AN IN VITRO EVALUATION OF ANTIMICROBIAL ACTIVITY OF DIFFERENT ENDODONTIC SEALERS

Sabyasachi Saha1, Sonali Saha2*, Firoza Samadi3, J.N. Jaiswal4, Ujjala Ghoshal5

1. M. D. S. (Professor & Head) Department of Public Health Dentistry, Sardar Patel Postgraduate Institute of Dental and Medical Sciences, Lucknow, India.
2. Dr., M.D.S. Department of Pedodontics (Senior Lecturer), Sardar Patel Postgraduate Institute of Dental and Medical Sciences, Rai-bareilly Road, Lucknow, India.
3. M.D.S. Department of Pedodontics, (Professor & Head) Sardar Patel Postgraduate Institute of Dental and Medical Sciences, Rai-bareilly Road, Lucknow, India.
4. M.D.S. Department of Pedodontics, (Professor & Director), Sardar Patel Postgraduate Institute of Dental and Medical Sciences, Lucknow, India.
5. M. D. (Assistant Professor) Department of Microbiology Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow, India.

Abstract

Microbes are considered as the primary etiologic agents in endodontic diseases. The ways of reducing these agents are: root canal debridement, antimicrobial irrigants and antibacterial filling materials. But the complexity of the pulp canal system presents a problem for chemo mechanical preparation. One of the factors determining the success of endodontic treatment is the sealing material with a potent bactericidal effect. The aim of the present study was to assess the antimicrobial activity of endodontic sealers of different bases – in vitro.

The antimicrobial activity of three root canal sealers (Endomethasone, AH 26 and Apexit) was evaluated against seven strains of bacteria at various time intervals using the agar diffusion test. The freshly mixed sealers were placed in prepared wells of agar plates inoculated with the test microorganisms. The plates were incubated for 24, 48, 72 hours and 7 and 15 days. The mean zones of inhibition were measured. All statistical analysis was performed using the SPSS 13 statistical software version. The analysis of variance (ANOVA), Post-hoc Bonferroni test and Paired “t” test were performed to know the effects of each variable and to reveal the statistical significance. All the data were presented in tabular and Bar diagram form.

Zinc oxide eugenol based sealer (Endomethasone) exhibited the highest antibacterial activity at all time intervals followed by the Epoxy resin based sealer (AH 26) and least by the Calcium hydroxide based sealer (Apexit). Greatest antimicrobial efficacy for all the three sealers was seen at 24 hour time interval which kept on diminishing with time and reached to the lowest level at 7 day time interval.

Results also showed that the zones of inhibition produced by each sealer decreased with time, and was the least after the seven days of incubation. The differences among all the groups were significant statistically (p<0.001) at all the four time intervals under study.

Zinc oxide eugenol based root canal sealer produced largest inhibitory zones followed in decreasing order by Epoxy resin based sealer and least by Calcium hydroxide based root canal sealer.

Keywords: Antimicrobial activity, root canal sealer, Endomethasone, AH26, Apexit.

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Introduction

Microorganisms and their by products are considered to be the primary etiologic agents in endodontic diseases1. Failure, during and after endodontic treatment are linked to the presence of bacteria in the root canal2.

This result hence emphasizes the importance of completely eliminating bacteria from the root canal system3. The most effective
ways to achieve this aim are by means of instrumentation and irrigation. However, no less important than the biomechanics is an adequate filling of the root canal4.

But the irregularity in shape (lateral canals, anastomosis, bifurcations and curvatures), solid or semisolid root canal filling material alone cannot provide an exact fit5. Therefore, root canal sealers with good sealing ability and antimicrobial activity are desired to kill and eliminate residual microorganisms6. Hence the present study has been taken up to test the antimicrobial activity of currently used endodontic sealers, against microbes found in the tooth with a vital inflamed pulp or pulpal necrosis.

The aim of the present study was to assess the antimicrobial activity of endodontic sealers of different bases – in vitro.

Material and Methods

The present study was conducted in the Department of Pedodontics and Preventive Dentistry, Sardar Patel Postgraduate Institute of Dental and Medical Sciences, in collaboration with Department of Microbiology, Sanjay Gandhi Post Graduate Institute of Medical Sciences (SGPGIMS), Lucknow, Uttar Pradesh (India).

