French Connection Root Canal Treatment (FCRCT)

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Introduction

In dentistry, root canal treatment remains an ingrained part of our professional culture. It would be highly surprising for any dentist not to recommend root canal treatment as a dental procedure. The only alternative to endodontics is extraction, and most health conscious patients are now willing to keep their teeth. Over the years root canal treatment and gutta-percha have become synonymous but the fact remains that gutta-percha obturated teeth may show failure in due course of time. This can be attributed to the relatively weak disinfecting properties of gutta-percha cones.

This reinforces the fact that root canal therapy depends on the bedrock principles of instrumentation, canal disinfection, and obturation, but relatively little attention has been given to disinfection of the deeper, microscopic spaces in the root and the dentinal tubules. The classic method of deepening the disinfection of root canals and the associated dentinal tubules has been to use a treatment dressing of calcium hydroxide, often mixed with chlorhexidine or iodine that is left in the canal between appointments. However, calcium hydroxide preparations are not suitable for long term root fillings because they remain soluble and subject to leaking and washing out. For many years, at the fringes of dentistry, there has been another material for permanent filling of root canals that merges the advantages of calcium hydroxide with a hard setting, canal sealing, three dimensional obturation: calcium oxide [CaO] also called as **the French Paste**.

Calcium oxide, or quicklime, has been used as a disinfectant since time immemorial. Its use in modern endodontics dates back to France in the mid 1960's and the publication of Pierre Bernard's work, **Therapie Ocalexique**.[1] Bernard proposed that CaO would diffuse through the hidden, microscopic spaces of the root canal system, providing continuous disinfection throughout the structure of the dentin, and ultimately obturation, by hardening in place; in other words, a treatment for both the root canal and the dentin tubules. His work was promoted and improved upon by Pierre Fohr, and Pierre Morin, who introduced "heavy" CaO, a much denser crystalline form that delivers up to three times as much calcium per volume as the original quicklime formula. The "**three Pierres**" and others including Cohen-Scali, began an era of interest in ocalexique root canal therapy in Europe, which has waned severely in recent years in the face of technical improvements or what we may call as marketing pressure from American gutta percha methods. The ocalexique technique was brought to North America by Duquet in 1979.

Commercially, CaO root canal material was manufactured and marketed for a long time by Spad Laboratories in France, under the name "Biocalex 6/9." Biocalex was discontinued in 2001, shortly after Spad was acquired by Dentsply. It is now manufactured and sold by the Biodent Company of Montreal, under the name "Endocal-10."

Composition Formula

Endocalex Plus Powder-

- Calcium oxide 67%
- Zinc Oxide 33%

The powder can be used for additional treatments provided the vial is closed tightly immediately after use.

Endocalex Plus Liquid-

- Propylene glycol 75%
- Distilled water 25%

Rationale for using Calcium Oxide

Calcium Oxide as a root canal filling material represents an attempt to merge the well known disinfecting properties of calcium hydroxide with a hard setting, obturating material that tries to make the calcium hydroxide effect permanent.

Calcium oxide (CaO) undergoes two reactions that make it much better suited as root canal filler.

First of all, it reacts with water, to form $Ca(OH)_2$, yielding all its beneficial properties:

$$CaO + H_2O \rightarrow Ca(OH)_2$$

Secondly, it reacts with carbon dioxide ambient in the cellular environment to form calcium carbonate, also known as limestone:

$$CaO + CO_2 \rightarrow CaCO_3$$

Calcium carbonate will form and remain insoluble only as long as the milieu is basic. So in an infected root canal, where the environment is made acidic by bacterial metabolic products, CaO will generate $Ca(OH)_2$ to buffer and disinfect. When the infection comes under control and the fluids return to physiological pH, the reaction of CaO turns to generation of calcium carbonate, and the material hardens in place. It's a selfregulating system, a material that is both an active disinfectant and an obturator, as required by the surrounding conditions. If the periapical infection reasserts itself and again produces acid, the previously hardened calcium carbonate will redissolve, yielding more $Ca(OH)_2$ to fight the infection.

