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Review Article

The cold ceramic material

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ABSTRACT

The purpose of this paper was to review the composition, sealing ability, biocompatibility and various physical properties of cold ceramic (CC) material that potentially used as a root filling material. The review of the articles was performed by electronic and manual searching methods regarding the properties of CC from November 2000 to May 2016. The results revealed that there were many published reports carried out on the properties of CC. Only one article had extensively studied the composition of CC, five studies had investigated the sealing ability of CC, three articles had studied the biocompatibility, and some studies had investigated the radiopacity, setting time, pH value, and solubility of CC. It was concluded that CC material had good potential for endodontic use. Furthermore, clinical studies are needed in these areas.

Key Words: Biocompatibility, root-end filling material, physical properties, sealing, solubility

INTRODUCTION

An ideal root filling material should seal all pathways of communications between the root canal system and periapical/periradicular tissues. It should also be nontoxic, noncarcinogenic, biocompatible, insoluble in tissue fluid, and dimensionally stable. Moreover, the presence of moisture should not affect its sealing ability; it should be easy to be handled and be radiopaque for detection on radiographs.[1,2] A number of materials have historically been used for orthograde and retrograde filling.[3,4] Thus, existing filling materials used in root canal treatment do not possess these "ideal" features.[2]

The cold ceramic (CC) was first introduced in 2000 by Modaresi from Yazd University, Iran.[5] CC is a mineral trioxide aggregate (MTA)-like material that is developed and it is recommended to be used as a root-end filling material, a root perforation repair material, an apical barrier in teeth with open apices, and it may potentially be considered as a paste filling material for the obstruction of root canals and also as a capping material for pulp capping and pulpotomy.[6-9]

The purpose of this study was to review the composition, sealing ability, biocompatibility, and various physical properties of CC material that used in endodontic treatments.

SEARCH METHODOLOGY

A literature review was performed for articles published from September 2000 to May 2016. The internet databases such as PubMed and Google Scholar and manual searching were used to search for the keywords such as CC, new root-end filling material, and experimental ceramic based root-end filling material.

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COMPOSITION

CC is a calcium hydroxide-based material and its powder contains fine hydrophilic particles that set in the presence of moisture.[10]

It is reported that CC is prepared by mixing its white powder with its special liquid in appropriate powder-liquid ratio.[10] Various methods have been used to examine CC composition, including X-ray diffraction analysis and X-ray fluorescence spectrometry. The major elemental components of CC are calcium oxide, silicon oxide, barium oxide, and sulfur trioxide. These elements constitute 93% of its components. The other components include MgO, MnO, Fe_2O_3, Na_2O, K_2O, and TiO_2 [Table 1].[5] The results of X-ray diffraction showed that CC in crystalline was consisted of larnite (Ca_2SiO_4), barite ($BaSO_4$), and calcium silicate (Ca_3SiO_5).[5]

SEALING ABILITY

The ultimate aim of root canal therapy is to provide a hermetic seal that prevents recontamination of the canal and subsequent leakage of fluids and stimulating agents into the periapical tissues.[11] The sealing ability and marginal adaptation of CC have been evaluated by various methods, such as electrochemical method, dye penetration, and scanning electron microscopy.[6,7,10-12]

An investigation compared sealing ability of CC with glass ionomer (GI) using through an electrochemical test. The results showed that there was a statistically significant difference between the CC and GI regarding microleakage. Thus, the CC provides a better seal than the GI.[10]

Modaresi *et al.* investigated sealing ability of two root-end filling materials using methylene blue penetration. Their results revealed that CC displayed significantly less microleakage as an apical barrier than calcium hydroxide.[7]

An *in vitro* study compared the sealing properties of MTA and CC in different environments. The results demonstrated that sealing property of CC is better than MTA in blood-contaminated condition and similar to MTA in dry- and saliva-contaminated conditions, using dye penetration test.[12]

Table 1: The cold ceramic composition in percentage

CaO	SiO_2	BaO	SO_3	MgO	MnO	Fe_2O_3	Na_2O	K_2O	TiO_2
48.12	16.19	18.61	10.15	0.39	0.002	0.36	0.08	0.24	0.10

Mokhtari *et al.* compared the marginal adaptation of CC with MTA, using of scanning electron microscopy. They concluded that both CC and MTA had equivalent marginal adaptation as retrograde materials, but there was a trend toward higher interfacial adaptation in CC.[6]

BIOCOMPATIBILITY

Materials used in root canal treatment are often placed in close proximity with the periodontium and thus must be nontoxic and biocompatible with host tissues.[13] There are several *in vitro* and *in vivo* studies to evaluate the biocompatibility of CC.[8,14,15]

ANIMAL STUDY

Modaresi *et al.* compared tissue reaction to CC and MTA in rats. In this study, tablets of the materials were placed subcutaneously in rats and histological analyses were performed. The results showed that MTA induced less inflammatory responses in short period of observation, but CC might be more biocompatible for slightly longer periods. However, both MTA and CC were biocompatible.[14]

Jahromi *et al.* carried out a histological comparison between the effects of pro-root, CC, GI cement, and root MTA on healing of periodontal tissues after furcal perforation in dog's teeth. The results determined periodontal tissues surrounding pro-root showed less inflammatory responses than the CC, GI, and root MTA. During the first and second month, no significant differences were observed among the four materials. After three months, tissues surrounding CC and root MTA showed decreasing inflammatory responses.[8]

CELL CULTURE

An *ex vivo* study was carried out to evaluate cytotoxicity of CC in comparison with MTA and intermediate restorative material (IRM). The results showed that IRM was the most cytotoxic root-end filling material, and MTA demonstrated the least cytotoxic followed by CC. In this study, CC demonstrated competitive cell viability values when set; moreover, CC was consistently second or equal to MTA.[15]

RADIOPACITY

Radiopacity is a physical property for all root canal filling materials. To fill the cavity correctly and facilitate the recall of the cases and detect the material from the surrounding anatomical structures such as tooth and bone, the filling material should present adequate radiopacity.[16] The ISO 6876:2001 establishes 3-mm aluminum as the minimum radiopacity value for endodontic cements.[17] The mean radiopacity for CC has been reported as 4.02 mm of an equivalent thickness of aluminum. This value is higher than the value reported for Portland cement and lower than the value reported for MTA. Thus, CC has acceptable radiopacity.[17]

SETTING TIME

The CC is set in the presence of moisture by adding its mixing liquid. It is reported that the primary setting time of CC is about 15 min, which is shorter than MTA that was reported as about 165 min. The CC is set completely in 24 h.[12,18]

pH VALUE

In another study, Modaresi measured the CC pH values. In his study, the fragments of CC in dimension of 12.5 mm^2 were built. Each sample was placed in a beaker containing 5 ml of distilled water. After vibrating, the pH solution was recorded. Their results showed that the pH value of CC was 7.36 after mixing. This value was raised up to 10.11, 10.84, and 11.16 after 1–2 h and 7 days, respectively. Thus, CC could slowly create an alkaline environment.[19]

CONCLUSION

The physical properties, sealing ability, and biocompatibility of CC have been discussed. CC material has been shown to have good potential in endodontic use. However, more investigations are needed to be carried out to determine the clinical usage of this material.

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Conflicts of interest

The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or nonfinancial in this article.

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