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ORIGINAL RESEARCH

Influence of Concentration and Agitation of Sodium Hypochlorite and Peracetic Acid Solutions on Tissue Dissolution

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ABSTRACT

Aim and objective: To evaluated the tissue dissolution of sodium hypochlorite (NaOCl) and peracetic acid (PA) solutions at different concentrations, with or without ultrasonic agitation.

Materials and methods: The following solutions were analyzed: 2.5% NaOCl, 0.5, 1 and 2% PA, 1% PA associated with 6.5% hydrogen peroxide (HP) and saline. Fragments of bovine pulp tissue with 25 ± 2g mg were immersed into test tubes containing 4 mL of the solutions for 10 minutes. In the groups with agitation, pulp tissues were submitted to 2 cycles of 1 minute of ultrasonic agitation. The specimens were weighed after the removal from the solutions. The percentage of mass loss was calculated according to the difference of mass before and after exposure to solutions. Data were submitted to ANOVA and Tukey tests ($p < 0.05$).

Results: A total of 2.5% NaOCl with or without agitation showed the higher tissue dissolution (between 64.5 and 67% of mass reduction) ($p < 0.005$). By comparing the PA solutions, the concentrations of 1 and 2% with or without agitation and the concentration of 0.5% with agitation showed similar dissolution activity (between 35.4 and 44% of mass reduction). The use of the ultrasonic agitation promoted an increase of the dissolution ability only for 0.5% PA.

Conclusion: Peracetic acid solution has pulp tissue dissolution. However, this ability is lower than 2.5% NaOCl solution.

Clinical significance: The sodium hypochlorite solution shows higher ability to dissolve tissue than PA.

Keywords: Dental pulp, Irrigating solution, Root canal treatment.

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INTRODUCTION

The anatomical complexity makes it difficult to achieve the complete disinfection of root canal system during endodontic treatment. The irrigant solution should provide effectiveness in cleaning the root canal system and areas inaccessible to the root canal preparation.[1] The removal of organic and necrotic tissues is important to inhibit the development of the endodontic microbiota.[2]

Root canal irrigants should exhibit organic tissue dissolution, antimicrobial effectiveness and low cytotoxicity.[3] Sodium hypochlorite (NaOCl) solutions are the most used as root canal irrigant due to the antimicrobial activity[4,5] and pulp tissue dissolution.[3,6] Nevertheless, high concentrations of this solution are potentially toxic to the periapical tissue.[7]

A total of 2.5% NaOCl shows an effective dissolution activity of organic tissue.[3] The dissolution capacity of NaOCl solutions can be increased by its heating,[8,9] pH increasing[10,11] and prolonged contact time.[12] Also, its effectiveness may be favored by ultrasonic agitation.[13-15]

Alternative irrigant solutions associating antibacterial effect and cleaning capacity have been studied.[6,16] Peracetic acid (PA) solution has antibacterial,[16,17] antifungal, and antiviral[18] properties and it can remove the smear layer.[19-21] Different PA concentrations were studied.[6,20] These characteristics allow the use of this solution as root canal irrigant.

The aim of this study is to evaluate and compare the effect of 2.5% NaOCl and PA solutions at different concentrations, with or without ultrasonic agitation,

on bovine pulp tissue dissolution the null hypothesis is that PA do not present tissue dissolution at different concentrations, and the solutions do not present influence of ultrasonic agitation.

MATERIALS AND METHODS

The following irrigant solutions were evaluated: 2.5% NaOCl, 0.5, 1, and 2% PA, 1% PA associated with 6.5% hydrogen peroxide (HP) (Peresal, Henkel-Ecolab, Dusseldorf, Germany), and saline (control group). The solutions were evaluated with or without the use of passive ultrasonic agitation, at controlled temperature of approximately 25ºC.

Tissue Dissolution

Lower incisors from young bovine were used.[22] Once the animals were killed, the teeth were extracted from bovine mandibles and immediately frozen at –20ºC. Twenty-four hours later, two longitudinal grooves were performed onto the interproximal surfaces to allow tooth fracture. The pulp tissue was removed and washed in distilled water and then maintained at –20ºC in a flask containing saline. After 24 hours, the pulp tissues were defrosted until a controlled temperature (25ºC ± 1) and dried with absorbent paper. Following, 120 samples of pulp tissue with similar mass (25–30 mg) were obtained after section with scalpel blade. The initial mass of each specimen was measured using a balance (Ohaus Adventurer™, AR2 140, São Bernardo do Campo-SP, Brazil) with the accuracy of 0.0001 gm. After measurement, the samples were randomly divided into 12 groups (n = 10) and individually placed into eppendorf tubes containing 1 ml of distilled water.

For the experiment, 4 ml of each evaluated solution were placed in tubes. After drying the pulp tissue samples in absorbent papers, they were individually inserted into tubes. Each sample was kept immersed into the solution for 10 minutes. After this period, the samples were removed from the solutions and washed in distilled water. Next, they were dried in absorbent paper and a new mensurement of the tissue mass was performed. In groups with ultrasonic agitation, a piezoelectric device (40 Hz) (CVDent 1000, CVD Vale, São José dos Campos, SP, Brazil) was used with ultrasonic tip (smooth wire-IRRI S #25, VDW Endodontic Synergy, Munich, Germany). The tissue sample was also kept inside the solution for 10 minutes. During this period, after 2 minutes, the ultrasonic tip was immersed into tube, 2 mm below the pulp tissue, during 2 cycles of 1 minute, with an interval of 1 minute between them.