Calcium oxide is strongly hygroscopic it attracts water, and expands through a water layer. This gives it the ability to actively diffuse through the microscopic spaces of a tooth, the tiny fins, isthmuses, lateral canals, and dentinal tubules. Minana et al[2] showed that CaO, placed in the root canal of extracted teeth, can diffuse completely through the dentin and raise the pH at the cemental surface as effectively as $Ca(OH)_2$. Guigand et al[3,4] demonstrated that calcium from CaO penetrates into dentin tubules further than that from $Ca(OH)_2$. They also showed that CaO dissolves organic matter such as predentin and smear layer more effectively that $Ca(OH)_2$. The overall success rate for CaO technique has been reported to be around 89% according to the strict criteria while a success rate of 98% on the basis of retained teeth in function.[5,6]

Concerns with the use of CaO

There have been three persistent objections to its use. First, the commercial products that have been available for the CaO technique, Biocalex 6/9 [Spad Laboratories, Saint Quentin en Yvelines, France], which is no longer on the market, and Endocal-10 [Albuca, Montreal, Canada], have not been radio-opaque enough to be distinguished from tooth structure. This problem has been solved with the addition of non-toxic, moderately radio-opaque yttrium oxide. Second, the expansive nature of CaO in an aqueous environment has led to the fear that the material will expand with force and fracture of the roots of teeth treated with it. While the proponents of CaO have maintained that it acts more by penetration of the tooth structure, does not expand with force, and does not cause excess root fractures, the perception of it as a hazard still prevails.[7] This anticipation of negative outcomes has prevented the endodontic community from embracing the CaO technique, leading to the third objection: the lack of validation from university based research.

Technique for CaO Root Treatment

Case Selection

There does not seem to be any condition that can be treated endodontically and can not be treated with CaO. The same problems that compromise any root canal treatment will adversely affect CaO treatments as well broken instruments, incompletely prepared canals, long standing infection, etc. There have been claims that because CaO is penetrating and actively disinfecting, it can succeed in reversing infection in cases where the canals are not fully accessible but unfortunately there's no research to back up the statement.

Informed Consent

The dentist must inform the patient that the CaO root canal technique is not the prevailing standard that it is an "alternative" method, and that if the patient prefers, he or she can receive the standard treatment

instead, either in your office or by referral.

Legally, Biocalex and Endocal have section 510(k) "premarket notification" approval from the FDA, allowing them to be sold for use by dentists in the USA. No state dental board has ruled as to whether CaO root treatment is within the standard of care or not.

Canal Preparation

Because the CaO material is a paste filling, the goal of instrumentation is to allow a Lentulo spiral to reach the apex without binding or obstruction. The modern machine driven rotary techniques with NiTi files make this goal so much easier to attain. The location of the apex should be within 1 millimeter of the radiographic apex, or the actual full length measurement if you use an electronic apex locator.

The earlier French authors preferred very little preparation, to preserve as much tooth structure as they felt that the ocalexique technique was essentially chemical, not mechanical. But the experiments at the University of Texas argues in favor of the wide prep.[8,9]

Irrigation

There is no conflict between the CaO root filling technique and any irrigation scheme you like, with one important exception: you must limit the use of EDTA canal irrigants. Any EDTA remaining in the canal will sequester the calcium, and poison the calcium based root filling. It will absolutely prevent CaO from setting. You must rinse it out thoroughly. Rinse with sterile water and dry with paper points two or three times after using EDTA.

Go Right to CaO, or use a Treatment Dressing?

There is a debate going on in endodontics right now over the single visit treatment that has been advocated over the last decade. Some authors advocate a treatment dressing of $Ca(OH)_2$ for a week or two after the instrumentation appointment, and obturation on a second visit.

