminophen use for postoperative endodontic pain.

The study included 71 adult patients in good health and ≥ 18 years of age who required emergency endodontic treatment for a symptomatic tooth with a pulpal diagnosis of necrosis and periapical radiolucent area and presentation with moderate to severe pain. Patients reported pain on a Heft-Parker visual analogue scale (VAS). After treatment with hand and rotary instrumentation, the patients were randomly divided into 2 groups.

In one group, patients received 600 mg ibuprofen; the other group received 600 mg ibuprofen combined with 1000 mg acetaminophen. Both groups were instructed to take medication every 6 hours as needed for pain. Patients also kept a diary for 5 days in which they recorded pain, symptoms and the amount of medication taken. If the study medication did not alleviate their pain, patients received an escape medication (hydrocodone/acetaminophen).

There were no statistically significant differences in pain between the

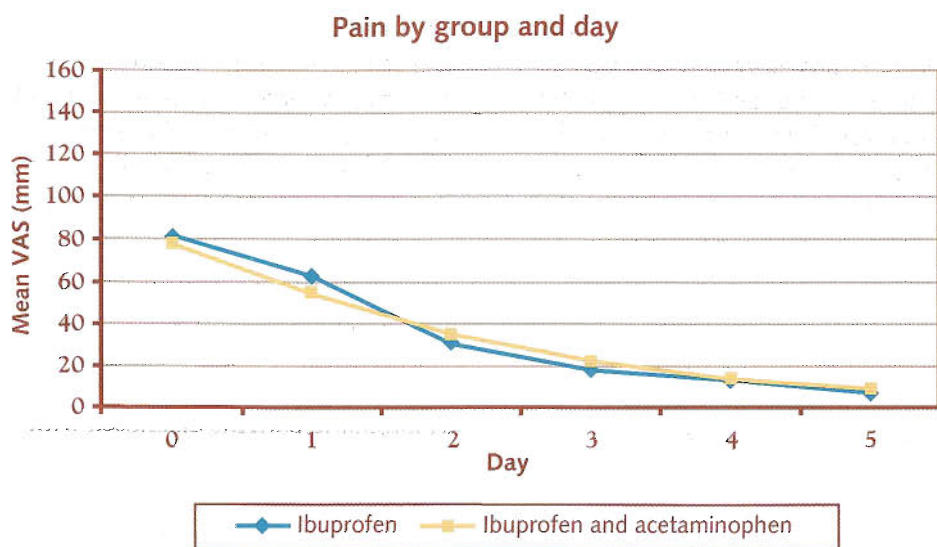


Figure 2. Pain by group and day, measured by a Heft-Parker VAS.

2 groups; pain ratings for both groups decreased over time. Figure 2 shows pain by day for the ibuprofen and ibuprofen/acetaminophen groups. Approximately 20% of patients in both groups required escape medication to control pain.

Conclusion

In this group of patients, the addition of acetaminophen to ibuprofen failed to show any statistically significant difference in analgesia or escape medication use. Few endodontic studies have evaluated postoperative analgesic efficacy, and these studies included diverse diagnostic categories. The best combination of analgesics in the postoperative period may vary depending on the specific subgroup of patients based on their diagnoses, or it may be possible that the addition of acetaminophen to an NSAID may not provide superior pain relief. Further studies are indicated.

Wells LK, Drum M, Nusstein J, et al. Efficacy of ibuprofen and ibuprofen/acetaminophen on postoperative pain in symptomatic patients with a pulpal diagnosis of necrosis. *J Endod* 2011;37:1608-1612.

Human Cytomegalovirus, Epstein-Barr Virus and Periapical Lesions

Periapical lesions, the result of pulp necrosis and infection, exhibit a variety of manifestations. Cytokines have been implicated in the development, maintenance and healing of periapical lesions. Herpesviruses, especially human cytomegalovirus (HCMV) and Epstein-Barr virus (EBV), have shown a strong association with symptomatic periapical pathosis through the activation of mammalian cells and production of numerous cytokines and chemokines, which can induce further cell activation and cytokine production in a system of regulation and cross-regulation.

To determine the extent to which periapical herpesviruses influence the course of endodontic disease, Sabeti et al from the University of Southern California examined the presence

of HCMV and EBV DNA, and the expression of mRNA transcripts of tumor necrosis factor (TNF)- α , γ -interferon (IFN), interleukin (IL)-1 β , IL-6, IL-12 and IL-10 in periapical lesions. The researchers collected periapical samples from 15 teeth undergoing apicoectomy, performed because of radiographic evidence of incomplete periapical healing after conventional root canal therapy. The teeth, 9 symptomatic and 6 asymptomatic, all had periapical lesions.

