Effect of calcium hydroxide and sodium hypochlorite in dentin resistance: in vitro study

Rita Pinho **NOITES**[1]
Luis Filipe **MALHEIROS**[2]
Manuel Fontes **CARVALHO**[3]
Irene Pina **VAZ**[3]

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ABSTRACT

Introduction: A number of substances used as intracanal dressings have been linked to the weakening of tooth structure, particularly if used for prolonged periods. This study assessed the effect of 5% sodium hypochlorite solution and calcium hydroxide paste in the inorganic composition of the dentin. **Methods:** Twelve instrumented root canal of monoradicular teeth, divided into four groups of 3 teeth each were sectioned longitudinally into two equal parts after removing the crown. Then, group A was irrigated with sodium hypochlorite and stored in the calcium hydroxide; group B was irrigated with sodium hypochlorite and stored in saline; group C was irrigated with saline solution and stored in saline; group D was irrigated with physiological serum and stored in calcium hydroxide. The teeth were stored for 1 and 3 months and subsequently analyzed by electron microprobe. **Results:** After the chemical composition analysis, Ca/P ratio are relatively constant. **Conclusion:** Our results suggest that neither calcium hydroxide nor sodium hypochlorite affected the inorganic component of the teeth, supporting the idea that the main effect of this substances are on the organic part.

Keywords: Calcium hydroxide. Chemical composition. Dentin. Sodium hypochlorite.

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[1]Universidade Católica Portuguesa, Departamento de Endodontia (Viseu, Portugal).
[2]Universidade do Porto, Faculdade de Engenharia (Porto, Portugal).
[3]Universidade do Porto, Faculdade de Medicina Dentária (Porto, Portugal).

Contact address: Rita Pinho Noites
Universidade Católica Portuguesa - Polo Regional das Beiras
Estrada da Circunvalação - 3504-505 Viseu
E-mail: rnoites@gmail.com

Introduction

In Endodontics, some substances used as irrigants or intracanal dressings have been linked to the weakening of the tooth structure, particularly if used for prolonged periods. The first suspicion fell on the calcium hydroxide, particularly in the case of teeth with immature apexes, where it used to be in the root canals for long periods being responsible for an increased incidence of fracture of these teeth.[1]

The weakening of the tooth, i.e. the decreasing of its impact resistance, could be due to a change in the inorganic component,[2,3] with formation of new and weaker substances or an action on the organic component, in particular due to collagen degradation.[4,5] This degradation cannot be restricted to the conjunctive dental tissue present in the main root canal, but also to their processes in the dentinal tubules, weakening the surrounding dentin structure.[1,3,5-9]

In addition to calcium hydroxide, other substances, such as sodium hypochlorite, used as irrigant solution might also contribute or could even be the main responsible for this effect, particularly with regard to collagen degradation. Due to its high wettability, sodium hypochlorite is more prone to act on the collagen of the dentin canaliculi than calcium hydroxide. Moreover, as calcium hydroxide slurry is subsequently placed after the irrigation with sodium hypochlorite solution, it does not seem likely to reach the collagen and act on it.[3,5,10]

The aim of this study is to assess the potential effect of 5% sodium hypochlorite solution and calcium hydroxide paste, as intracanal dressing, in the chemical composition of the dentin at short, medium and long term.

Material and Methods

Sample collection and preparation

A sample of 12 extracted human central incisors, single rooted teeth, were selected. Only teeth without root cracks, caries, restorations and previous endodontic treatments were selected. The access cavity was prepared. Working length was determined using a size 15 K-file (Maillefer® Inc, Ballaigues, Suisse), until its tip became visible from the apical foramen, 1mm short of the apical foramen. Root canals were prepared up to a size 40 K-file (Maillefer® Inc, Ballaigues, Suisse). Teeth were irrigated with 2 ml of saline solution at each change of file. Smear layer was removed with 10% acid citric solution (10ml) and a final irrigation of saline solution was made according to the method of Schafer E.[11]

After preparation teeth were divided into four groups of three teeth each (A, B, C, D). In two of the groups (A, B) irrigation was made, for 1 minute, with 5% sodium hypochlorite and in the other two groups (C, D) irrigation was made with saline solution during 1 minute. After irrigation, the crown was removed from each tooth, and the root was sectioned longitudinally into two similar parts with a diamond disk (Fig 1). There were obtained 24 species, of which 12 served as control.

