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Assessment of pH of Calcium Silicate Based Root Canal Sealers at Various Time Periods – an In Vitro Study

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ABSTRACT

Calcium silicate sealers otherwise known as the bioceramic sealers were introduced into dentistry as an alternative root canal sealer. This material originally came from the combination of calcium silicate and calcium phosphate. Calcium phosphate enhances the setting properties resulting in a chemical composition and crystalline structure similar to tooth and bone apatite materials, thereby improving the sealer to root-dentin bonding. Comparison of the physicochemical and biological properties of bio ceramic sealers with the conventional sealers reveals that the calcium silicate based sealers are similar or better. Therefore, the aim of this study is to assess the pH of calcium silicate based root canal sealer at various time periods. Commercial brand of calcium silicate sealer [Bioroot RCS, Septodont] was used for this study. To determine pH, 3 samples were prepared and introduced into polyethylene tubes. Each sample was placed in a tube containing 10ml of distilled water and stored at 37 degree C. pH assessment was performed after 1hr, 3hr, 24hr, 48hr, 120hr, 168hr, 192hrs, 28 days after immersion. The samples were assessed for pH using the digital pH meter. The control for the method was based on the reading of pH values of distilled water in which no samples were immersed. Descriptive analysis of the values was performed. The pH of calcium silicate based root canal sealer at various time periods was 11.1 at 1hr, 11.5 at 3hrs, 11.9 at 24hrs, 11.9 at 48hrs, 12.3 at 120hrs, 12.2 at 168hrs, 12.0 at 192hrs, 11.9 at 28 days. The pH of the distilled water in which no samples were immersed was found to be 7.04. Bioroot RCS calcium silicate based sealer had alkaline pH. High alkaline pH of the sealer assumes particular importance because it enhances the deposition of hard tissue, improving the antibacterial properties by the release of calcium ions. Clinical trials and long term follow up studies would be highly valuable to evaluate the bio ceramic sealer's clinical performance.

KEY WORDS: BIO CERAMIC SEALERS, CALCIUM SILICATE, PH, TIME PERIODS, ALKALINITY.

INTRODUCTION

Endodontic sealers are used to attain a fluid-proof seal throughout the root canal system. An ideal root canal

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NAAS Journal Score 2020 (4.31) SJIF: 2020 (7.728) A Society of Science and Nature Publication, Bhopal India 2020. All rights reserved. Online Contents Available at: http://www.bbrc.in/ Doi: http://dx.doi.org/10.21786/bbrc/13.7/48 sealer should offer an excellent seal when set, dimensional stability, a sufficient setting time to ensure working time, insolubility against tissue fluids, proper adhesion with canal walls, and biocompatibility. (Lee et al., 2017) The commercially available sealers are categorized as zinc-oxide eugenol, calcium hydroxide containing, resin-based, glass-ionomer based, silicone-based, and bio ceramic-based sealers.

Calcium silicate-based sealers are usually known as bio ceramic sealers and introduced to dentistry as an alternative endodontic sealer. This material originally



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came from a combination of calcium silicate and calcium phosphate. Calcium phosphate enhances the setting properties of bioceramic sealers resulting in a chemical composition and crystalline structure similar to the tooth and bone apatite materials, thereby improving sealer-toroot dentin bonding. (Mendes et al., 2018).

Root end filling materials should possess certain properties such as their own good sealing ability, improve the seal of existing root canal filling material, and should be biocompatible with the periradicular tissues. The root end filling material should also have the ability to increase the pH and release of calcium ions (Ca++) as it leads to mineralized tissue formation. (Kumari et al., 2018)

Calcium based sealers were used due to their antimicrobial activity owing to their Ca++ releasing potential. These sealers have been popularly used because of their potential for providing a high alkaline environment. The use of these materials highly aids in mineralization of hard tissue and provides good antimicrobial activity. (Shashank et al., 2019) Alka¬line pH could neutralize the lactic acid from osteoclasts and prevent dissolution of minera¬lized components of teeth. (Poggio et al., 2017)