HCMV was found in 5 of 9 (55.6%) and EBV in 8 of 9 (88.9%) symptomatic teeth with periapical lesions. In 4 (44.4%) symptomatic teeth, researchers detected expression of cytokines, HCMV and EBV coinfection. Neither HCMV nor EBV was found in any asymptomatic teeth. The difference in the presence of HCMV, EBV and cytokines between symptomatic and asymptomatic periapical lesions was statistically significant. There was also a significant direct correlation between EBV; HCMV; and TNF- α , γ -IFN, IL-1, IL-6 and IL-12 expression in symptomatic periapical lesions.

Conclusion

Periapical host defenses may be periodically suppressed by changes in environmental exposure or alterations in gene expression of the immune system, leading to reactivation of resident herpesviruses and increases in proinflammatory mediators, which can bring about an overgrowth of pathogenic bacteria. A further understanding of the role of herpesviruses in apical infection might identify targets for disease prevention and a long-term cure.

Sabeti M, Kermani V, Sabeti S, Simon JH. Significance of human cytomegalovirus and Epstein-Barr virus in inducing cytokine expression in periapical lesions. *J Endod* 2012;38:47-50.

Calcium Hydroxide Use in Endodontics And Dental Traumatology

Endodontic treatment makes extensive use of materials and therapeutic agents containing calcium hydroxide ($\text{Ca}(\text{OH})_2$). Mohammadi from Hamedan University of Medical Sciences, Iran, and Dummer from Cardiff University, United Kingdom, reviewed the properties and clinical applications of $\text{Ca}(\text{OH})_2$ in endodontics and dental traumatology.

The characteristics of $\text{Ca}(\text{OH})_2$ include the following:

1 Chemical composition and activity: $\text{Ca}(\text{OH})_2$ slowly releases calcium and hydroxyl ions because of its dissociation coefficient. This low solubility is a useful clinical characteristic because $\text{Ca}(\text{OH})_2$ requires an extended period of time before it becomes solubilized when it comes into direct contact with fluids from vital tissues.

2 Mode of action: Depending on its application, the mode of action of $\text{Ca}(\text{OH})_2$ may vary:

- **Antimicrobial activity**—The antimicrobial activity of $\text{Ca}(\text{OH})_2$ is related to the release of hydroxyl ions in an aqueous environment.
- **Mineralization activity**—When used as a pulp-capping agent and in apexification, $\text{Ca}(\text{OH})_2$ may induce a calcified barrier. The mineralizing action of $\text{Ca}(\text{OH})_2$ is directly influenced by its high pH.

Clinical uses of $\text{Ca}(\text{OH})_2$ include the following:

1 Intracanal medicament: Because some areas of the root canal system are not reached by instruments, a root canal medicament is recommended to aid in the elimination of bacteria. $\text{Ca}(\text{OH})_2$ exerts an antibacterial effect in the root canal system as long as a high pH is maintained. While several studies have demonstrated the antibacterial effectiveness of $\text{Ca}(\text{OH})_2$ as an interappointment dressing, these findings have not been universally accepted. Additionally, $\text{Ca}(\text{OH})_2$ inactivates endotoxins and currently appears to be the only clinically effective medicament to do so.

2 Pulp-capping agents in vital pulp therapy: Vital pulp therapy in which $\text{Ca}(\text{OH})_2$ may be used includes indirect and direct pulp-capping, partial pulpotomy and cervical pulpotomy. Considering its alkalinity, biocompatibility and antimicrobial activity, $\text{Ca}(\text{OH})_2$ should be a suitable material for pulp capping and pulpotomy. However, its solubility in fluids is a problem that requires a good coronal seal to overcome.

3 Apexification: This process creates an environment within the canal and periapical tissues after pulp death that allows a calcified barrier to form across the open apex of an immature root. $\text{Ca}(\text{OH})_2$ has been the material of choice to create a calcified barrier at the root-end of teeth with necrotic pulps and immature “open” apices; however, recent research has suggested that mineral trioxide aggregate (MTA) appears to be the better choice in apexification procedures (see “A Comparison of Calcium Hydroxide

and Mineral Trioxide Aggregate for Pulp Capping” article).

4 Root resorption: $\text{Ca}(\text{OH})_2$ has an active influence on the local environment around a resorptive area; it reduces osteoclastic activity and stimulates repair. This action is a direct result of the alkaline pH of $\text{Ca}(\text{OH})_2$, which permeates the dentin. Hard-tissue resorption, with its enzymatic activity, requires an acidic pH; $\text{Ca}(\text{OH})_2$ creates an alkaline environment in which the reaction is reversed and hard-tissue deposition can take place.

Conclusion

$\text{Ca}(\text{OH})_2$ has a wide range of antimicrobial activity against common endodontic pathogens. It is also an effective agent to inactivate endotoxins; however, its effect on microbial biofilms remains controversial.

Mohammadi Z, Dummer PMH. Properties and applications of calcium hydroxide in endodontics and dental traumatology. *Int Endod J* 2011;44:697-730.

In the next issue:

- Diabetes mellitus and apical periodontitis
- Microbiota of root canal-treated teeth

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