ORIGINAL ARTICLES

Effect of Tea tree Oil as a vehicle for Ca(OH)₂ capping material on healing of exposed dental pulp

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ABSTRACT

Objective Evaluation of the effect of Tea tree Oil as a vehicle for Ca(OH)₂ capping material on healing of exposed pulp of dog’s teeth. Materials & Methods The pulps of 144 teeth were exposed. The exposure sites were capped with either Ca(OH)₂ mixed with saline, Ca(OH)₂ mixed with Tea tree oil or only IRM. Histological examination was done at 1, 4, 8 and 12 weeks using scoring system described by Faraco Junior and Holland. Results Ca(OH)₂ mixed with TTO showed mild to moderate inflammation at 1, 4 and 8 weeks, while Ca(OH)₂ mixed with saline and IRM groups showed severe inflammation at the 3 examination periods. At 12 weeks, Ca(OH)₂ + TTO showed no to mild inflammation. Furthermore, Ca (OH)₂ with distilled water and IRM; both showed severe inflammation or necrosis. Conclusion Reaction of the pulp towards Ca(OH)₂ capping material differs according to the type of vehicle used, as addition of TTO to Ca(OH)₂ minimizes the inflammatory reaction to the material.

Key words: Tea tree Oil, capping material, exposed dental pulp.

Introduction

Like other connective tissues, dental pulp tissue has the potential to heal. Characteristics of exposed pulp tissue that advance healing, include reorganization of damaged soft tissue, differentiation of odontoblast-like cells from subodontoblast cells, and repair of exposed pulp tissue with reparative dentin bridge formation.

Many materials have been used as pulp capping agents. Calcium hydroxide was introduced into dentistry by Hermann 1930 as a pulp capping agent, and since then, has been accepted as the agent of choice. Nevertheless, it has shown that calcium hydroxide is soluble and degrades with time. Moreover most of the dentine bridges contain multiple tunnel defects, which often leads to failure of a bacteriometric seal (Olsson et al, 2006).

The type of vehicle used with calcium hydroxide to obtain the paste has a direct relationship with the concentration and velocity of ionic liberation of calcium and hydroxyl ions. In General, different types of vehicles can be used: either aqueous or oily. The aqueous group is represented by water and saline. When calcium hydroxide mixed with one of these substances, Ca+2 and OH- are rapidly released. This type of vehicle promotes a high degree of solubility and resorption (Estrela & Pesce 1996).

The aim of the present study was to evaluate the effect of Tea tree oil as a vehicle for Ca(OH)₂ capping material.

Materials and methods

Twelve adult mongrel dogs were used in this study, with an average body weight of 20-30 kg, and of ages ranging from 1 – 1.5 years. All dogs were examined thoroughly before the selection and kept under observation for 2 weeks before being used as experimental animals in the study in order to exclude the diseased animals. The dogs were randomly divided into four groups; three dogs each, relative to the observation periods tested, 1, 4, 8 and 12 weeks. A Total of 144 teeth were selected for this study (12 teeth of each dog).

The utilized teeth of each dog (12 teeth) were classified into 3 equal groups (4 teeth each) as follows:

Group A: Ca(OH)₂ used as capping material.
Group B: Ca(OH)₂ mixed with TTO used as capping material.
Group C: IRM used as capping material.

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The animals were anesthetized with a mixture of Xylazine HCl 1 mg/Kg body weight and Ketamine HCl 5 mg/kg. The anesthesia was maintained through the operative time by venous drip (1/2g Thiopental / 500 ml dextrose 5%).

Prior to operative procedure, teeth were cleansed and polished with pumice paste to remove plaque and calculus. The operating field was disinfected with antiseptic solution. Working area was isolated using sterile cotton rolls and gauze. Animal was covered using sterile towels, exposing only the operative field.

On the facial surfaces of the selected teeth, class V cavities were prepared in a standardized protocol approximately 1 mm coronal to the gingival margin (approximately 3× 5 mm). The cavity was prepared using sterile carbide inverted cone bur under copious sterile water coolant and at rotational speed ranging between 25000 –40000 r.p.m. A new bur was used on every fourth tooth to ensure good cutting efficiency. The finished cavities were having proper undercuts at the line angles to retain the capping and filling material.

