THE IMPACT OF CALCIUM HYDROXIDE ON THE PENETRATION OF ROOT FILING MATERIAL IN SIDE CANALS

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Abstract: *The present work aims at highlighting the permeability of secondary lateral canals after the endocanalicular appliance of calcium hydroxide paste as intermediary stage in the endodontic treatment.*

INTRODUCTION

The usage of calcium hydroxide as medicine in the endodontic treatment is still widely practiced even nowadays.

In 1999, Calt S. and Serper A. conducted a study on teeth extraction raising the problem of the presence of calcium hydroxide residue in side canals after performing the washing protocols and its interference with the sealant adhesion.

The latest researches have shown that calcium hydroxide is not efficient enough against the entire spectrum of existing germs at endodontic level, as viable bacteria have been detected after the treatment with calcium hydroxide. Also, it was proven its limited effect on the bacterial biofilm.(1,2)

The dentinal permeability can be reduced if the calcium hydroxide has been used in the initial treatment, as the ionized calcium released by the residual hydroxide can interact with the phosphate ions present at dentinal level, thus producing calcium phosphates aggregates that reduce the dental permeability. The initial root canal sealing may influence dentinal permeability due to sealant penetration in dentinal canals.(3,4)

It must be taken into account that none of the irrigation substances or their combinations completely removes the bandage. Thus, the use of citric acid and EDTA provided promising results compared to sodium hypochlorite.(5)

The three-dimensional sealing of the root canal is extremely important because it can prevent reinfection of the endodontic space and can inactivate the remaining microorganisms in its inaccessible areas. The difficulty of an efficient root canal filling is given primarily by the complex endodontic anatomy, characterized by multiple apical apertures, apical delta and side canals. It would be ideal that all these \`escaping gates\` were perfectly permeable before the obturation, in order to allow the root obturation material to perfectly seal the area, but in everyday practice this target is difficult to achieve. Most of the time, these orifices are masked either by smear layer or by material residues such as calcium hydroxide introduced by the dentists themselves.(6,7)

The use of calcium hydroxide as an intermediate step in most endodontic treatment protocols is well-known because of its antimicrobial role and its ability to dissolve tissue debris.

PURPOSE

In conducting this study, we were motivated by the belief that achieving a root filling that tightly seals all the orifices of the endodontic system is particularly important for long-term success, and efforts must be made to find ways to prevent clogging them with materials other than those intended for definitive obturation.(8)

Besides the proven antimicrobial effect, the calcium hydroxide paste has the disadvantage of a difficult removal from the hidden areas of the root canals and especially from the entrances in the lateral channels.

In this paper, we aim to determine whether calcium hydroxide can be completely removed from the root canals so that it does not interfere with the tightness of the future root filling.(9,10)

MATERIALS AND METHODS

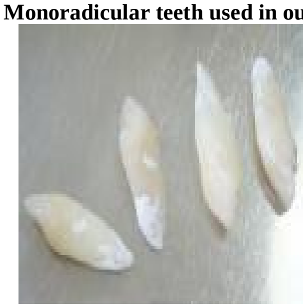
Considering the literature data, we expect that the calcium hydroxide paste cannot be completely removed from the canal which is reflected in the impossibility of obstructing or merely partially filling the accessory lateral root canals that we artificially have created.

We have used 12 upper frontal monoradicular teeth (figure no.1), with straight roots, which were extracted due to advanced parodontopathy. We have included in the study only integral teeth without deep lesions that could lead to significant loss of dental hard tissues, which would make it impossible to carry out the study. We also excluded the teeth that were previously treated.

RESULTS AND DISCUSSIONS

The tartar was removed from the coronary surfaces of the teeth with an ultrasonic scaler and the soft tissues were cleaned off the roots with a no 15 scalpel and curettes. Until the beginning of the experiment the teeth were preserved in a 2.5% sodium hypochlorite solution.

