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Research Article

Evaluation of Ph of a Novel Bioceramic Material for Use in Endodontic Practice: An *In-Vitro* Analysis

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Abstract

Introduction: Bioceramic materials have a come long way in terms of their potential role in critical tooth saving procedures, especially during endodontic management. The process of developing new materials with MTA like properties is still in progress in order to make materials which are clinically efficient but at the same time cost effective. One of the essential pre-requisites of these bioceramic materials is their ability to attain a highly alkaline pH after setting so that they can exhibit the osteogenic potential. The current study was carried out in these lines in order to evaluate the alkalinity of the newly introduced MTA in the Indian market in order to explore its osteogenic potential as the biological properties of MTA are attributed to its alkalinity.

Aim: To investigate the pH of a novel Bioceramic material, MTA (Maarc Dental, India) in order to validate its osteogenic potential.

Methodology: MTA Powder was mixed with its special liquid as per the manufacturer's instructions, ensuring the complete dissolution of the powder particles. 20 polyethylene tubes measuring 3 mm in diameter and 2 mm in height were filled with freshly prepared material. The samples were sealed in tubes containing 10 ml of distilled water and stored at 37 degree celsius. The pH was measured after 3 hours, 24 hours and 48 hours using a calibrated pH meter.

Observations and Results: The maximum pH was observed to be 10.59 after 24 hours with a mean of 10.52. After 24 hours, a gradual fall in pH was observed in the samples.

Conclusion: Within the parameters set in this study, it was concluded that new MTA seems to be promising enough as it obtained a high alkaline pH after 24 hours of mixing. However, long term clinical evaluation in patients is required to support the laboratory findings.

Keywords: *Alkalinity; Bioceramics; Endodontics; MTA; pH*

Introduction

The main objective of endodontic therapy is to save an infected tooth in order to increase its longevity in the oral cavity [1]. The research in the field of biomaterials has always been directed towards this objective in terms of searching for a new material which has excellent osteo-inductive and osteo-conductive properties [2,3]. These properties enable the material to help the tooth heal much faster and subsequently increase the chances of treatment success exponentially [4].

Amongst the several essential pre-requisite physical and biological properties which an ideal bioceramic material must possess, its alkaline nature holds paramount significance [5]. There are several bioceramic materials available in the market which possess MTA like

properties and thus are being frequently used in endodontic practice across the globe [6,7]. The hunt for new materials in this category is still going on, in order to improvise upon the existing properties of these materials and at the same time making them cost-effective. Interestingly, a new MTA has been introduced in the market (MTA, Maarc Dental, India) claiming to have improvised physical and biological properties.

The current study was taken up to evaluate the pH of this new MTA in order to validate its potential for osteo-induction and osteo-conduction.

Materials and Methods

A novel MTA (Maarc Dental, India) recently introduced in the market was evaluated in this study for its alkalinity. It is provided in a packing, comprising of MTA powder and a special liquid (Figure 1a and 1b). MTA Powder was mixed with its special liquid as per the manufacturer's instructions, ensuring the complete dissolution of the powder particles. 20 polyethylene tubes measuring 3 mm in diameter and 2 mm in height were filled with freshly prepared material [8]. The samples were sealed in tubes containing 10 ml of distilled water and stored at 37 degree Celsius in a water bath (Figure 2). The pH was measured after 3 hours, 24 hours and 48 hours using a calibrated digital pH meter (Systronics, India) (Figure 3).