In this study, the antimicrobial efficacy of three commercially available root canal sealers of different bases namely zinc-oxide eugenol, epoxy resin and calcium hydroxide were evaluated against seven strains of bacteria (aerobes, facultative and obligate anaerobes) known to be common isolates in necrotic pulps and endodontic lesions, at various time intervals using the agar diffusion test.

Previously, a pilot study was carried out in the same departments, to overview the proper study design and to take care of the possible constraints during the main study.

Tested sealers:

Root canal sealers used in this study were Endomethasone (Zinc-oxide Eugenol based sealer), AH 26 (Epoxy resin based sealer) and Apexit (Calcium hydroxide based sealer).

The sources of the sealers were as follows.

<table>
<thead>
<tr>
<th>Sealer</th>
<th>Manufacturer</th>
<th>Batch No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endomethasone</td>
<td>Septodont, Saint-Maur des-Fosses Cedex, France</td>
<td>612000679</td>
</tr>
<tr>
<td>AH26</td>
<td>Dentsply De Tray GmbH, Konstanz, Germany</td>
<td>32455</td>
</tr>
<tr>
<td>Apexit</td>
<td>Ivoclar Vivadent, Schaan, Liechtenstein</td>
<td># 533281</td>
</tr>
</tbody>
</table>

Composition of the sealers:

**Endomethasone:**
- **Liquid:** Eugenol
- **Powder:**
  - Dexamethasone: 0.01 gm
  - Hydrocorisone acetate: 1.0 gm
  - Paraformaldehyde: 2.2 gm
  - Minium: 5.0 gm
  - Di – iodotyramol: 25.0 gm
  - Zinc – oxide: 41.79 gm
  - Barium sulphate: 15.0 gm
  - Magnesium stearate: 10.0 gm

The powder to liquid ratio (gm/ml) was 4:1

**AH 26:**
- **Resin:** Bisphenol diglycidyl ether
- **Powder:**
  - Silver powder: 10.0 gm
  - Bismuth oxide: 60.0 gm
  - Hexamethylenetetramine: 25.0 gm
  - Titanium dioxide: 5.0 gm

The powder to liquid ratio (gm/ml) was 1.75:1

**Apexit:**
- **Base:**
  - Calcium hydroxide: 31.9
  - Hydrogenised colophony: 31.5
  - Silicon dioxide: 10.4
  - Paraffin oil: 7.3
  - Calcium oxide: 5.6
  - Zinc oxide: 5.4
  - Calcium phosphate: 4.1
  - Polydimethysiloxane: 2.5
  - Alkyl ester of phosphoric acid: 1.0
  - Pigments: 0.3

**Activator:**
- Trimehexyhexahexo1,2,4,5,6 salicylate: -25.0
- Bismuth carbonate: 18.2
- Bismuth oxide: 18.2
- Silicon dioxide: 16.4
- Butanediol1,2 salicylate: 11.3
- Hydrogenised colophony: 5.4
- Calcium phosphate: 5.6
- Alkylester of phosphoric acid: 0.3

This calcium hydroxide based root canal sealer is prepared by mixing equal volumes of base and activator on a mixing pad.

Preparation of the sealers:

The sealers were prepared in strict compliance with the manufacturer’s recommendations.
Test microorganisms:

Antibacterial activities of the sealers were evaluated against five aerobes and facultative anaerobes and two obligate anaerobes.

Strains used, their source, and morphotype are given below:

Staphylococcus aureus -- ATCC 25923-- Gram positive cocci
Streptococcus β haemolyticus -- ATCC 10556- - Gram positive cocci
Enterococcus faecalis-- ATCC 29212-- Gram positive cocci
Escherichia coli-- ATCC 25922-- Gram negative bacilli
Pseudomonas aeruginosa-- ATCC 27853-- Gram negative bacilli
Peptostreptococcus sp. (obligate anaerobes)-- NCTC 9821-- Gram positive cocci
Bacteroides fragilis (obligate anaerobes)-- ATCC 35406 -- Gram negative bacilli

ATCC= American Type Culture Collection
NCTC= National Culture Type Collection

Procedure:

Cultures of the individual bacterial strains were obtained from the laboratory stock of the Department of Microbiology, Sanjay Gandhi Post Graduate Institute of Medical Sciences (SGPGIMS), Lucknow.