Figure no. 1. Monoradicular teeth used in our study



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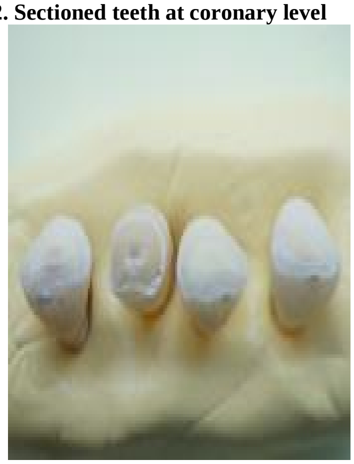
Preparing the root canals

To facilitate access in a straight line, we horizontally sectioned the incisal third of each tooth thus obtaining a surface through which the trepanation was made (figure no.2).

Figure no. 2. Sectioned teeth at coronary level



Using a diamond-cut, small-sized turbine cutter, we trappened the teeth through the dentine to open the pulp chamber, confirmed with a Kerr tool no.15. We continued to perform the endodontic access cavity with the help of the Gates Frets in ascending order up to No.5 at a depth of approximately 3-4 mm.

We then penetrated with a Kerr tool no 10 or 15 onto the canal to check its permeability. With each canal, we determined the working length through direct visibility, by guiding the tool in the apical direction until its top would reach the exact apical orifice without exceeding it. When reaching it, the rubber boll of the tool was directed to the coronary surface and then the instrument would be withdrawn from the canal, and the length from the tip of the tool to the roundel was measured with an endodontic liner and preserved throughout the entire process of preparing the canals.

The actual instrumentation began with the manual preparation using pile Kerr tools up to size 25, while frequently irrigating the canal with 5% sodium hypochlorite solution. We performed circumferential filings pressing the instrument with equal force against all the walls of the canal. We periodically checked the permeability of the canal with the Kerr pile no 10 which we introduced approximately 2 mm beyond the apex.

There followed the instrumentation with rotative tools made of nickel-titanium (NiTi) alloy. We used the MTwo instruments from VDW firm, Germany. The whole set of rotative instruments was used at 250 rotations/min, with auto-reverse function activated, with the engine and endodontic counter-angle tool Endo-Mate (NSK, Japan). We started with no. 15 conicity 5% (15 / .05) in the canal flooded with sodium hypochlorite, the engine set at a torque of 1.3 Ncm with "knock" movements towards the apex without pressing too hard. If the instrument barely moved forward and the auto-reverse function would trigger automatically due to reduced conicity of the canal, we would wash and switch to the thinner instrument, suitable for smaller conicity of 10/.04, with the engine set up at 1,2 Ncm, and using the same cautious movements towards the apex. After the first or second penetration to apex I performed a wash and then returned to instrument size15 / .05. We entered twice in the same way through the working length and switched to instrument 20/.06. Usually, with the latter instrument, the penetration implied several tries due to the high conicity as compared to the previous instrument (6% as compared to 5%). When we reached the working length with this instrument as well, we washed the canal and entered it with the final instrument of size 25/.06. We then washed with 5 ml of sodium hypochlorite 5%, with 5 ml of citric acid 40% and finally with 5 ml of distilled water.

Next, we created four lateral root canal channels on the approximate sides of each root, respectively 2 on the medial and 2 on the distal side (figure no. 3). Each artificial side canal communicated with the main root canal, as the axis of the artificial canals was perpendicular on the axis of the main root canal. We used rotative instruments such as „K-Reamer" (VDW, Germany) for the counter-angle tool, size 0.15, length of 25 mm (figure no. 4), with approximately 450 rotations /min. The lubrication was made with EDTA solution.

Figure no. 3. Creating the accessory side canals

Figure no. 4. K-Reamer (VDW, Germany) for the counter-angle tool, size 015, length 21 mm

The prepared teeth were dried out with the compressed air injector from the dental unit and then they were applied two composite "soles" medial and distal to ensure that the teeth can be positioned horizontally, always in the same position, with the vestibular surface up. We then split the teeth randomly into two equal groups of six, took ortoradial X rays equivalent to retroalveolar X-rays (figure no. 5).

