A Comparative Evaluation of Antimicrobial Effectiveness of Pulp-capping Agents

Anshul Gangwal

ABSTRACT

Aim: To analyze the antimicrobial properties of five pulp-capping agents calcium hydroxide powder, calcium hydroxide and glycerine 'Excela R', Metapex, Dycal, Septocal LC against Staphylococcus aureus, Streptococcus mutans, Peptostreptococcus species and Bacteroides melaninogenicus. The capping agents were tested 1, 3 and 7 days after manipulation.

Materials and methods: Caries sample collected from excavation from deep carious lesion. The samples obtained with each bur were immediately collected into test tubes containing BHI broth, and were incubated at 37°C and plated onto BHI agar. The zone of inhibitions was measured and analyzed.

The specimens were divided into five groups as follows:
Group A—Calcium hydroxide powder and distilled water, group B—calcium hydroxide and glycerine 'Excela R', group C—Metapex 5, group D—Dycal, group E—Septocal LC.

Results: The group D Dycal was found most effective antibacterial pulp-capping agents while group B (calcium hydroxide with glycerine) was the least effective antibacterial pulp-capping agent.

The group E (Septocal LC), group C (Metapex) and group A were in descending order between groups D and B.

Conclusion: Intergroup comparisons for zones of inhibition during the overall period of study revealed significant differences against all the bacterial strains under the study. Between all the comparisons made, the most significant difference was between groups B and D and least significant difference between groups C and E. Thus, indicating that group D was the most effective antibacterial pulp-capping agent while group B was least effective.

Keywords: Bacteria, Calcium hydroxide, Pulp-capping.


INTRODUCTION

Pulp damage might be resulted from the leftover microorganisms in dentin after the cavity preparation. This damage makes it necessary to use pulp-capping agents with antimicrobial activity underneath permanent restorations. The treatment can fail when the microorganisms in dentin, pulp and periapical tissues persist and reproduce, especially in the long-term.

Calcium hydroxide is widely used in endodontics and restorative dentistry, especially as a sublining to stimulate osteodentin bridge formation in cases of pulpal exposure. Vital pulp therapies consist of indirect and direct pulp-capping, partial (superficial) pulpotomy and cervical pulpotomy.

Currently, pulp-capping is the primary method for preserving vital pulp, but the success rate of this approach during the treatment of deep caries is low at only 33%.1 The presence of bacteria is the major reason for failure. Bacteria located in deep caries can induce severe inflammatory reactions in the pulp and even cause pulp necrosis.2 Therefore, the prevention of bacterial infections is an important objective for improving pulp-capping methods in the treatment of deep caries.

In general, an ideal pulp-capping material should possess both excellent antibacterial properties and the ability to induce mineralized tissue formation.3 The most common pulp-capping materials used clinically include various formulations of calcium hydroxide [Ca(OH)2].

Calcium hydroxide has been shown to be effective in eliminating bacteria. The antimicrobial activity is believed to be related to its alkalinity although other components could be implicated.

The purpose of this study was to evaluate the antibacterial properties of three different pulp-capping agents using agar diffusion test.

MATERIALS AND METHODS

Micro-organisms, for this study, were obtained from carious teeth with a spoon excavator. The samples were separately placed in the tight screw-capped bottles containing the Robertson’s cooked meat media. The samples were collected under rubber dam isolation to avoid any salivary contamination. Caries samples were inoculated in the Robertson’s cooked meat media and were incubated for 24 hours at a temperature of 37 ± 1°C.4 The bacterial species were isolated on the basis of colony character, morphology and gram’s staining and biochemical reactions.
The test materials evaluated in this study were calcium hydroxide powder (Rolex Chemical Ltd, Mumbai) glycerine 'Excela R' (Qualigens Fine Chemicals Ltd, Mumbai) Metapex (Meta Dental New York, Elmhurst, New York) Dycal (Dentsply), Septocal LC (Septodont, France).

All materials were prepared in strict compliance with the manufacturer’s recommendation.

The test strains include: S. aureus, S. mutans, P. species and B. melaninogenicus. The isolated bacteria were subcultured in petridishes. Wells were cut in petridishes and then the pulp-capping agents were added. The petridishes were incubated and observed for zones of inhibition at an interval of 1, 3 and 7 days. Agar diffusion test (Fig. 1) was used to determine the antibacterial activities of the materials. Zone of inhibition was measured using Vernier caliper and divider.

Analysis of zone of inhibition around pulp-capping agents against micro-organisms was done using one way analysis of variance test.