The pulpal floor of the prepared cavities were finished as close as possible to the pulps until the pink shadow of the pulp became apparent, leaving a thin dentin barrier. A sterile explorer was used to create pulp exposure in the center of the cavity floor. Bleeding of the pulp was controlled using sterile cotton pellets moistened with sterile saline until physiologic haemostasis occurred, and then dried with cotton pellets.

After preparation of the exposure sites, they were dried with cotton pellets and capped directly with one of the tested materials: Calcium hydroxide powder mixed with sterile distilled water or Calcium hydroxide powder mixed with TTO or IRM.

All teeth were sealed with intermediate restorative material (IRM). This material was used to exclude bacterial leakage according to the method used by Brännström and Nyborg.

After 1,4,8 and 12 weeks, the animals were sacrificed and the used teeth were extracted, fixed in 10% neutral buffered formalin solution and decalcified. The teeth specimens were embedded in paraffin, sectioned at an average thickness of 6 µm, and stained with hematoxyline- eosin.

The analysis of the results were evaluated using light microscope(400X), according to the criteria that were based on a scoring system described by Faraco Junior and Holland, (2004). Each histomorphological event was evaluated by scores of 1 to 4 according to the severity of inflammation and thickness of dentin bridging as follows:

I) **Intensity of inflammatory reaction of the dental pulp:**
   (Evaluated at a magnification of 400X)
   1. Absent or very few inflammatory cells.
   2. Mild: average number less than 10 cells.
   3. Moderate: average number of 10-25 cells.
   4. Severe: average number greater than 25 cells.

II) **Thickness of hard tissue bridge formation:**
    (Evaluated in three different points of the bridge)
    1. Partial or absent bridge.
    2. From 1 to 149 µm.
    3. From 150 to 249 µm.
    4. Above 250 µm.

Data were presented as mean and standard deviation (SD) values. Friedman's test was used for comparisons between inflammation scores and dentin thickness scores with different capping materials.

**Results:**

I. **Degree of Inflammation:**

**One week observation period:**

All capping materials revealed mild to severe inflammation. Ca (OH)₂ + TTO revealed moderate inflammation (score 3), followed by Ca (OH)₂ with distilled water and IRM which showed severe inflammation (score 4), where pair-wise comparison revealed no significant difference between both of them.

**Four weeks observation period:**

No significant changes were found. Ca (OH)₂ + TTO showed moderate inflammation, followed by Ca (OH)₂ with distilled water and IRM groups. Pair-wise comparisons showed that there was no statistically
significant difference between Ca (OH)$_2$ with distilled water and IRM groups; both revealed severe inflammation (score 4).

**Eight weeks observation period:**

Ca (OH)$_2$ + TTO showed few number of inflammatory cells which revealed mild to moderate inflammation (score 2.5), while Ca (OH)$_2$ with distilled water and IRM groups showed severe inflammation (score 4).

**Twelve weeks observation period:**

Ca(OH)$_2$ + TTO showed no to mild inflammation (scores 1, 1.5). There was a statistically non significant difference between mean degrees of inflammation of both groups. Furthermore, Ca (OH)$_2$ with distilled water and IRM; both showed severe inflammation or necrosis (score 4) with no statistically significant difference between them.

**Table 1:** The mean, standard deviation (SD) values of the inflammatory scores of different capping materials at the tested periods.

<table>
<thead>
<tr>
<th>Capping</th>
<th>Ca (OH)$_2$</th>
<th>Ca (OH)$_2$ + TTO</th>
<th>IRM</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>1 week</td>
<td>4 $^a$</td>
<td>0</td>
<td>3 $^b$</td>
<td>0</td>
</tr>
<tr>
<td>4 weeks</td>
<td>4 $^a$</td>
<td>0</td>
<td>3 $^b$</td>
<td>0</td>
</tr>
<tr>
<td>8 weeks</td>
<td>4 $^a$</td>
<td>0</td>
<td>2.5 $^c$</td>
<td>0.6</td>
</tr>
<tr>
<td>12 weeks</td>
<td>4 $^a$</td>
<td>0</td>
<td>1.5 $^c$</td>
<td>0.6</td>
</tr>
</tbody>
</table>

**Fig. 1:** Bar chart representing mean degree of inflammation with the three capping materials.

**Table 2:** The mean, standard deviation (SD) values and results of comparison between dentin thickness scores with different capping materials.