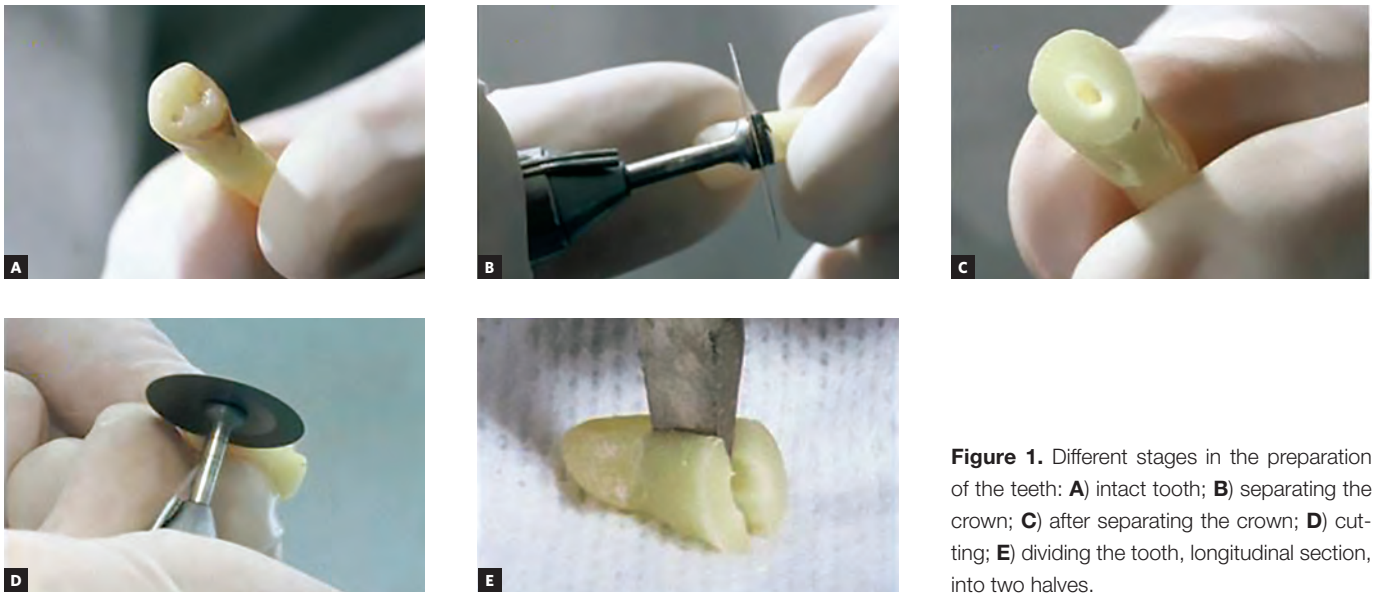

Figure 1. Different stages in the preparation of the teeth: **A**) intact tooth; **B**) separating the crown; **C**) after separating the crown; **D**) cutting; **E**) dividing the tooth, longitudinal section, into two halves.

Experimental groups: irrigation and storage

After longitudinal section, one of the groups irrigated with sodium hypochlorite at 5% (A) was saved on calcium hydroxide and the other group (B) in saline solution. Likewise, one of the groups irrigated with saline solution (D) was stored on calcium hydroxide paste and the other (C) in saline solution.

The study was constituted four groups: group A (n = 3), irrigated with sodium hypochlorite and stored in a calcium hydroxide; group B (n = 3), irrigated with sodium hypochlorite and maintained in saline solution; group C (n = 3), irrigated with saline solution and stored in saline solution (placebo group); group D (n = 3), irrigated with saline solution and stored in calcium hydroxide.

The other half of each tooth served as respective control and was stored in distilled water for the same period of time. Groups were stored for 6 months, and at the end of the 1st month and 3rd month a specimen was removed (one half of the experimental group and the other half of the control group) for short and medium term analysis, respectively, and left a half for analysis at 6 months (long term).

Evaluation of the chemical composition of the dentin

The chemical composition of the dentin, particularly the elements calcium (Ca) and phosphorus (P) were evaluated using an electron-probe micro analyzer (EPMA).

After each of these periods of time (1, 3 and 6 months) the specimens were removed from the respective solutions, thoroughly cleaned with water spray for 2 min, dried and linked to acrylic resin (Figure 2). Subsequently, samples were polished (blocks) and in order to promote its electric conductivity during EPMA observations, coated with a carbon layer with approximately 20 nm thickness by sputtering.