Growth conditions and bacterial culture:

S. aureus, E. faecalis, E. coli and P. aeruginosa were grown aerobically in Brain Heart Infusion (BHI) Broth and Streptococcus β haemolyticus in Trypticase soy broth. Bacteroides fragilis and Peptostreptococcus sp. were grown in BHI containing Hemin & Menadione.

Preparation of the inoculums:

Inoculum for each bacterial strain, was prepared by picking up four to five colonies with the help of a circular, previously sterilized loop of four millimeter internal diameter and dissolving them into respective test-tubes containing 5 ml of 0.85% saline solution – to produce a turbidity of 0.5 on McFarland scale which corresponds to a concentration of 10^8 colony forming units ml^-1. Petridishes, 90 millimeter diameter, containing four millimeter thick Mueller-Hinton agar (MH; Difco Laboratories, Detroit, Michigan, USA) were used for all the above bacterial strains except Streptococcus β haemolyticus, for which Blood agar plates were used.

To ensure even distribution of the inoculums, the respective bacterial dilutions were then swabbed evenly onto freshly prepared respective agar plates using the “Lawn Technique”. Each plate (for every individual bacterial strain) was evenly divided into three equal sections. In each section of each plate, wells of six millimeter diameter were created with the help of previously fabricated and sterilized copper wells. (Figure 1) The three wells in each section were then filled with the three different based freshly mixed sealers. (Figure 2)
The MH agar plates were incubated at 37°C. The Blood agar plates inoculated with *Streptococcus b haemolyticus* strain was incubated in a CO₂ incubator (Jouan, Saint Herblain, France) in an atmosphere of 10% CO₂. Plates with strict anaerobes were immediately placed into GasPak anaerobic jars [nitrogen (90%) and CO₂ (10%)].

The plates for facultative anaerobes were read at 24 hours, 48 hours, 72 hours and lastly at 7 days for size of the zone of inhibition while readings for strict anaerobes were carried out after 48 hours, 7 days and 15 days. The whole experiment was repeated six times for each isolate and the mean zone of inhibition was then calculated.

**Measuring the size of Zone of Inhibition:**

Growth inhibitory zones around each sealer was evidenced by lack of bacterial colonization (clearing of agar) adjacent to each sealer. The most uniform diameter segment of the zone of inhibition was measured with an endodontic millimeter ruler and the six millimeter diameter of the well was extracted from the measurement as the cut-off value. All measurements above this value were considered indicative of significant bacterial growth inhibition.

Wider zones of inhibition were interpreted to indicate greater antimicrobial activity of the involved sealers.

**Positive growth control / Negative growth control:**

**Positive growth control:**- Seven agar plates were streaked with individual test microorganisms only without the sealers to ensure that the bacterial life cycle did not become inactive before the last 7-day observation in case of aerobes / facultative anaerobes and last 15-day observation in case of obligate anaerobes.

**Negative control:** - Three different based sealers were placed on seven plates which had not been inoculated with bacteria, and one plate had neither sealer nor bacteria.

**Statistical analysis:**

All statistical analysis was performed using the SPSS 13 statistical software version. All the data were presented in tabular and Bar diagram form. The analysis of variance (ANOVA), Post-hoc Bonferroni test and Paired “t” test were performed to know the effects of each variable and to reveal the statistical significance.

The confidence level of the study was proposed to be 95%, hence a “p” value <0.05 has been considered significant, “p” value <0.01 has been considered highly significant and a “p” value <0.001 has been considered very highly significant.