We have numerous highly cited publications on well designed clinical trials and lab studies (Govindaraju, Neelakantan and Gutmann, 2017; Azeem and Sureshbabu, 2018; Jenarthanan and Subbarao, 2018; Manohar and Sharma, 2018; Nandakumar and Nasim, 2018; Teja, Ramesh and Priya, 2018; Janani and Sandhya, 2019; Khandelwal and Palanivelu, 2019; Malli Sureshbabu et al., 2019; Poorni, Srinivasan and Nivedhitha, 2019; Rajakeerthi and Ms, 2019; Rajendran et al., 2019; Ramarao and Sathyanarayanan, 2019; Siddique and Nivedhitha, 2019; Siddique et al., 2019; Siddique, Nivedhitha and Jacob, 2019). This has provided the right platforms for us to pursue the current study. Therefore, this study aims at the assessment of pH of a calcium silicate based root canal sealers [Bioroot RCS Septodont] at various time periods.

MATERIAL AND METHODS

One commercial brand of bio ceramic sealer [Bioroot RCS Septodont] was tested. To determine the pH of calcium silicate based root canal sealer, 3 samples were prepared. The samples were prepared by mixing the powder and liquid in smooth consistency. The mixed sealer was introduced into the sample of dimensions 1 mm height and 1mm diameter. These samples were placed in a tube containing 10ml of distilled water. One tube containing 10ml of distilled water without any sealer was used as the control. All the samples are placed inside the incubator at 37degree C at the room temperature.

The pH measurements were done after 1hr, 3hr, 24hr, 48hrs, 120hrs, 168hrs and 192hrs, 28 days of immersion. The pH of each sample was measured in a digital pH meter. (Leonardo et al., 2013) The readings were noted and tabulated. [Table 1]

Table 1. This table shows the pH of calcium silicate sealer [Bioroot RCS Septodont] at various time periods.								
SAMPLE	pH after 1 hr	pH after 3hr	pH after 24hr	pH after 48hr	pH after 120hr /5 days	pH after 168hr /7 days	pH after 192hr /8days	pH after 28 days
DISTILLED WATER	6.8	7	7	7	7.2	7.29	7	7
1ST SAMPLE	11.2	11.5	11.9	12	12.4	12.3	12	11.8
2nd SAMPLE	11.1	11.5	11.9	12	12.3	12.2	12	12
3rd SAMPLE	11.1	11.6	11.9	11.9	12.3	12.2	12	12

RESULTS AND DISCUSSION

The pH of the bioceramic root canal sealer used {Bioroot RCS Septodont] at different time periods of 1hr, 3hr, 24hr, 48hr, 120hrs, 168hr, 192hrs, 28 days were noted and tabulated as follows: [Table 1] [Figure 1]

The results revealed that the pH of the calcium silicate based root canal sealer [Bioroot RCS Septodont] was 11.1 at 1hr, 11.5 at 3hrs, 11.9 at 24hrs, 11.9 at 48hrs, 12.3 at 120hrs, 12.2 at 168hrs, 12.0 at 192hrs, 11.9 at 28 days. This shows that the pH constantly increases with the increasing time periods till 5 days. Remains above 12 until 168 hrs. Remains at pH 12 at 192 hrs and 28 days [Table 1, Figure 1].

Bio ceramics are specifically designed for medical and dental use with the prefix 'bio' referring to their biocompatibility. The active bio ceramics and reabsorbable ones are applied in the endodontic field. They are composed of alumina, zirconia, bioactive glass, glass ceramics, coatings, composites, hydroxyapatite, resorbable calcium phosphates and radiotherapy glasses. Calcium silicates and bio-aggregates (Mineral Trioxide Aggregate for example) are used for apical plug in apexification procedures but also for coronal/root repair in case of perforations.

Sterilizing and obtaining a root canal free of bacteria, following disinfection is impossible to obtain. Apart from disinfecting, the obturation plays an important role to trap residual bacteria, fill the pre-disinfected space and ultimately seal it, in order to avoid any bacterial leakage into the periapical area. Modern techniques for filling the root canals are based on the association of gutta percha (the core of the filling) and a sealer. The latter acts as a sealing material and, because of its fluidity, it is able to spread into any free space, notably those which were not enlarged during the mechanical root canal preparation. (Marchi, Scheire and Simon, 2020).