Next the teeth from the control group were filed, while the others from the experimental group were first treated with calcium hydroxide paste for two weeks, and were filed only after the treatment.

Comparing Group

Following the previously described steps – the preparation of the main canal, artificial lateral canals and radiography - the teeth in the control group were kept in a closed hermetically sealed glass jar in gauze watered with distilled water for two weeks while the dressing of Ca (OH) 2 lasted.

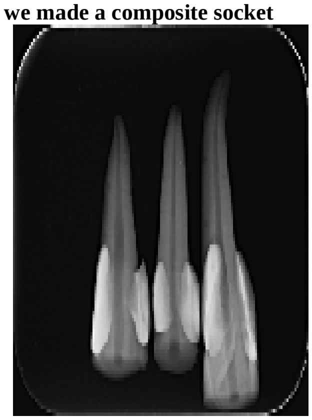
After the two-week period, the teeth of both groups were obturated simultaneously under the same conditions.

Here is the process of root obturation.

We chose a Lentulo needle not too thin, so it would stop at approximately 1-2 mm from the end of preparation.

For each tooth we chose a Gutta Percha point size 25 and conicity 6% (25/.06) and we tried it in the canal. If the con would stop at working length, it was considered appropriate and no changes would be made. If the tip of the con surpassed the apex, then the excess part would be sectioned with a scalpel. When the con stopped before reaching the working length, it was replaced by another one of smaller size but same conicity (20/.06) and the potential excess surpassing the apex would be sectioned.

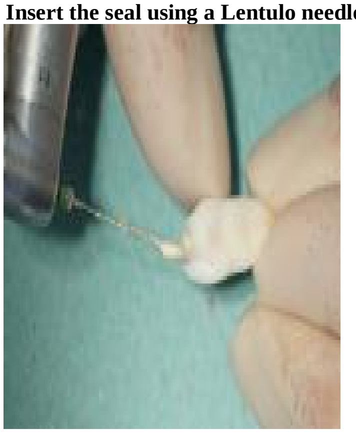
Figure no. 5. Retroalveolar X-ray showing the canals mechanically operated and the artificial accessory canals on the approximately root faces. For teeth stability at the time of positioning we made a composite socket



The root canal filing paste Endomethasone (Septodont, France) was prepared. Its consistency was sour-cream like, accordingly to producer's instructions. We dried the root canal with paper points.

We loaded the lentulo needle with a root-fill paste and inserted it into the canal at a speed of about 1000 rpm with the engine of the dental unit and not the endomotor (figure no. 6). Here we made circumferential to and fro movements, holding the needle against the walls and, without slowing down the speed, we pulled the needle out of the canal. We applied a small amount of paste on the tip of the Gutta Percha point and pushed it into the canal on the working length (figures no. 7 and 8).

Figure no. 6. Insert the seal using a Lentulo needle



With a hand tool like a plugger, heated to the flame of a lighter, we cut the Gutta Percha point roughly at the level of the parcel. We immediately condensed the coronary end of the point, still malleable after slicing. For condensation we used a plugger with the surface large enough to cover almost the entire surface of the sectioned point but not too large less it should block in the walls of the canal (figure no. 9).

Figure no. 7. Introducing a master point with the remaining sealant paste

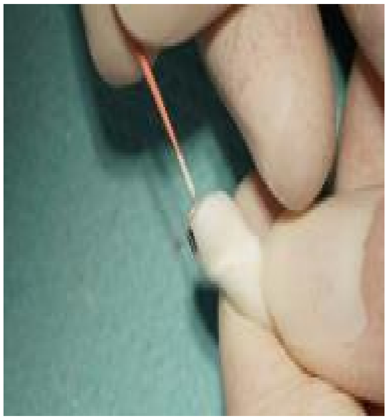


Figure no. 8. Gutta Percha point introduced to the level of apical contriction

Figure no. 9. Compacting with the Plugger without applying excessive pressure to avoid blockage in the walls, resulting in fracture

After root canal filing, we performed ortoradial X-rays with the teeth in the same position as the initial X-ray, with the help of composite structures.

