Antibacterial properties of calcium hydroxide and oxide in endodontic medication

Introduction

The invasion of bacteria in the endodontic space leads to pulp necrosis with a resulting infection of the periradicular tissue. The aim of endodontic therapy is to eliminate the infection and allow the tissue to heal (1) (fig. 1). One of the most important stages of endodontic therapy is the cleaning and shaping of the root canal system. The necrotic pulp tissue present in the root canal and on the canal walls is removed during mechanical shaping. The endodontic system is then cleaned using irrigating solutions able to dissolve and remove organic tissue. An ideal irrigating solution, according to the modern concept of endodontics which envisages the emptying of the endodontic space and its complete three-dimensional obturation, should therefore have an antibacterial action, be able to dissolve the tissue and the organic material present inside the canal, have a lubricating action that favours the action of the root canal instruments, prevents the formation of the smear layer and promotes its removal without decalcifying the dental tissue and, finally, should not be harmful for the organism.

One of the most widely used irrigating substances in endodontic therapy is sodium hypochlorite which is able to drastically reduce the intracanal bacterial load. Not all the bacteria are eliminated and for this reason some Authors have suggested the need to associate intermediary antimicrobial medications with the canal washing (Tab. I).

One of the most common of these is calcium hydroxide [Ca(OH)\textsubscript{2}]. Its antibacterial properties are attributed to the high pH levels, the ability to destroy the cytoplasmic barriers and denaturalize the enzymes and bacterial proteins. An alternative intermediary medication is Chlorhexidine (CHX): this is effective on a wide range of bacteria and can also be adsorbed by hydroxyapatite and slowly released.

A material which appears to give valid results as an alternative to the intracanal medications discussed so far could be calcium oxide. The aim of this randomized clinical study is that of evaluating the antibacterial capacity in vivo of two different intermediate medication materials (calcium oxide and calcium hydroxide) set against control cases.

Materials and methods

In the period from January to June 2008 30 patients having teeth requiring endodontic treatment due to caries were selected. The tooth to treat was isolated using a rubber dam (Hygenic Coltene/Whaledent Cuyahoga Falls, OH – USA) and disinfected with Chlorhexidine 0.20% (Eburos Dentsply Betafarm SpA, Cesano Boscone, Milan – Italy). The pulp chamber was then opened using diamond rotary instruments mounted on a turbine paying great attention to eliminate coronal interferences. The work length was measured using an apical detector (Root ZX J Morita Corporation Kyoto, Japan) and a K-file 10 (Dentsply – Maillefer- Ballaigues- Switzerland). Manual steel instruments were taken to the work length (K-file 15-20) to assess the canal lumen patency. The canal was prepared using NI-Ti Pro-Taper rotary instruments (Dentsply – Maillefer, Ballaigues- Switzerland) taking to the work length S1-S2 and F1. The use of heated sodium hypochlorite 5% (Ogna Farmaceutici, Muggiò, Milan - Italy) was alternated with a canal lubricant (Glyde Dentsply, Montigny de Bretagneux - France) in the instruments. At this point the apical gauging was measured and the preparation of the canal was completed with instruments F2-F3 and when necessary F4 and F5. A final washing was then performed with EDTA at 17% (Ogna Farmaceutici, Muggiò (Mi)-Italy) followed by a wash with a physiological solution (Ogna Farmaceutici, Muggiò (Mi)-Italy). 10 elements were medicated with calcium oxide (Endocalex Plus – Robidan sas, Milan - Italy); a cotton pellet and Fermi closed the pulp chamber (Group A);
10 elements were medicated in a temporary way with calcium hydroxide calciupulp (Septodont, Saint Maure des Fosses Cedex, France); a cotton pellet and Fermit closed the pulp chamber (Group B).

10 elements were left without intermediary medication (Group C, control), a cotton pellet and Fermit – N (Ivoclar-Vivadent, Schaan, Liechtenstein) closed the pulp chamber. The following week the material chosen for the intermediary medication was removed, alternating sodium hypochlorite washes with manual instruments with steel K-file 10-15-20-25 to the work length.

A final wash was performed with EDTA at 17% and subsequently with physiological solution. The canals were dried using sterile paper points (Paper points Dentsply – Mallefer- Ballaigues-Switzerland) and the canals were three-dimensionally obturated using hot guta-percha (Thermafil Pro-Taper Obturators Dentsply – Malleffer, Ballaigues-Switzerland) and PCS ewt canal cement (Kerr Orange, Ca – USA). At this point the tooth was ready for the coronal reconstruction.