**Results**

![Figure 3 & 4. Growth inhibitory zones evidenced by lack of bacterial colonization (clearing of agar) adjacent to each sealer.](image)

Table 1 shows the antimicrobial efficacy of Zinc oxide eugenol based sealer (Endomethasone), Epoxy resin based sealer (AH 26) and Calcium hydroxide based sealer (Apexit) against all the five aerobic microorganisms (*Staphylococcus aureus, Streptococcus b haemolyticus, Enterococcus faecalis, Escherichia coli* and *Pseudomonas aeruginosa*) at 24 hours,
48 hours, 72 hours and 7 days time interval. (Figure 3 & 4)

Table 1. Antibacterial Efficacy of Different Sealers for Aerobic Bacteria
(Values in Mean±SD)

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Time Period</th>
<th>Endomethasone</th>
<th>AH 26</th>
<th>Apexit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>24 hours</td>
<td>32.97±8.77</td>
<td>20.33±7.45</td>
<td>3.97±5.03</td>
</tr>
<tr>
<td>2</td>
<td>48 hours</td>
<td>31.57±6.87</td>
<td>18.43±6.24</td>
<td>3.60±4.52</td>
</tr>
<tr>
<td>3</td>
<td>72 hours</td>
<td>30.53±9.06</td>
<td>17.26±7.02</td>
<td>0.47±4.48</td>
</tr>
<tr>
<td>4</td>
<td>7 days</td>
<td>22.57±7.28</td>
<td>10.43±2.92</td>
<td>1.40±1.85</td>
</tr>
</tbody>
</table>

It was seen that the mean antimicrobial efficacy of Endomethasone was significantly higher as compared to that of AH 26 and Apexit. Maximum antimicrobial efficacy was seen for Endomethasone (32.97±8.77 mm) at 24 hours while minimum antimicrobial efficacy was seen for Apexit (1.40±1.85 mm) at 7 days.

Table 1a shows analysis of variance (ANOVA) of the three different sealers for the aerobic strains of bacteria. Results reveals a highly significant (p<0.001) difference among the sealer groups for their antimicrobial efficacy against aerobic bacteria at the four different time intervals.

<table>
<thead>
<tr>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F*</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>24 hours</td>
<td>12664.692</td>
<td>6342.341</td>
<td>20.62±0.001</td>
</tr>
<tr>
<td>Within Groups</td>
<td>4574.560</td>
<td>8762.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>17299.256</td>
<td>7259.26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>48 hours</td>
<td>11746.472</td>
<td>5873.231</td>
<td>22.19±0.001</td>
</tr>
<tr>
<td>Within Groups</td>
<td>4147.933</td>
<td>8762.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>15994.405</td>
<td>7259.26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>72 hours</td>
<td>10986.872</td>
<td>5454.931</td>
<td>10.75±0.001</td>
</tr>
<tr>
<td>Within Groups</td>
<td>4395.733</td>
<td>8762.56</td>
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<td></td>
</tr>
<tr>
<td>Total</td>
<td>15382.605</td>
<td>7259.26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>7 days</td>
<td>6768.472</td>
<td>3384.931</td>
<td>5.16±0.001</td>
</tr>
<tr>
<td>Within Groups</td>
<td>1883.953</td>
<td>8762.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>8652.425</td>
<td>7259.26</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1a. Analysis of variance of Different Sealers for Aerobic Bacteria.

Table 2 shows the antimicrobial efficacy of Endomethasone, AH 26 and Apexit against the two anaerobic microorganisms (Bacteroides fragilis and Peptostreptococcus sp.) at 48 hours, 7 days and 15 days time interval. It was seen that the mean antimicrobial efficacy of Endomethasone was significantly higher as compared to that of AH 26 and Apexit. Maximum antimicrobial efficacy was seen for Endomethasone (50.92±2.74 mm) at 2 days while minimum antimicrobial efficacy was seen for Apexit (1.25±1.36 mm) at 15 days time interval.

Table 2. Antibacterial Efficacy of Different Sealers for Anaerobic Bacteria (Values in Mean±SD).

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Time Period</th>
<th>Endomethasone</th>
<th>AH 26</th>
<th>Apexit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 days</td>
<td>50.92±2.74</td>
<td>39.00±1.61</td>
<td>3.75±3.93</td>
</tr>
<tr>
<td>2</td>
<td>7 days</td>
<td>46.08±2.43</td>
<td>35.83±1.80</td>
<td>2.08±2.19</td>
</tr>
<tr>
<td>3</td>
<td>15 days</td>
<td>37.25±1.14</td>
<td>29.16±1.03</td>
<td>1.25±1.36</td>
</tr>
</tbody>
</table>

Table 2a shows analysis of variance (ANOVA) of the three different sealers for the anaerobic strains of bacteria. Results reveal a highly significant (p<0.001) difference among the groups for their antimicrobial efficacy against anaerobic bacteria at different time intervals.

