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Pozzolan Dental Cement: A review

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Abstract : *Tricalcium silicate based cements like MTA though initially introduced as root end filling materials, have found wide acceptance in other treatment modalities like pulp capping, pulpotomies, apexification, perforation repairs because of their biocompatibility, sealing abilities etc. At the same time its limitations like longer setting time, difficult handling characteristics, potential to cause tooth discoloration have led to the exploration of modifications of the material. This article reviews a newer modification 'Pozzolan Dental Cement' which has been evaluated and compared with the existing tricalcium silicate-based cement.*

Keywords –*MTA, Portland Cements, Pozzolan Dental Cement, Tricalcium Silicate Based cements*

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I. Introduction

The purpose of endodontic treatment, nonsurgical or surgical is a comprehensive disinfection of the root canal system and efficacious healing of the periradicular tissues. This has led to the quest of materials which will be most biocompatible, enhance healing, and at the same time be non-discoloring to the tooth, and least cytotoxic. One such material recently introduced to dentistry is pozzolan dental cement.

II. Pozzolan Cement

A newly developed material based on pozzolan cement (Endocem, Maruchi, Seoul, Korea) has been manufactured in South Korea endorsing its short setting time (5 minutes). Even though the major component of a pozzolan cement is the amorphous or glassy silica, the chemical composition of Endocem is very similar to that of MTA [1].

III. Tricalcium Silicate Based Cements

Tricalcium Silicate based cements (eg. MTA, Portland cement) have been widely used in endodontics because of their excellent biocompatibility, superior sealing abilities & setting even in the presence of moisture [2]. Hence, considered material of choice in the treatment of pulp capping, pulpotomy, perforation repair, single appointment apexification procedure and root end filling material.

However, these materials have a few drawbacks like, difficulties while placing the material, longer setting time and potential to cause discoloration [3]. Also, bismuth oxide added to MTA for radiopacity, can result in increased porosity and decreased resistance in the long term [4][5]. Many researchers have attempted to develop fast setting MTA or its derivatives [6] [7] [8] [9] [10] [11]. However, most of these trials have focused on the addition of chemical setting accelerators, some of which proved to have detrimental physical and biologic effects. To overcome these limitations a new modification of medical Portland Cement has been introduced which as endorsed by the manufacturers has properties improved than other tricalcium based cements.

IV. Pozzolan Dental Cement & Its Comparative Properties with Other Tricalcium Silicate Based Cements

Pozzolan Cement has been studied for its properties like regenerative capabilities, washout resistance, cytotoxicity, biocompatibility, tooth discoloration, hydrogenic potential, radiopacity, solubility and electrical conductivity.

Studies on surface electromyography (EMG) of masticatory muscles, orofacial motion, temporomandibular disorders (TMD), and orofacial myofunctional status according to gender, age, tooth status, and facial morphology have shown that both healthy and treated teeth require resistance to occlusal forces. Thus, root-end filling materials should provide resistance to masticatory load [12] [13] [14] [15]. Sergio et al conducted a randomized clinical trial on 30 teeth of 12 patients who underwent endodontic surgery with root end filling material. The materials tested for root end filling were MTA-Angelus® & Pozzolano Biologic Silva Cement (PBS®).

The authors instituted that PBS® is a biocompatible & bioactive material with resistance to compression due to the presence of natural additives (pozzolano and calcium carbonate) in its composition. The presence of PBS® can be detected in radiographs without the addition of radiopaque agents. They concluded that the use of Pozzolana Biologic Silva and mineral trioxide aggregate as root-end filling materials led to regeneration of periradicular tissues and repair of periradicular lesions. Thus, the clinical use of PBS is an alternative to the treatment of endodontic surgery[16].

Gan-Yeon Jang et al investigated the effects of various root canal irrigants on "washout" of the MTA-derived pozzolan cement & ProRoot MTA in a furcal perforation model. The irrigant solutions used were physiologic saline, 2.5% NaOCl, or 2% CHX.