Figure 1: Figure showing the simple scatter plot of the pH of distilled water and the calcium silicate sealer. Here, X axis shows the time at which pH was assessed and Y axis represents the pH of distilled water (blue line) and the calcium silicate sealer (red line). The pH of the calcium silicate sealer increased gradually with time and remained around 12 after a specified time. Similarly the pH of the distilled water remained around 7 over the time analysed. Chi square analysis showed that the variation in the pH of the distilled water and calcium silicate sealer was statistically not significant [Pearson's chi-square test; p >0.05 - statistically not significant]. Though statistically not significant, this minimal increase in the pH may be clinically significant.



This study evaluated the pH of the calcium silicate sealers at various time periods. The calcium silicate based root canal sealers revealed that the pH increases with increasing time periods after the setting time and there is stable pH after 168hrs of immersion. This high alkaline pH promotes elimination of bacteria such as Enterococcus faecalis that might survive after chemo mechanical preparation and induce or maintain periapical inflammation. The mechanism of repair stimulation by deposition of mineralized tissue depends on pH and on the ability to release Ca2+ and water. (Candeiro et al., 2012).

MTA Fill Apex and AH Plus promoted an alkaline pH when immersed in distilled water, with values ranging from 7.30 to 11.35, which remained high until the end of the experiment. MTA-based cements are rich in calcium ions, which are converted to calcium hydroxide upon contact with the water, and dissociate into calcium and hydroxyl ions, increasing pH of the solution. Thus, the variation in the concentration of calcium hydroxide leads to different pH values. A high pH activates alkaline phosphatase, an enzyme strictly involved in the mineralization process and also neutralizes the acids secreted by osteoclasts, avoiding the destruction of mineralized tissue. (Borges et al., 2014) (Silva et al., 2003) (Jafari and Jafari, 2017) (Schäfer and Zandbiglari, 2003).

Literature search reveals various reports on the antimicrobial activity of calcium hydroxide based sealers. (Muniti et al., 2019) It is guite familiar that the pH values above 12 inhibit the growth of many microorganisms, including E. faecalis. Limited antibacterial efficacy against E. faecalis for calcium hydroxide based sealers which have pH beyond 12, exhibits the inefficiency of calcium hydroxide based sealers. Extremely high pH value was not sufficient and that apart from it, some other factors also interfere with bacterial growth. (Geetha and Veeraraghavan, 2016) Previous reports showed that BC sealer exhibited an immediate, potent antibacterial effect up to 24 h after setting. However, its antibacterial effect considerably decreased within 3 days and was completely diminished at 7 days. This is in agreement to the result of an in vitro study that reported a short antibacterial action of BC sealer against E. faecalis. (Trisic et al., 2019) (Chotvorrarak et al., 2017)

In the study conducted for the fracture resistance of roots filled with various root canal sealers, the Bioceramic sealers showed the highest fracture resistance. Physicochemical properties of MTA Plus sealer such as calcium ion release, hydration reaction and pH did not change when powder was mixed either with water or gel. (Uzunoglu Ozyurek and Aktemur Turker, 2019) In the study conducted for assessing the biocompatibility, calcium silicate-based sealers showed decreased cell viability by time in fresh media, which might be a result of their high pH in the fresh state. Although the high pH of root canal sealers might have this negative effect on cell viability, it may provide several biological advantages. (Lim et al., 2015) (Lee et al., 2019) (Alsubait et al., 2018) pH of calcium silicate based root canal sealer [Bioroot RCS Septodont] were higher than the other root canal sealers evaluated in the previous studies. (Zhou et al., 2013) (Duarte et al., 2003) However, the high solubility of the calcium silicate sealers needs to be studied further.

CONCLUSION

Within the limitations of this study, pH of the calcium silicate sealer [Bioroot RCS Septodont] was found to be 11.1 at 1hr, 11.5 at 3hrs, 11.9 at 24hrs, 11.9 at 48hrs, 12.3 at 120hrs, 12.2 at 168hrs, 12.0 at 192hrs, 11.9 at 28 days.

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