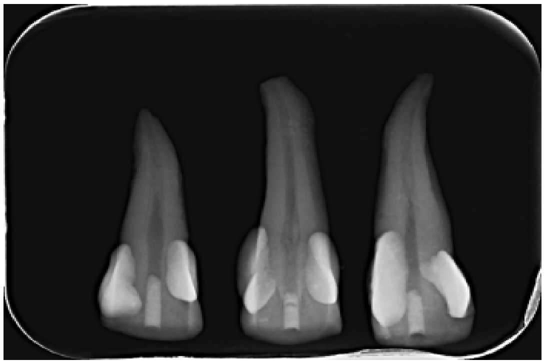
Figure no. 10. Radiologic image of canines showing the present sealant in the artificial side canals

Experimental group

As mentioned above, the experimental group consisted of 6 teeth, which, after preparing the root canal and creating the artificial lateral canals, were used for introducing into their root canals the calcium hydroxide paste for 14 days, in order to fill the canals after that period.

In order to introduce the calcium hydroxide paste, we first dried the channels with paper cones and then inserted the cannula tip of a hydroxide syringe (Calxyd, Spofa, Czech Republic) as close to the end of the preparation and started to gradually inject the material into the canal. As the canal filed up, we would withdraw the cannula from the channel while maintaining pressure on the plunger, thus injecting it further. With dry cotton buds, I buffered the surplus of water from the material, stuffing them into the entrance to the pulp chamber. In the created space at the entrance of the pulp chamber we introduced a temporary filing (Citodur, Detax, Germania). We made ortoradial radiographies from the vestibular direction (figure no.11).

Figure no. 11. Radiologic image of canines with calcium hydroxide. Closure of secondary canals with calcium hydroxide can be noticed

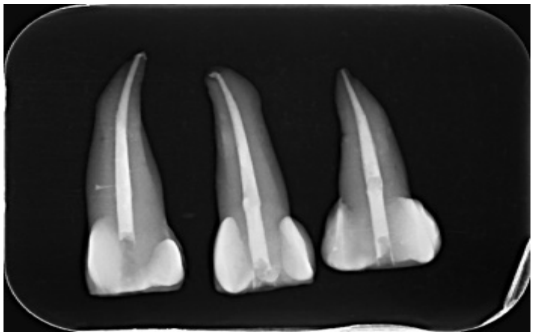


Thus prepared, the teeth from the experimental group were wrapped in gauze watered with distilled water and preserved in a hermetically sealed glass bottle for two weeks.

After the 14-day period, the calcium hydroxide was removed and then the root filing was applied according to the protocol described above.

Removing the calcium hydroxide paste was done with a Kerr tool of size 15; 20 and 25 as well as 20 ml of sodium hypochlorite. Scraping movements were performed by pressing the instruments on the walls of the canal. We did not use the rotative tools, nor did we activate the ultrasonic washing.

Figure no. 12. Radiologic image of obturated canines showing the absence of filings with sealant in the side canals, as they are still filed with the remaining calcium hydroxide paste



RESULTS

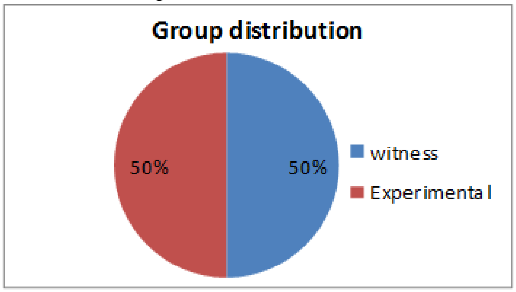
For the collecting of the results we analyzed the X rays made after the root filling and we counted the artificial lateral canals penetrated by which the root filling paste (figure no. 10).

We have also checked the number of canals in which the calcium hydroxide paste had entered within the teeth from the experimental group (figure no. 12).

