Extended Abstract

Nanomedicine 2017: Effect of colloidal nano-silica on setting time, radiopacity and physical properties of a nano cement based compound for endodontic applications

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Abstract

Long setting time is one of the main disadvantages of cements in endodontics procedures. The main objective of this study is to decrease the setting time of a nano cement based compound (NCBC) (similar materials to white mineral trioxide aggregate). Accordingly, colloidal nano-silica instead of distilled water were added to NCBC and its effect on setting time, radiopacity, compressive strength, flexural strength was measured and analyzed. The initial and final setting times were measured using the Gilmore apparatus according to regulations of American Dental Association specification no. 57 and American Society for Testing and Materials Specification C266- 03. The compressive and flexural strength were determined using a Universal testing machine with a crosshead speed of 1 mm/min. The radiopacity of NCBC samples were also determined and expressed in mm Al equivalent thickness. The results suggest that NCBC setting time can be decreased by addition of colloidal nano-silica. Moreover, it has positive impact on the compressive and flexural strength properties.

Mineral trioxide aggregate (MTA) has been widely used in all fields of endodontics. One of the major drawbacks of this material is the long setting time. MTA is primarily composed of type 1 Portland cement and bismuth oxide. In cement, nanoscale SiO2 behaves as a filler to improve microstructure and to accelerate hydration process. Therefore, mentioned reaction is also expected in MTA because of the same structure. Thus, the aim of this study was to evaluate the effect of addition of nano-SiO2 to MTA on the setting time and its physical properties.

In root canal therapy where an apical infection is persistent, an apicoectomy may be required. Flap is raised over the tooth and the root tip is resected and a cavity created (3–4 mm) in the root tip remaining. Retrograde application of MTA to the root tip cavity is completed.

MTA was originally developed for root-end filling. There were several different materials such as amalgam, reinforced zinc oxide eugenol cements (interim restorative material - IRM), super ethoxy benzonic acid [EBA], glass ionomer cement and composite resin for root-end filling after apicoectomy. MTA, a refined "Portland cement" - calcium alumino-silicate cement-, was found to have less cytotoxic and better results in biocompatibility and micro-leakage sealing ability, giving it more success over root-end filling materials. MTA is not acceptable as "ideal root-end filling material" because MTA has some drawbacks of toxic heavy metal presence, discoloration, difficult handling, short working time, long setting time, washout before setting and washout after set (calcium carbonate based MTA has solvent of carbonic acid). The long term effect of MTA as a root-end filling material compared to other materials (eg amalgam, zinc oxide eugenol and

IRM) is currently inconclusive according to a 2019 Cochrane review.

For ideal Root-end filling, there are many new materials or improved materials developed.

It is based on alumino-silicate based bioceramic material. Most cytotoxicity is caused by polyacrylic acid. So current GIC as root-end filling material is reducing the cytotoxic acclerator's concentration. - calcium alumino-silicate - MTA (calcium alumino-silicate) + GIC (alumino-silicate), calcium reinforced glass ionomer cement is developed. It's a promising material. These newly developed root-end filling materials are based on bioceramic, chemically bonded ceramic, not by mineral (ceramic in nature) like MTA. Even if mineral shows higher biocompatibility, minerals have potential toxic heavy metals in material. Bioceramic or bioMaterial is used for medical and dental products. BioMaterials can reduce the issues on discoloration and toxic heavy metals' presence initially.

Two concentrations (8% and 10%) of nano-SiO2 were added to the white MTA powder. After mixing with water, the setting time, compressive strength, and flexural strength were investigated and compared with pure MTA.

With the addition of 8% and 10% of nano-SiO2 to the MTA, the setting time of both mixtures decreased significantly . However, the compressive strength (after 1 day and 1 week) and flexural strength increased; this was not significant There was no significant difference between MTA mixed with 8% and 10% nano-SiO2 in setting time, compressive strength, and flexural strength.

The addition of 8% and 10% of nano-SiO2 to MTA accelerated the hydration process, reduced the setting time, and had no adverse effect on the compressive and flexural strength of MTA.

Lateral perforation occurs when an instrument has perforated the root during cleaning & shaping of the canal by the dentist. If it happens, one should finish cleaning & shaping of the canal, irrigate the canal with sodium hypochlorite to disinfect it and dry it with a paper point. The perforation can be sealed with a thick mixture of an MTA-type product, preventing bacterial ingress. Make sure that you can locate the canal while the MTA has not set and remove the excess material from the area.

Development of new pulp capping agents has paved the way towards the preservation of pulp vitality, which is an important goal in restorative dentistry. This study sought to assess the calcium ion release, pH and setting of mineral trioxide aggregate (MTA) Angelus, an experimental formulation of nano-hybrid MTA containing nano-SiO2, nano-Al2O3 and nano-TiO2 and MTA Angelus plus nano-oxides. Methods: In this experimental study, five specimens from each material were placed in polypropylene tubes and immersed in a flask containing deionized distilled water. The quantity of calcium ions released into the solution from each material was measured at 15 minutes, one hour, and 24 hours by using atomic absorption spectroscopy. The pH of the solutions was measured by using a pH meter at the respective time points. The setting time was also assessed by using a Gilmore needle. Data were analyzed by using repeated measure ANOVA. Results: The quantity of released calcium ions was not significantly different among the groups ($P=0.060$). All materials were alkaline and the pH at 24 hours was significantly higher than the other two time points in all groups ($P<0.001$). The experimental group had the shortest and the MTA Angelus had the longest setting time. All materials were alkaline and capable of releasing calcium. Addition of nanoparticles to MTA Angelus significantly decreased the setting time but had no effect on the release of calcium ions or pH. Abbreviations: MTA = mineral trioxide aggregate, VPT = vital pulp therapy.

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