We can use CaO as both a treatment dressing and as an obturant, since it either generates $Ca(OH)_2$ or sets hard as $CaCO_3$, depending upon the surrounding conditions. Instances of weeping or bleeding from the canal apex, that one would normally treat with a $Ca(OH)_2$ dressing, can be equally treated with CaO.

Filling the Canals with CaO

Mix the CaO material (Endocal^R) according to manufacturer's directions, to the sour cream consistency. The canals are filled using a Lentulo spiral. In order to prevent trapping of air bubbles, start with a smaller number spiral, load it only to its own diameter and slowly advance to greater sizes. Don't glob the paste on it, to avoid trapping air. Slide it down to the apex and rotate at a medium-slow speed. Temporize with a noneugenol temporary filling.

Check that the CaO filling has Hardened

When the canal is filled, schedule an appointment for post operative buildup a week or two later.

Re-open the access and probe the canal with a file. If the CaO filling has not set, you will be able to slip right down the canal as you would into a $Ca(OH)_2$ dressing. In that case, rinse it out, reapply new material, and re-appoint the patient for another week or two. If, instead, your file meets resistance, its set, and you're ready to proceed with the restorative. Sometimes the set is stony hard, while at other times it seems more compacted yet able to be picked out.

"Treatment failures" have generally proven to have soft material in the canals, meaning either that the onceset material has been redissolved by acids produced by the recurring infection, or it was never properly set in the first place.

If your treatments begin to experience more frequent failures to harden, get a fresh kit of material, as your old stock may have absorbed too much moisture from the air.

Post Preparation

A fully hardened CaO root filling cannot be drilled for the post prep. If you intend to restore the tooth with a post, you must prepare the post space by removing some fresh CaO paste just after you place it. A convenient method is to dip out the paste to the appropriate length with a paper point

Overfills

Some practitioners have reported that overfills cause postoperative pain, though most others have not seen it. Biologically, there is no problem with overfills of this highly biocompatible material, as it resorbs with no consequences.

Radio-opacity

The original Biocalex formulation contained 2/3 calcium oxide and 1/3 zinc oxide. The insoluble ZnO was used as an inactive ingredient, an extender to reduce the degree to which the material would expand into the water layer. Unfortunately, neither of these ingredients is radio-opaque relative to tooth structure. This problem was solved by substituting yttrium oxide for the zinc oxide. Yttrium oxide, Y_2O_3, has physical properties identical to ZnO[10], and a completely benign toxicological profile.[11]

It is moderately radio-opaque, enough to make all the difference in the radiograph.

Retreatment

Most cases that are indicated for retreatment will be found to have soft material in the canals, and are easy to retreat. Occasionally there will be a tooth you'll want to retreat in which the fill in the canals is still rock hard. These cases should be considered for apical surgery, or carefully evaluated for fractured roots. But if you want to re-negotiate the canals, soak the access cavity with 17% EDTA solution for a few minutes, and the material will soften up, allowing you to pick through it.

Conclusion

This paper is an attempt to promote the works of the "three Pierres" towards achieving nearly perfect root canal disinfection as well as filling. It can be said without doubt that filling endodontically treated roots with CaO may produce clinical results that are indistinguishable from conventional methods, without incurring an excessive rate of root fractures. With the addition of yttrium oxide, CaO can be made radio-opaque to an acceptable degree. CaO should be considered a safe and viable alternative to other current methods of root obturation.

This concept looks promising but the problem of lack of scientific evidence should excite researchers for further exhaustive trials in order to establish CaO as new dimension to the root canal treatment protocols.

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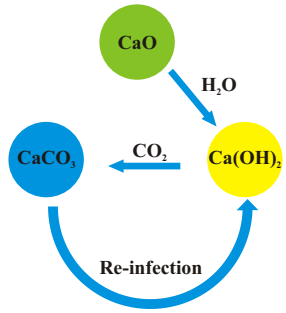

Figure: Rationale for CaO

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