Table no.1. Group distribution

Number of cases	Control group	Experimental group
12	6	6

Figure no. 13. Group distribution

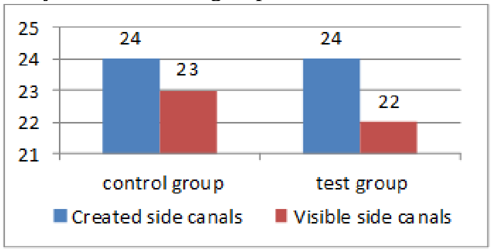


The 12 teeth were divided into two groups.

Table no. 2. The radiological visibility of the artificially created side canals in both groups, immediately after preparation just before the introduction of calcium hydroxide

Number of canaliculi	Control group	Test group
Created canals	24	24
Evident canals	23	22

Figure no. 14. Radiologic visibility of lateral side canals artificially created in both groups

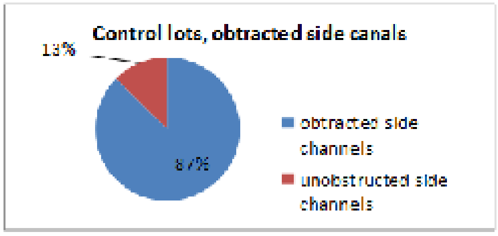


In both groups there were created a total of 48 lateral canals, 24 in the control group and 24 in the experimental group, of which 23 are radiological visible in the control group and 22 in the experimental group.

Table no. 3. Filing root canals with sealant in the control group

Number of sealed side canals	Number of unsealed side canals
21	3

Figure no. 15. Control lots, obtracted side canals

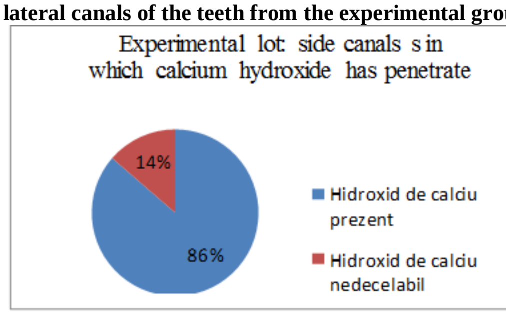


From the total of 24 artificial side canals, 21 of them were penetrated by the sealant, thus become opaque at X-ray.

Table no. 4. The presence of calcium hydroxide paste in the lateral canals of the teeth from the experimental group

Number of visible canals with $Ca(OH)_2$	Number of visible canals without $Ca(OH)_2$
19	3

Figure no. 16. The presence of calcium hydroxide paste in the lateral canals of the teeth from the experimental group

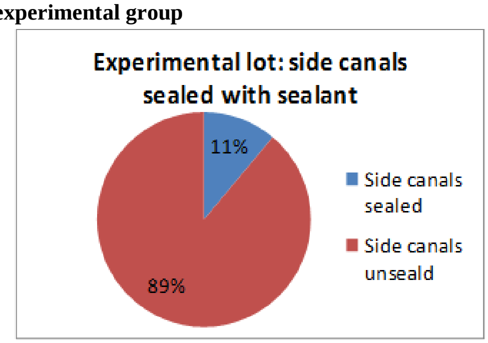


In the experimental group we have created 24 side canals, out of which 22 are radiological visible. The calcium hydroxide paste is present in 19 side canals.

Table no. 5. Closure of the lateral canals with sealant from the experimental groups

Number of sealed side canals	Number of unsealed side canals radiologic visible	Total number of side canals
3	19	24

Figure no. 17. Closure of the lateral canals with sealant from the experimental group



From the total of 22 artificial side canals that are radiologic visible, 3 do not contain remains of calcium hydroxide and allowed the penetration of the sealant inside, thus becoming radio opaque.

In the prognosis of endodontic treatment, the root filling occupies an important place, so every clinician aims at trying to fill the endodontic space as hermetically as possible. Obviously this is extremely difficult to achieve due to the complex intern anatomy of roots. Thus, in the endodontic space, we encounter accentuated curves, supernumerary canals, bifurcations, apical deltas, niches, communication between the canals of the same root and, last but not least, lateral canals. The latter can be closed without being prepared in the classical method by means of endodontic instruments, provided they have a wide lumen and a permeable orifice opening in the main canal.