RESULTS

Table 1 shows the mean zone of inhibition scores for various bacteria with different the pulp-capping agents after 7 days which depicts that mean zone of inhibition for various pulp-capping agents are found higher against S. aureus, S. mutans, P. and B. melaninogenicus in group D (Dycal) showed maximum effectiveness while group B [Ca(OH)₂ + glycerine] found to be least effective.

Bar graphs (Graphs 1 to 3) shows the overall scores for different bacterial strain inhibition as against all the experimental pulp-capping agents at different time intervals.

DISCUSSION

The pulp is the formative organ of the tooth. Even in compromised situations when the pulp becomes infected the tooth ought to be preserved in dental arch to maintain integrity of stomatognathic system.

Micro-organisms can invade the dentinal tubules of both teeth with vital and nonvital pulps, but the invasion is less severe with vital pulps because of the protective function of the pulp. Bacteria entering either the pulpal surface or periodontal surface of the root can exist within the dentinal tubules. If viable, these bacteria could act as reservoirs of infection.

The agar diffusion test is a quantitative and reproducible method designed to simulate the contact of the micro-organism with the root repair materials in the root canal. The antibacterial activity of dental cements has been intensively tested. Calcium hydroxide (CH) is still considered the reference material for pulp-capping, due to its antibacterial properties and its capacity to induce enzymatic reactions leading to the formation of a dentin bridge. Antibacterial activity of calcium hydroxide based materials depends on the ionization that releases hydroxyl ions causing an increase in pH. Cellular membrane enzymes of the micro-organism might be reversibly or irreversibly inactivated by a pH.

The present study compared the antibacterial activity of commercially available pulp-capping materials. The results for various bacterial growth consistently demonstrated that the experimental material Dycal exhibited stronger antibacterial activity. These findings are consistent with the study done by McComb D and Ericson D (1987). Calcium hydroxide mixed with glycerine produced low inhibitory range in accordance to previous study by Gomes BPEA et al.

Studies report that pulp response after direct capping is linked to bacterial microleakage. Microbes interfere with the pulpal response to capping materials. It was noted that bacteria stimulate pulpal inflammatory activity and

<table>
<thead>
<tr>
<th>Bacteria</th>
<th>Group A (mm)</th>
<th>Group B (mm)</th>
<th>Group C (mm)</th>
<th>Group D (mm)</th>
<th>Group E (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. aureus</td>
<td>10.32 ± 0.41</td>
<td>7.96 ± 0.26</td>
<td>15.82 ± 0.53</td>
<td>25.08 ± 0.11</td>
<td>17.84 ± 0.22</td>
</tr>
<tr>
<td>S. mutans</td>
<td>12.30 ± 0.24</td>
<td>8.30 ± 0.28</td>
<td>16.18 ± 0.23</td>
<td>25.96 ± 0.22</td>
<td>16.32 ± 0.33</td>
</tr>
<tr>
<td>P. species</td>
<td>9.50 ± 0.16</td>
<td>7.92 ± 0.18</td>
<td>15.24 ± 0.18</td>
<td>21.82 ± 0.28</td>
<td>14.42 ± 0.38</td>
</tr>
<tr>
<td>B. melaninogenicus</td>
<td>12.80 ± 0.41</td>
<td>6.98 ± 0.36</td>
<td>15.86 ± 0.13</td>
<td>20.58 ± 0.32</td>
<td>15.26 ± 0.30</td>
</tr>
</tbody>
</table>
reduce the area of dentin bridge formation irrespective of the material used for pulp-capping. Many studies indicate that it is not an agent’s potential bioactivity but its capacity to protect the pulp from bacterial exposure that plays a role in pulpal survival after an oral exposure.\textsuperscript{2,9}

Calcium hydroxide also presents some deficiencies: (i) It incites pulp necrosis during the first days, then the pulp reacts by establishing an atubular tertiary dentin bridge, but this dentin formation is made to the detriment of the pulpal volume with long-term biological consequences, (ii) when the paste is only Ca(OH)\textsubscript{2}, its application in the root canal system is easy but the low hardening and the retraction by drying do not allow tight fillings, consequently it is only used as temporary material in this indication for which hermeticity is a priority, (iii) to get round this disadvantage, i.e. to increase the crushing strength and to decrease the setting time, polymeric bases were added, but under these conditions the setting time is too short to use these materials as root canal filling.

Furthermore, the present study only evaluated the antibacterial activity in an \textit{in vitro} study and additional important parameters for pulp capping materials, such as the physical properties, chemical properties, bioactivity and biological properties, need to be evaluated in further experiments.

**REFERENCES**