The percentage of gain or loss of tissue mass was calculated by the difference of initial (before to the exposure) and final mass (after the exposure to the solutions), which was divided by the initial mass and multiplied by 100. All measurements were performed by the same examiner blinded regarding to the experimental groups. The results were analyzed by analysis of variance (ANOVA) and Tukey tests, with level of significance of 5%. To compare the same solutions with or without passive ultrasonic agitation, the paired t-test was used.

RESULTS

The obtained data are expressed in Table 1, demonstrating that 2.5% NaOCl with or without agitation showed a higher dissolution ability than the other solutions ($p < 0.001$). Peracetic acid solutions at 1. 2% (with or without agitation) and at 0.5% (with ultrasonic agitation) exhibited similar ability ($p > 0.05$). Only 0.5% PA presented an increased dissolution ability ($p < 0.05$) when ultrasonic agitation was used. The PA and HP association showed a lower dissolution ability than the other solutions ($p < 0.05$).

DISCUSSION

The concentration, time, temperature, volume and pH of different irrigant solutions, as well as the use of passive ultrasonic irrigation may influence the organic tissue dissolution.[8-11,13] The bovine pulp tissue has been used due its similarity with human pulp tissue.[22-25] The tissue should be kept immersed into the solution during 10 minutes simulating a clinical period.[26]

Sodium hypochlorite solution is the most common irrigant used. Its ability to dissolve tissue is already known.[3,6,14] However, high concentrations of this solution may cause an irritating effect to the periapical tissues.[7]

Table 1: Mean and standard deviation of tissue dissolution ability expressed in percentage of mass loss in the experimental groups

Groups	*2.5% NaOCl*	*0.5% PA*	*1% PA*	*2% PA*	*PA + HP*	*Saline*
Without ultrasound	67.05 aA ± 9.3	24.67 cB ± 4.9	36.95 bA ± 8.8	35.44 bA ± 7.7	5.04 dA ± 3.8	3.65 dA ± 2.7
With ultrasound	64.56 aA ± 12.8	43.40 bA ± 6.2	44.09 bA ± 10.1	38.67 bA ± 7.4	4.78 cA ± 5.1	5.24 cA ± 2.2

The same case letters in horizontal line indicate statistical similarity ($p > 0.05$) among the difference solutions inside the same group (with or without passive ultrasonic agitation). The same capital letters in vertical line indicate statistical similarity ($p > 0.05$) of the same solution among groups with or without passive ultrasonic agitation

According to the results of this study, 2.5% NaOCl shows an effective dissolution activity of organic tissue, which is in agreement with other studies.[3,14,27,28]

The search for new irrigant solutions has focused on substances presenting antibacterial effect and cleaning capacity of dentinal surfaces. Peracetic acid has been studied due its smear layer removal ability[19-21] and antimicrobial activity.[16,18] Different PA concentrations were studied, such as 0.2,[29] 2.25[20] and 10%.[6] The use of high concentration of PA increases the erosion of dentin.[20] Peracetic acid is potentially cytotoxic.[30] For this study, the evaluated concentrations were 0.5, 1.0 and 2.0%.

In this present study, 2.5% NaOCl showed the highest ability of pulp tissue dissolution when compared with the other solutions. The ability of dissolution tissue is consistent with other studies.[3,25,28] The association of the antimicrobial capacity with the organic tissue dissolution property contributes to the indication of this irrigant solution during the endodontic treatment.

Peracetic acid solutions at 1 and 2%, and at 0.5% with ultrasonic agitation showed tissue dissolution. De-Deus[21] showed that after 60 seconds, low concentrations of PA (0.5 and 2.25%) are similar and enough to dissolve the smear layer. Lottanti[20] observed the removal of the smear layer after 3 minutes in contact with 2.25% PA.

The results of the present study demonstrated that only 0.5% PA presented an increase in pulp tissue dissolution when the passive ultrasonic agitation was used ($p < 0.05$). For the other groups, 1 and 2% PA, PA + HP and 2.5% NaOCl, the use of the ultrasound did not exhibit a significant effect on the dissolution ability. However, 2.5% NaOCl associated with passive ultrasonic irrigation in artificial accessory root canals demonstrated higher tissue dissolution.[14] The authors attributed the highest dissolution ability to the temperature increase of the irrigant caused by the agitation, which have already been reported.[8,9] Peracetic acid associated with HP and saline did not promote pulp tissue and they were similar when agitation was or was not used.

CONCLUSION

One and 2% PA solutions showed pulp tissue dissolution. However, this capacity was lower than those observed for 2.5% NaOCl solution. The use of ultrasound does not affect the dissolution ability of the irrigating solutions, except for the 0.5% PA.

CLINICAL SIGNIFICANCE

The NaOCl solution shows higher ability to dissolve tissue than PA. This property is important for its indication as endodontic irrigating solution.

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