The permeability of the opening orifice of the side canals is facilitated by the widening of the main canal but especially by the effect of the washing solutions if they have not only a mechanical effect of transporting the residues but also a chemical effect of dissolving the residual debris pressed into the side canal entrance. As it is well known, this type of effect is attributed to sodium hypochlorite, EDTA and citric acid.

The orifice of the canals is not closed only with detritus, but also with the calcium hydroxide used as a disinfectant bandage. Given the difficulty in removing the remains of calcium hydroxide from the canal, it is expected that the calcium hydroxide interferes with the closure of the side canals. Therefore, we hereby tried to verify the hypothesis according to which if we apply a calcium hydroxide bandage in a root with artificial canals, the latter cannot be sealed or can partially be sealed, after the removal of the calcium hydroxide.

The greatest difficulty was the creation of the artificial side canals. The natural canals have the maximum diameter at the opening from the canal and the minimum at the exit on the external surface of the root. This conformation is impossible to achieve artificially because the approach is made from the external surface so that, in the best case, the artificial channel created by us will be cylindrical.

This would be possible if we used a cylindrical tool for drilling into the canal, which would function without vibrations. Unfortunately there are no cylindrical dental instruments of stainless steel. The closest in this respect is the Engine Reamer or, in German literature, the Torpan Bohrer. It resembles a Kerr drilling tool, which is why some manufacturers such as VDW (Germany) sell it under the name of “K-Reamer”.

In order to create artificial side canals as thin as they are naturally, we tried to drill with K-Reamer no. 10 instruments, but they proved to be insufficient, so we had to move to no 15. We tried to work with the K-Reamer no. 15 at 1000 rotations/min, but the speed was too high and the tip of the instrument would blunt rapidly, so instead of advancing into the dentine it would burn it. We reduced the speed gradually until we discovered that the optimum rotation was of 400rotations/min. it would have been ideal to use continuous cooling from a water jet, but it was technically difficult to achieve, so we applied on the drilling spot a small amount of EDTA gel.

For the introduction of calcium hydroxide into the channels we used an injectable substance because they are easier to find on the specialized market. We could have used a Lentulo needle, but it would have increased the risk to introduce air bubbles. Since these preparations contain a large amount of watery vehicle, we have condensed to some extent with dried cotton buds.

As for the removal of calcium hydroxide from the canal, we chose not to use ultrasonic activation because probably most clinicians would not resort to it. This is because, although an efficient method, if it is not adequately controlled, it can lead to the creation of obstacles.

When choosing the method of root canal filing we took into account the fact that it was rotative prepared with relatively high conicity. We could have used a vertical condensation technique coupled with injection, but we preferred a simple technique, within everyone's reach, mono-cone obturation, with standardized Gutta Percha points on the size of the last rotative instrument used. Thus we have ensured a proper correspondence between the form and the volume of the canal and Gutta Percha points.

Plus, to enhance the chances that the sealant penetrates the artificial side canals after the sectioning of the Gutta Percha point while it was still warm and malleable, we vertically condensed it with a plugger and we exerted hydrostatic pressure on the sealant by pushing it into the side canals, if they were permeable. The results of the study confirmed our hypothesis that calcium hydroxide residues prevent sealant penetration into artificially created lateral canals.

CONCLUSIONS

1. Regardless of the method, full removal of calcium hydroxide from the root canal is definitely a great challenge for any practitioner.
2. The efficient removal of calcium hydroxide remains is essential because they might influence the adhesion of the sealant on the root canal walls.
3. The specialized studies show that the passive ultraviolet lavage with 2% sodium has an increased efficiency in the removal of calcium hydroxide has
4. Clinically, long term root canal filing could reduce the risk of persistent infection in the root canal and the periapical tissue.
5. Our in vitro study has demonstrated that calcium hydroxide remains can interfere with the penetration of the sealant in our artificially created side canals.

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