The results of the study were ProRoot showed higher washout scores than Endocem under all irrigation solutions. Furthermore, the washout scores of ProRoot and Endocem were significantly lower in the NaOCl-treated group compared to the saline- and CHX-treated groups. Kogan *et al*. reported that different additives produced a wide range of MTA setting times, and NaOCl gel decreased the setting time while saline and CHX gel resulted in an increase in setting time [2].

Notably, NaOCl has an alkaline pH of 9.0 - 10.5 whereas CHX and saline have neutral pH. The literature indicated that lower pH environments may affect various physical and chemical properties of MTA negatively [17] [18] [19]. Recently, Hong *et al*. reported that CHX adversely affected the physical properties and hydration behaviors of MTA when it was in contact with MTA before initial setting [20]. The authors concluded that Endocem may be considered a substitute for ProRoot in a single-visit scenario of conventional root canal treatment with furcal perforation repair because it is less loosened during the setting reaction. Furthermore, NaOCl can be considered a more suitable irrigant than physiologic saline and CHX in a tooth with furcal perforation repaired using Endocem in terms of washout resistance.

Minju Song et al, carried out a study to evaluate *in vitro* cytotoxicity of the pozzolan cement and other root-end filling materials using human periodontal ligament cell. Endocem (Maruchi), white ProRoot MTA (Dentsply), white Angelus MTA (Angelus), and Super EBA (Bosworth Co.) were tested after set completely

in an incubator at 37℃for 7 days, Endocem was tested in two ways: 1) immediately after mixing (fresh specimens) and 2) after setting completely like other experimental materials.

In the results of microscopic examination and cell counting, Super EBA showed significantly lower viable cell than any other groups ($p < 0.05$). As the results of WST-1 assay, compared with untreated control group, there was no significant cell viability of the Endocem group. However, the fresh mixed Endocem group had significantly less cell viability. The cells exposed to ProRoot MTA and Angelus MTA showed the highest viability, whereas the cells exposed to Super EBA displayed the lowest viability ($p < 0.05$). The cytotoxicity of the pozzolan cement (Endocem) was comparable with ProRoot MTA and Angelus MTA. Considering the difficult manipulation and long setting time of ProRoot MTA and Angelus MTA, Endocem can be used as the alternative of retrofilling in endodontic surgery. [1]

A Comparative Analysis of Selected Physicochemical Properties of Pozzolan Portland and MTA-Based Cements was carried out by Maura Cristiane Gonçales Orçati Dorileo et al in which they studied the hydrogenic potential, radiopacity, solubility and electrical conductivity. They concluded that the solubilities of all tested materials were in accordance with the ANSI/ADA standards. Only the MTA-based cements met the ANSI/ADA recommendations for radiopacity and that the pH and electrical conductivity of pozzolan Portland cement are similar to and comparable to MTA based cements [21].

A limitation of MTA is its potential to cause discolouration of teeth. Ji-Hyun Jang, DDS, MSD et al studied tooth discoloration after the use of mineral trioxide aggregate (MTA) and to examine the effect of internal bleaching on discoloration associated with MTA. The materials studied were ProRoot MTA, MTA Angelus and Endocem. The results of their study were The ProRoot and Angelus groups displayed increasing discoloration during a period of 12 weeks. The discoloration associated with ProRoot and Angelus was observed at the MTA-dentin interface and on the interior surface of the dentin. However, the Endocem groups demonstrated no significant discoloration and no marginal discoloration was observed around the material in the Endocem group. They concluded that ProRoot and Angelus caused tooth discoloration. However, Endocem did not affect the contacting dentin surface. As also, removing the discolored MTA materials contributed more to resolving the tooth discoloration than post-treatment internal bleaching [22].

V. Conclusion

Within the limitations of this review it can be said that Pozzolan based dental cements may serve as a promising alternative to other Tricalcium Silicate based Cements in the near future because of its enhanced or comparable properties in most of the aspects. But, it is also important to note that further in vivo studies and randomized controlled trials are needed to assure the endorsing of this material.

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