

Calcium Hydroxide is the chemical formula $\text{Ca}(\text{OH})_2$. It is a very small molecule. The hydroxyl ion OH^- is even smaller and can penetrate through dentin to the cementum as demonstrated by: Foster KH, Kulild JC, Weller NR. Effect of smear layer removal on the diffusion of calcium hydroxide through radicular dentin. *J.Endodon.*1993;19:136-40. That means it will also penetrate isthmus areas and cul de sacs.

CH works by a hydrolysis reaction in which the OH^- ion cuts protein chains and bacterial endotoxin into pieces as it breaks chemical bonds. It does this by inserting water molecules between the carbon-carbon bonds (and breaking C-C bonds by the process of hydrolysis), the backbone of proteins and endotoxin. So if the pearls on a pearl necklace represent atoms, and the string between the pearls represents C-C bonds, CH is like a pair of scissors that cuts the string (hydrolyzes the bonds) between the atoms breaking the protein down into harmless non functional pieces. It is a tissue solvent! It also kills bacteria and it dissolves the endotoxin (bacterial LPS)!

CH hydrolyzes the lipid moiety of bacterial LPS(endotoxin) -

Safavi, K.E. & Nichols, F.C. Effect of calcium hydroxide on bacterial lipopolysaccharide. *J Endodon* 1993;19:76-8.

Safavi, K.E. & Nichols, F.C. Alteration of biological properties of bacterial lipopolysaccharide by calcium hydroxide treatment. *J Endodon* 1994;20:127-9.

Buck RA, Cai J, Eleazer PD, Staat RH, Hurst HE. Detoxification of endotoxin by endodontic irrigants and calcium hydroxide. *JOE* 2001;27:325-7.

CH kills bacteria

7 days of **CaOH₂** was effective in eliminating the bacteria in the canals in **83% of the cases (15 of 18 cases)**. *Enterococcus faecalis*, a microbe found to be particularly resistant to CaOH₂ was eliminated by instrumentation and 7 days exposure to CaOH₂ **Sjogren 91**

65 single-rooted teeth with periapical lesions were chemomechanically instrumented in the first appointment and treated with one of the following intracanal medicaments: Calasept, CMCP, or camphorated phenol. **After treatment with Calasept (CH), bacteria were recovered from only 1 of 35 treated canals. Bystrom Sundqvist 85**

Stuart KG, Miller CH. The comparative antimicrobial effect of calcium hydroxide. *Oral Surg Oral Med Oral Rad.* 1991;72:101-4

Behnen MJ, West LA, Liewehr FR, Buxton TB, McPherson JC. Antimicrobial activity of several calcium hydroxide preparations in root canal dentin. *JOE* 2001;27:765-7.

CH dissolves pulp tissue

This finding was confirmed by Andreasen 92: *In vitro* solubility of human pulp tissue in calcium hydroxide and sodium hypochlorite. Interim dressing with $\text{Ca}(\text{OH})_2$ for 1 week or more may ensure dissolution of

pulpal fragments due to its long-term solvent effect. The combined use of NaOCl and Ca(OH)₂ has a good potential for removing autolyzed pulpal tissue.

Morgan R W, Carnes D L, Montgomery S. The solvent effects of calcium hydroxide irrigating solution on bovine pulp tissue. J Endodon 1991;17:165-68.

In a 1989 study, Metzler and Montgomery found that CH to be better than standard instrumentation alone at debridement of isthmuses at the 1mm level (down where it really counts!)

CH improves the debridement efficacy of NaOCl

Hasselgren, G.; Olsson, B. & Cvek, M. Effects of calcium hydroxide and sodium hypochlorite on the dissolution of necrotic porcine muscle tissue. J Endodon 1988;14:125-7.

Hasselgren Cvek in 89 found the CH dissolves tissue and enhances the effects of NaOCl

CH is best applied with a lentulo spiral.

Sigurdsson A, Stancill R, Madison S. Intracanal placement of Ca(OH)₂; a comparison of techniques. JOE 1992;18:367-70.

Removal of CH

Removal of CH by instrumenting one file size larger is not enough, healing is not affected by extrusion of CH- **Porkaew Retief 90**

The best removal of CH - instrumentation with EDTA followed by NaOCl allows penetration of sealer into tubules. **Calt 99**

CH is most appropriate for teeth with apical lesions and healing rates will improve about 10% and approach the success rate for endodontic treatment of teeth with vital pulps .

Endodontic treatment of teeth with apical periodontitis: Single visit vs. multivisit treatment.

Radiographic healing in humans at 1 year. Empty canals (2 visits) vs. 1 appointment or 2 appointments with CH. There was a 10% incidence of better healing with the CH group compared to the one appointment group but it was not statistically significant due to the small sample size. **Trope JOE 99**

Histological periapical repair after obturation of infected root canals in dogs.

Histological evaluation revealed better healing with CH and 2 appointments than 1 appt or empty canal and 2 appointments. **Trope JOE 99**

Calasept and Pulpdent are 2 common commercial formulations of CH.

There is also another 2-5yr old study in JOE that indicates that CH affects the set of eugenol sealers but I cannot locate it. It accelerates the set and those using eugenol sealers should be aware of this effect.

As far as being able to effectively instrument fins and isthmuses beyond the coronal 1/3 of the canal it is a commonly accepted fact, as demonstrated in many cross sectional instrumentation studies both with light microscopy and SEM, that predictable debridement of fins and isthmuses is not possible . I accept my mortality and use CH to disinfect these areas when appropriate. Those who think it is possible to routinely clean isthmuses and fins have a responsibility to provide some evidence from independent sources. We need SEM, light microscopy, bacterial culturing studies demonstrating these claims. For those who claim to be able to routinely and predictably debride isthmuses and fins in the apical 2/3s it's up to you to provide the independent research or literature that shows it works for the common endodontist and GP, not only for a select few. Radiographs are useless in proving debridement of canals, isthmuses and fins. Radiographs only demonstrate where the obturation is it doesn't indicate if the canal was cleaned effectively or if the obturation is imbedded in a sea of contamination.

Friends and colleagues here is just some of the established research from some of the most respected researchers. I'd like to ask a hypothetical question. In the rare event you were to be sued for one of your endodontic treatments and you were asked to justify your technique in a deposition how would you do it? Would you rather say, "I do it like Dr. So & So because he said it's the best way" or would you rather be able to say, "Here is the established research that supports my clinical decisions." Research matters in engineering, aerospace, construction and throughout our country and economy. It is how our society advances. Sure the greatest advancements start out with a theory or an opinion but eventually those theories and opinions must be backed up with legitimate, independent research to be validated. Without validation opinions and theories remain opinions and theories and never become fact. In theory Arsenic may be a good antibacterial medicament but research indicated it caused bone necrosis and tooth loss and it is no longer used because of research and the literature.

Think about what we do and the biologic basis for our decisions, blind loyalty is not good for science.

Randy Hedrick on ROOTS 8/26/05