Statistical Analysis

The elements analyzed, Ca and P, were calculated and describe as percentage of weight. The weight elemental analysis was obtained for 5μm, 10μm, 20μm, 30μm, 40μm and 50μm depth. Each value was based on 5-point analysis. Each tooth received 30 measures (in reference to various depths); thus, each half tooth received a total of 180 points of analysis

Results

The results of the short, medium and long term effect of 5% sodium hypochlorite and calcium hydroxide in the chemical properties of the dentine are given in Table 1. The results derived from the analysis by electronic microprobe were expressed in percentage of the total weight. The results of group C, show that irrigation with saline for 1 minute and subsequent retention of the tooth in serum seems to be harmless to the dentine. There were no changes in Ca / P ratio. Irrigation with sodium hypochlorite for 1 minute and the subse-

Figure 2. Samples in acrylic resin.

Table 1. Values of hydroxyapatite constituents of dentin after treatment with 5% sodium hypochlorite and / or calcium

		Month 1	Control	Month 3	Control	Month 6	Control
Group A	Ca (%)	32,30	28,27	26,66	27,34	30,41	26,45
	P (%)	14,10	13,15	12,59	12,92	12,27	12,57
	Ca/P	1,78	1,67	1,64	1,64	1,92	1,63
Group B	Ca (%)	26,55	30,13	26,42	26,28	25,61	28,72
	P (%)	12,23	14,26	12,48	12,19	12,17	13,21
	Ca/P	1,68	1,64	1,64	1,67	1,63	1,68
Group C	Ca (%)	26,58	25,09	25,37	25,07	27,37	29,93
	P (%)	12,66	12,36	12,14	12,29	13,14	14,18
	Ca/P	1,63	1,57	1,62	1,58	1,61	1,64
Group D	Ca (%)	35,61	26,04	34,59	25,99	34,51	26,85
	P (%)	13,89	12,43	13,98	12,31	12,78	12,19
	Ca/P	1,99	1,62	1,92	1,64	2,09	1,71

Ca, calcium; P, phosphorus; Ca / P ratio calcium-phosphorus. Note: the values are expressed in % of the total weight of the tooth.

quent preservation in serum (Group B) caused a slight decrease in the Ca / P ratio much by decreasing the proportion of calcium. Teeth irrigated with physiological saline and stored into calcium hydroxide (Group D) and teeth irrigated with sodium hypochlorite and stored into calcium hydroxide (Group A) increased Ca / P ratio due to a more pronounced loss of phosphorus. Despite the Ca / P ratio being greater in group D, group A presented, in absolute terms, a higher loss of calcium and phosphorus. Indeed, group A lost approximately 2% of each element, a value that is twice the value of group D.

Discussion

The aim of this study was to investigate whether sodium hypochlorite irrigation alone or followed by the application of calcium hydroxide has any influence on chemical composition of dentin. Our preliminary results suggest that neither sodium hypochlorite nor the calcium hydroxide cause substantial changes in the composition of the dentin, which could eventually help to explain the weakening of these teeth. After the chemical composition analysis, we found the Ca / P ratio relatively constant.

Some authors[1,9] suggest that calcium hydroxide is the major responsible for the weakness of the dentin due to changes in the organic matrix and consequently influencing the mechanical properties of the dentin. It has been shown that calcium hydroxide has the ability to dissolve pulp tissue,[12] a process which may occur by denaturation and hydrolysis. After exposure to calcium hydroxide there is an increase in the pH,[13] which can be associated to the reduction of the organic matrix of dentin.[14] This process can cause rupture of the bonds between the collagen fibers and hydroxyapatite crystals negatively influencing the mechanical properties of the dentin. Irrigant solutions as sodium hypochlorite and calcium hydroxide do have some effect in the organic components of dentine.[15]

Others emphasize that long time exposure to calcium hydroxide and sodium hypochlorite may alter the physical properties of the dentin modifying the inorganic matrix.[1] These data justified the present study, although we could not find the same effects.

Although some investigations present a decrease in the strength of the dentine after calcium hydroxide dressing, it is not clear if this effect is entirely due to the dressing. The alternative substances suggested, as the use of MTA don´t strength the weak root canal walls, neither.[15-18] Likewise, apexification techniques are not the gold standard for every clinical cases. Even the regenerative procedures are not predictable in reaching the root maturation.[19]

The sample size prevented us from doing a quantitative analysis.

Conclusion

It is still unknown if irrigant solutions or intracanal dressings are the main cause of the weakness of the teeth submitted to a prolonged period of apexification procedures with calcium hydroxide dressing, as they are frequently teeth with open apexes and thin dentine walls.

Our findings suggest that the inorganic component of dentine is not affected with these substances. The literature proved some effects specially in the collagen fibers, constituents of the organic part of the teeth.

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