Review Article

International Journal of Dental and Health Sciences
Volume 02,Issue 04

CALCIUM ENRICHED MIXTURE CEMENT

Chandani Bhatia[1], Manoj Chandak[2], Dwarkadas Adwani[3], Rakhi Chandak[4] ,Adwani Rahul[5]

1. PG. department of conservative dentistry and endodontics, SPDC, Wardha, India.
2. HOD. department of conservative dentistry and endodontics, SPDC, Wardha, India.
3. H.O.D. department of OMFS, VYWSM, Amravati Dental College, India.
4. PROF. department of ODMR, SDKS, Nagpur Dental College, India.
5. PG. department of Prosthodontics, Crown and Bridge, SPDC, Wardha, India

ABSTRACT:

A review of the existing literature was performed by using electronic and hand searching methods for CEM cement from January 2006 to December 2013. CEM cement has a different chemical composition from that of mineral trioxide aggregate (MTA) but has similar clinical applications. It combines the biocompatibility of MTA with more efficient characteristics, such as significantly shorter setting time, good handling characteristics, no staining of tooth and effective seal against bacterial leakage. The aim of this literature review is to summarize brief history, composition, mode of action, properties and clinical applications of CEM cement in experimental animals and humans.

Keywords: calcium enriched mixture cement (CEM), mineral trioxide aggregate (MTA).

INTRODUCTION:

Bio-ceramic materials have been seen as the dawn of a new era in dentistry. Although used mainly for dental implants and coatings for implants, their introduction into endodontics as mineralising materials has brought about enormous productive changes.[1]

Bio-ceramics can be classified as:

- Bio inert: Non-interactive with biological systems

- Bioactive: Durable tissues that can undergo interfacial interactions with surrounding tissue

- Biodegradable, soluble or resorbable: Eventually replaced or incorporated into tissue.[2]

CEM CEMENT

Asgary al. in 2006 introduced A novel endodontic material called CEM cement in dentistry because of its application in various endodontic procedures. CEM cement is believed to be similar to mineral trioxide aggregate (MTA), but with better physical properties. The clinical application of this cement is similar to the MTA. When the CEM is mixed with water-based solution, it forms bioactive calcium and phosphate enriched mixture. Mixed CEM cement releases calcium and phosphate ions and then forms hydroxyapatite not only in simulated body tissue fluid but also in normal saline solution; the latter of which is unlike MTA [3]. In addition, this novel cement releases calcium and

*Corresponding Author Address: Dr Chandani Bhatia Email: chandanibhatia1989@gmail.com

phosphorus ions from indigenous sources result in a rich pool of hydroxyl ions, calcium ions phosphate ions. These elements are used in the process of hydroxyapatite (HA) production.[4]

Composition and mechanism of action:

CEM cement is composed of different calcium compounds.

The major components of the powder are:

- 51.75% wt. calcium oxide, 9.53% wt. sulfur trioxide, 8.49% wt. phosphorous pentoxide , 6.32% wt. silicon dioxide , and Minor components are : aluminium trioxide , sodium oxide , magnesium oxide , chloride .

Under scanning electron microscope (SEM) study, the presence of calcium, phosphorous and oxygen ion on the surface of CEM cement was almost similar when compared to that of surrounding dentin. Hence, this finding shows that the composition of CEM cement is similar to dentin. Since HA is the main component of dentin; therefore, similarity in composition between CEM cement and dentin might help the cementogenesis despite the presence of high level of phosphorous in CEM cement. It seems reasonable to suspect that the presence of low concentration of phosphate ions in CEM cement media is probably due to its reaction with released calcium ion to form hydroxyapatite . [5]

PHYSICAL PROPERTIES:

The physical properties of CEM are almost similar to that of MTA.

Setting expansion of CEM cement expansion (0.075 ± 0.032 mm) doesn't differ significantly from that of MTA (0.085 ± 0.042 mm). The material also exhibited reasonable film thickness (174 ± 25 mm) and flow (14 ± 1 mm), which were statistically different from MTA (452 ± 63 mm and 10 ± 0.79 mm, respectively). The slight expansion and reasonable flow and film thickness of CEM can ensure an effective seal after setting, and reduce the subsequent leakage. The setting time of CEM was found to be less than an hour (50 min), and shows alkaline pH of 10.71 ± 0.19

BIOLOGICAL PROPERTIES:

a. Antibacterial and Antifungal properties:

Various studies have been evaluated to check the antibacterial efficacy of CEM cement against the common endodontic pathogens and results indicated that the antibacterial activity of CEM cement is almost similar to that of calcium hydroxide but better than MTA. Torabinejad et al. and Asgary et al. Evaluated CEM cement against Streptococcus mutans, E.coli, Actinomyces and Enterococcus faecalis and have concluded that CEM cement is effective against all the strains except E. faecalis. [6]

The antibacterial properties of the CEM cement may be because of the presence of alkaline earth metal oxide and

hydroxides (e.g. CaO and calcium hydroxide, calcium phosphate, and calcium silicate) which undergoes hydration reaction results in the formation of calcium hydroxide, which further dissassioates into calcium and hydroxyl ions, thus increasing the pH and calcium ion concentration.