<table>
<thead>
<tr>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F*</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2 days</td>
<td>14250.392</td>
<td>7129.380</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Within Groups</td>
<td>2699.177</td>
<td>8378.76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>14547.569</td>
<td>8157.93</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>7 days</td>
<td>12720.542</td>
<td>6380.251</td>
<td>33.07±&lt;0.001</td>
</tr>
<tr>
<td>Within Groups</td>
<td>1235.500</td>
<td>334.65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>13956.042</td>
<td>8705.89</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>15 days</td>
<td>8562.722</td>
<td>4281.393</td>
<td>33.07±&lt;0.001</td>
</tr>
<tr>
<td>Within Groups</td>
<td>45.177</td>
<td>331.40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>8608.899</td>
<td>8705.89</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2a. Analysis of variance of Different Sealers for Anaerobic Bacteria.

Graph 1 reveals the antibacterial efficacy of the three different test sealers against all the seven microbial strains. Statistically significant difference in antibacterial efficacy was seen for different microbial strains and sealers.

Graph 1. Antibacterial efficacy of the three different test sealers against all the seven microbial strains.

It was seen that Endomethasone had a higher efficacy as compared to all the other
sealers for all the microbial strains. Highest efficacy was seen against *Bacteroides fragilis* (46.06±7.42 mm) while Apexit was found to be ineffective against four strains. Results also revealed that Endomethasone and AH 26 exhibited the maximum antibacterial efficacy against *Bacteroides fragilis*, while Apexit showed maximum antibacterial efficacy against *Streptococcus ß haemolyticus*. *Enterococcus faecalis* was found to be the most resistant strain.

**Discussion**

Objective of root canal treatment is to eliminate the bacteria by cleaning, shaping and filling of the root canal system. But residual bacteria lead to endodontic failures. Therefore, root canal sealers with good sealing ability and antimicrobial activity are desired to kill the surviving microorganisms.

To standardize the whole experimental process, great care had been taken regarding the inoculation density, proper incubation, positive and negative growth control, careful reading of zone of inhibition and repetition of the whole experiment six times.

The most commonly used root canal sealers in endodontics are mainly of three types depending on their composition. These are Zinc oxide eugenol based, Calcium hydroxide based and Epoxy resin based root canal sealers.

Most of the studies reported evaluated initial microbial inhibition only, but it seems equally important to determine the effect over a longer time interval.

It was important to ensure that test bacteria selected were true endodontic pathogens. If a sealer is effective against these microorganisms, it will probably be effective against the more susceptible ones.

*Streptococcus ß haemolyticus* represents a standard against which antibacterial action of a sealer should be studied. *E. faecalis* was the most resistant species in the oral cavity and possible cause of failure of root canal treatment. *P. aeruginosa* was resistant to all antibiotics and flora of long standing therapy accounts for the Bacteroides species. *B. fragilis* has been isolated from infected root canals.

Most commonly used method in vitro for assessing antimicrobial activity of root canal sealers is the agar diffusion test. This test maintains the chemical properties of the tested sealers. ADT is influenced by the diffusibility of the material, hence plates were kept for two hours at room temperature (allow the diffusion) as suggested by Gomes et al. 2004.

A statistically significant fall in the mean antimicrobial efficacy was seen with the progression of time for all the three sealers under study (*p*<0.05). The results between groups and within groups at all the four time intervals demonstrated a statistically significant value (*p*<0.001). Zinc oxide eugenol based sealer (Endomethasone) exhibited the highest antibacterial activity. Epoxy resin based sealer (AH 26) showed significantly higher (*p*<0.001) antimicrobial efficacy as compared to the Calcium hydroxide based sealer (Apexit) for all time intervals. Greatest antibacterial property was observed at 24 hours interval for all the three sealers. However, the fall in antimicrobial efficacy of Endomethasone was not significant between 48 hours and 72 hours. For AH 26 change between 48 to 72 hours was not significant statistically and for Apexit, the change from 24 to 48 hours, 24 to 72 hours and 48 to 72 hours was not significant statistically (*p*<0.05). Results also showed that the zones of inhibition produced by each sealer decreased with time, and was the least after the seven days of incubation.