Microbiological samples were taken using sterile paper points after the pulp chamber was opened (T1), at the end of the canal instrumentation, before intermediary medication (T2) and one week later, before canal obturation (T3).

The samples taken, conserved in test tubes containing 9 ml of sterile phosphate buffer at a temperature of 4°C, were analyzed at the CNR – ISPA laboratory in Milan in order to assess the presence of bacterial microflora in the various stages of the treatment.

1 ml of sterile phosphate buffer was taken from each sample to analyze (T1, T2 and T3) and was distributed on a Petrifilm to determine the Standard Bacterial Counts (SBC) (Petrifilm Aerobic Count Plates – 3M – Milan - Italy).

The Petrifilms SBC were left to incubate at 37 °C for 72 hours in aerobiosis conditions. The SBC at 37°C represents the sum of all the bacteria, pathogenic and non-pathogenic, present in the samples analyzed.

To determine the number of microorganisms a count was made of the colonies present on each Petrifilm; this procedure was facilitated by an indicator that colours the colonies red (fig. 2 a-b). The result was expressed as a Colony-Forming Unit on ml of sample (CFU/ml).

Discussion

In group A, medicated with calcium oxide, only 1 case with a limited increase in the bacterial load (10%) was observed. In group B, medicated with calcium hydroxide, in 2 cases (20%) positivity to the standard bacterial load (SBC) was observed between time T2 and T3 following a limited increase of said. This result is in line with those already presented in other studies in the literature (3), with the problems linked to the difficulty of inactivation and removal of the calcium hydroxide of the root canal with the associated use of EDTA and sodium hypochlorite solutions (4).

In control group C, where the sodium hypochlorite was left in the canals without any intermediary medication, 3 cases with bacteria development were observed (as shown by the counts) (30%).

In all the samples of the 3 groups, measured at time T2 and T3, a drastic reduction of the SBC was observed with CFU/ml values close to 0.

The lowest values were measured in samples T2, demonstrating that the endodontic space chemical-mechanical disinfection procedures have a high capacity to clean the root canals. In the average values of the samples at time T3 in some cases a minimum increase in the bacterial load was observed because a microflora residue may be present at the end of the first endodontic therapy sitting with a possibility of growth in the period in which the intermediate medication continues.
As suggested by previous studies (5), endodontic treatment sometimes fails to completely clean the root canals, leaving a minimum bacterial load in the endodontic space which in a period of a few days can lead to a moderate bacterial re-growth with re-infection of the root canals (6).

The application of an intermediate medication, for at least one week, could contribute to the reduction of the bacterial load. Previous studies have shown that some substances, such as calcium hydroxide, Chlorhexidine, a combination of the two and sodium hypochlorite (7) do not seem to be able to ensure significant results in this sense.

In this controlled clinical study the calcium oxide appears to offer better results. This substance has been used since the early 60s when Bernard began to disseminate the results on the use of expansive calcium oxide in dentistry. The Author described the well-known “ocalexic” canal treatment therapy which was based on three fundamental functions of calcium oxide: expansion, disinfection, obturation.

It’s antimicrobial properties were attributed to the calcium oxide expansion and disinfection properties of the formation OH⁻ ions. The calcium oxide expands through “substitution”, allowing penetration also of the most inaccessible root canal (8-9).

Based on these considerations, calcium oxide was tested as an intermediary medication substance. At present the use of calcium oxide as a definitive obturation material of the canal system does not appear sustainable. Indeed, the calcium carbonate which forms following the reaction of the calcium oxide with the water is not able to satisfy some of the properties that an ideal root canal obturation material must have.

**Conclusions**

The complete cleaning of the root canal system is an objective which cannot always be achieved due to the anatomical complexity of the system, despite the fact that at present there are various irrigating substances and root canal preparation techniques that can help achieve the aim.

The possibility of combining intermediate medication with good anti-bacterial properties could be of interest. From this point of view, the results obtained with calcium oxide in this study in vivo appear to be encouraging. The substance has been known and used in endodontics for many years but its use as an intermediary medication and not as a definitive obturation of the endodontic spaces appears feasible as its good anti-microbial properties could be exploited. It is to be hoped that the results obtained be confirmed by other in vivo and in vitro studies, possibly on a larger number of samples.
References