An increased pH may reversibly or irreversibly inactive cellular membrane of the microorganism, resulting in a loss of biological activity. Another possible explanation is the antibacterial component of cement has better diffusion property.[7]

b. Biocompatibility:

The biocompatibility of CEM has been associated with its ability to release calcium ions during setting, and the subsequent binding of calcium with phosphorus to form hydroxyapatite crystals. Mozayeni et al. evaluated the cytotoxicity of CEM cement with MTA and intermediate restorative material (IRM) on mouse fibroblast using enzyme-linked immunosorbent assay and MTT essay and CEM cement demonstrated favorable cell viability compared to MTA and IRM. [8] Studies of CEM cement on peri-radicular tissue reaction demonstrated that the material is capable of inducing hard tissue formation, and also helps in cementogenesis. [9]

Under the SEM study, dentinal bridge formation had shown three different zones. The outer aspect was composed of CEM in direct contact with newly formed hard tissue. In the middle portion, a dentin-like bridge with irregular dentinal tubules was identified. The pulpal or inner aspects exhibited predentin layer, which was similar to normal condition. Young odontoblasts-like cells were differentiated, and they elaborated collagen matrix and predentin layer. [10]

c. Microleakage:

The sealing ability of the material is considered as an important factor when it is used as the root end filling material. The ideal material should prevent the ingress of microorganism and their by-products into periradicular tissue.

Hypothesis

CEM cement provides good handling characteristics. Once mixed, this cement does not adhere to the applicator and is easily adaptable. Saliva increases the wetting of the dentinal walls, enabling adaptation of CEM cement within irregularities of root canal walls, and also facilitates its penetration into the dentinal tubules. Slight setting expansion of CEM cement also contributes to the better adaptation of material to the root-end cavity walls. [11]

High percentage of small particles (0.5-2.5 micro.m) in this material supports this cement's access to dentinal tubules with inner diameter range of 2-5micro.m. [12]

In the presence of an aqueous environment, this biomaterial produces

large amount of hydroxyl, calcium, and phosphate ions which leads to HA formation and thus provides an additional seal at the interface of the material and cavity walls. [13]

CLINICAL APPLICATION:

a. Direct Pulp Capping : The bridges consisted of thee different aspects. The outer aspect was composed of CEM in direct contact with newly formed hard tissue. In the middle portion, a dentin-like bridge with irregular dentinal tubules was identified. The pulpal or inner aspects exhibited predentin layer, which was similar to normal condition. Young odontoblasts-like cells were differentiated and they elaborated collagen matrix and predentin layer. Based on the results of this study it was concluded that all test materials were effective pulp capping materials and able to stimulate hard tissue bridge. Also, CEM cement was found to have identical biologic effects with MTA.[14]

b. Pulpotomy :A recent case report has shown successful outcome after the use of CEM for pulpotomy in a maxillary first primary molar using cone beam computed tomography (CBCT) and histologic evaluation method. [15]

c. Root-end filling : In an investigation, the response of periradicular tissues to MTA and CEM cement as root-end fillings was compared, and hard tissue healing after periradicular surgery was analysed. The results demonstrated complete healing and absence of inflammation in 11 of 12 roots in the MTA group and 10 of 12 in CEM cement group. Cementum formation was observed adjacent to MTA and CEM cement in healed samples, whereas cementogenesis occurred over the dentinal surface of the resected root ends in all samples.[16]

d. Furcation Perforation : Samiee et al. compared the healing of furcation perforations repaired with CEM cement versus MTA in dogs' teeth. Calcium enriched mixture cement: review Their findings revealed hard tissue bridges in every specimen between the two edges of perforation and beneath the experimental materials after an interval of three months. Eight of MTA specimens and six specimens of CEM cement group demonstrated complete bridge formations, which were not statistically different.[17]

e. Resorption : Asgary et al. reported successful management of inflammatory external root resorption (IERR) using CEM cement in an avulsed tooth of a young male patient. Healing of a progressive IERR occurred within 40 months with re-establishment of normal periodontal condition.[18] The conventional apexification uses densely packed CH as an intra-canal medicament for the induction of calcified apical barrier. The main drawbacks of this procedure include its multiple scheduled visits and susceptibility of treated roots to fracture.[19] few case series have also described clinical procedures with CEM cement as an apical barrier in teeth with necrotic pulps and open apices. In one

study, [13] single-rooted teeth with necrotic pulps and open apices were successfully treated by CEM cement apical plug insertion with an average follow-up time of 14.5 months.[20]

f. Regenerative Endodontic treatment with CEM cement :

Revascularization is a valuable treatment in immature necrotic teeth that allows the continuation of root development. Several case reports, case series, and clinical studies have been published demonstrating successful results for this technique and material in treating immature necrotic teeth.[1]

CONCLUSION:

This cement has shown promising results because of their good bio-compatibility and better physical properties and has overcome disadvantages of other cements. Therefore, futuristic application of CEM cement for its various clinical applications requires high level of research when compared with other cements.

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