Zinc oxide eugenol based root canal sealer (Endomethasone) produced the largest inhibitory zones against all microorganisms, which was in accordance to similar inhibitory activity of Zinc oxide eugenol based sealers by Cox et al. 1978, Stevens and Grossman 1981, Orstavik 1981, Pupo et al. 1983, Barkhordar 1989, Al Khatib et al. 1990, Grossman (1980), Orstavik (1981), Stevens and Grossman (1981), Grossman and Orstavik (1983). Endomethasone showed a continued inhibitory effect for up to seven days and for up to fifteen days. Kaplan et al. (1999) stated that the most effective antimicrobial sealers contain eugenol and formaldehyde. Pupo et al. (1983) proved Endomethasone to be the most effective among all the Zinc oxide eugenol based sealers.

A gradual, continuous release of formaldehyde from the paraformaldehyde in the sealer (after setting) accounts for the antibacterial activity. Eugenol present is a potent antimicrobial agent (bactericidal agent). The Epoxy resin based sealer (AH 26) exhibited zones of bacterial growth inhibition but lesser in comparison with the Endomethasone, which was in accordance to the study of Grossman (1980), Orstavik (1981), Stevens and Grossman (1981).

AH 26 contain Hexamethylenetetramine (methenamine) in its basic composition. Methenamine is a hydrophilic material and in an acidic environment is hydrolyzed to ammonia and formaldehyde24. Release of formaldehyde during gives the resin based sealer its antimicrobial properties 26. Al-Khatib et al. (1990), showed existence of antibacterial activity of this material on Streptococcus strains and S. aureus1. AH 26 showed good antibacterial activity against E. faecalis.25

Apexit demonstrated no antimicrobial activity against four of the test microorganisms tested viz E. faecalis, E. coli, P. aeruginosa and B. fragilis and very little antimicrobial effect against S. aureus, Streptococcus and Peptostreptococcus strains. This result was consistent with the studies of Siquera and Lopes (2000)26.

Antibacterial activity of Calcium hydroxide based sealers is based on its ionic dissociation into calcium (Ca2+) and hydroxyl (OH−) ions causing an increase in pH (12.5)3. A pH > 9 may reversibly or irreversibly inactivate cellular membrane enzymes of the microorganism, resulting in a loss of biological activity of the cytoplasmic membrane. Very slight antimicrobial effect with Apexit might be explained by too slow release of hydroxyl ions during the duration of contact.6

Absence of an antibacterial effect on some strains of bacteria could conclude that, the release of hydroxyl ions from calcium hydroxide was not sufficient to inhibit the growth pH of these microorganisms9. In addition, artificial media, mainly those containing blood, have a buffer ability that could provide a reduction of the high pH of calcium hydroxide, making it less effective. In clinical situations, buffer action of blood and tissue fluids may cause the same effects26.

Estrela et al. (1999) observed that calcium hydroxide based root canal sealers were ineffective against P. aeruginosa and Bacteroides species27. This finding was also in accordance to the present study conducted.

Conclusions

On the basis of the results, observations and statistical analysis the following conclusion could be drawn:

1. Zinc oxide eugenol based root canal sealer produced largest inhibitory zones followed in decreasing order by Epoxy resin based sealer and least by Calcium hydroxide based root canal sealer. Zinc oxide eugenol based root canal sealer showed continued inhibitory effect for periods up to 7days / 15 days respectively, (presence of eugenol and continuous release of formaldehyde)

2. AH 26 exhibited zones of bacterial growth inhibition, at all time intervals, but a lesser growth inhibition in comparison with Endomethasone.

3. Apexit showed no antimicrobial activity against four of the test microorganisms tested – E. faecalis, E. coli, P. aeruginosa and B. fragilis. Very little antimicrobial effect against S. aureus, Streptococcus and Peptostreptococcus strains.

Declaration of Interest

The authors report no conflict of interest and the article is not funded or supported by any research grant.

References