<table>
<thead>
<tr>
<th>Capping</th>
<th>Ca (OH)$_2$</th>
<th>Ca (OH)$_2$ + TTO</th>
<th>IRM</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>1 week</td>
<td>1 $^a$</td>
<td>0</td>
<td>1 $^a$</td>
<td>0</td>
</tr>
<tr>
<td>4 Weeks</td>
<td>1 $^a$</td>
<td>0</td>
<td>1 $^a$</td>
<td>0</td>
</tr>
<tr>
<td>8 Weeks</td>
<td>1.5 $^a$</td>
<td>0.6</td>
<td>2 $^a$</td>
<td>0</td>
</tr>
<tr>
<td>12 Weeks</td>
<td>1.5 $^a$</td>
<td>0.6</td>
<td>2 $^a$</td>
<td>0</td>
</tr>
</tbody>
</table>

**II. Dentin thickness scores:**

**After 1 & 8 weeks:**

At these early stages, no evidence of dentine formation was found with any of the capping materials. All materials showed no dentine formation (score 1).
After 8 & 12 weeks:

At these periods, an evidence of dentine formation was found with capping materials with different scores. Ca(OH)$_2$ + TTO showed the highest score (2), followed by Ca(OH)$_2$ with distilled water and IRM (scores 1.5 and 1), the results showed no statistically significant difference between them.

![Fig. 2: Bar chart representing mean dentin thickness scores with the three capping materials.](image)

Discussion:

Preserving the dental pulp in a healthy state is important in treating teeth with deep caries. Exposure of the dental pulp can happen as a result of caries, trauma or during cavity preparation. (Nair et al, 2008)

Many materials have been used as pulp capping agents. Calcium hydroxide was introduced into dentistry by Hermann 1930 as a pulp capping agent, and since then, has been accepted as the agent of choice. Nevertheless, it has shown that calcium hydroxide is soluble and degrades with time. Moreover most of the dentine bridges contain multiple tunnel defects, which often leads to failure of a bacteriometric seal (Olsson et al, 2006).

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According to Kawakami et al, (1987a) The high molecular weight of oily vehicles prolongs the action of the paste, and Ca$^{+2}$ and OH$^{-}$ ions will be released at lower rate and the paste may remain for a longer time than pastes containing aqueous vehicles.

According to this study, using TTO as a vehicle improved the action of Ca(OH)$_2$, this may be due to the antinflammatory action of TTO which released over a longer period of time during dissociation of Ca(OH)$_2$ where ca(OH)$_2$ act as a carrier for TTO. This antinflammatory action caused less inflammation which resulted in more secondary dentin formation. Adding TTO to Ca(OH)$_2$ as a vehicle caused significant decrease in degree of inflammation from Ca(OH)$_2$ and distilled water group, this was obvious in all experimental periods starting from 1 week to 12 weeks. But there was insignificant difference between These 2 groups in secondary dentin formation in all experimental periods.

The type of vehicle may affect the speed of dissociation of calcium and hydroxyl ions and consequently the antimicrobial properties. Dissociation of calcium hydroxide is essential to produce its effect which may occur by release of both calcium and hydroxyl ions, and that leads to favorable biological and antimicrobial action. (Duarte et al, 2007)

Calcium hydroxide ions react with tissue carbonic gas forming calcium carbonate which favors dental pulp cell proliferation and differentiation. (Takita et al, 2006), while hydroxyl ions act by stimulating the release of alkaline phosphatase which participates in mineralization process. (Duarte et al, 2007)

Calcium hydroxide ions react with carbonic gas to remove the source of respiration of anaerobic bacteria, while hydroxyl ions maintain a high alkaline environment which was unfavorable for bacterial survival. As Enterococcus Faecalis is a resistant bacterium in root canals, surviving at PH 11.5, but being killed at PH 12.5, so a high PH value is desired to achieve antibacterial effect. (de Andrade Ferreira et al, 2004)
Conclusion:

The present experiments indicate that reaction of the pulp towards Ca(OH)$_2$ capping material differs according to the type of vehicle used, as addition of TTO to Ca(OH)$_2$ minimizes the long term inflammatory reaction to the material. Further studies are needed to determine the enhancement of antibacterial effect of Ca(OH)$_2$ after addition of TTO.

References