Figure 1a: *MTA (Maarc Dental, India).*

Figure 1b: *Powder and liquid of MTA.*

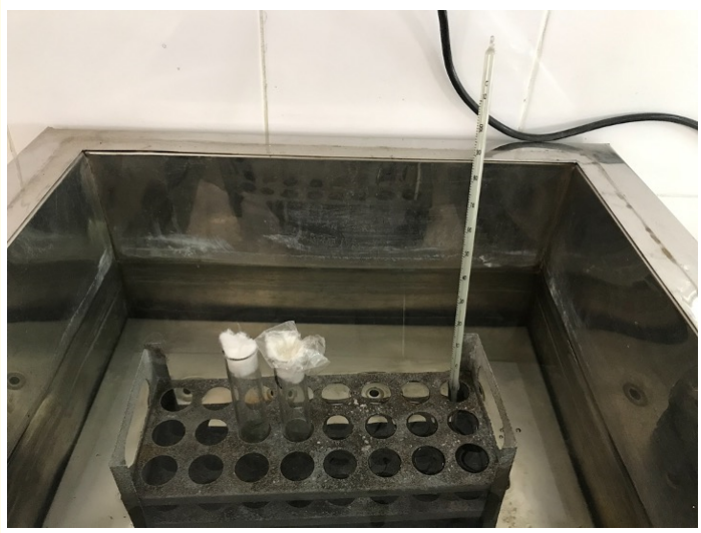

Figure 2: *Sample placed in distilled water and stored at 37 degree celsius.*

Figure 3: *pH meter inside the test tube containing sample.*

Observations and Results

The readings of pH measured after 3 hours, 24 hours and 48 hours have been tabulated in table 1. The highest initial Ph of the samples after 3 hours was found to be 8.77 and the maximum pH was observed to be 10.59 after 24 hours (Figure 4), following which t a decline in pH values was seen at 48 hours (maximum pH recorded was 10.31).

S. No.	3 Hours	24 Hours	48 Hours
1	8.71	10.54	10.28
2	8.67	10.47	10.27
3	8.54	10.45	10.26
4	8.62	10.48	10.26
5	8.69	10.51	10.27
6	8.67	10.50	10.25
7	8.68	10.54	10.26
8	8.77	10.59	10.31
9	8.73	10.55	10.28
10	8.74	10.56	10.29
11	8.75	10.58	10.34
12	8.70	10.51	10.28
13	8.71	10.51	10.29
14	8.69	10.49	10.26
15	8.75	10.56	10.30
16	8.74	10.55	10.29
17	8.71	10.53	10.27
18	8.72	10.55	10.28
19	8.71	10.56	10.28
20	8.70	10.57	10.29

Table 1: *pH values obtained from samples at 3 hours, 24 hours and 48 hours.*

Figure 4: *Ph value as seen on digital pH meter.*

The mean values of pH were found to be 8.69, 10.52 and 10.28 for 3 hours, 24 hours and 48 hours respectively (Table 2).

Time Interval	3 hours	24 hours	48 hours
Mean Value	8.69	10.52	10.28

Table 2: *Mean pH values at respective time intervals.*

Discussion

Bioceramic materials have come a long way and have gained a massive popularity in the field of dentistry because of the extraordinary benefits these have to offer. The osteoinductive and osteoconductive potential of these materials has increased the longevity of teeth in the oral cavity, especially for the ones which have guarded prognosis and were often extracted when these magical materials were not available to the dental professionals.

A paradigm shift in the field of dentistry happened when MTA (ProRoot, Dentsply) was introduced by Mahmoud Torabinajed from Loma Linda University [10-12]. It's composition was described as being primarily a mixture of calcium silicates comprising of calcium oxide (CaO) (50 - 75% w/w) and silicon dioxide (SiO_2) (15 - 25% w/w). Bismuth oxide was then added to make it radiopaque. This material possessed extraordinary properties and was started to be used for several clinical applications such as pulp capping, Pulpotomy, apexification, root-end filling, perforation repair etc [13]. The material had some shortcomings as well, the major ones being difficult manipulation and long setting time [6]. In order to overcome these, another product was launched named as Biodentine™ (Septodont, Saint-Maur-des-Fossés, France). This material had much easier manipulation and a short setting time [14].

Over a period of years, several other MTA like materials have been launched in the market, with each one trying to possess superior physical and biological properties in comparison to their contemporaries [15]. There has been a considerable increase in the innovative launching of local MTA like materials in different countries, probably with an intention of meeting the increasing demand and lowering down the cost so that maximum benefits of these materials can be passed on to the patients. One such material recently launched in Indian market is MTA (Maarc dental, India).

Amongst the several desired physical properties of the bioceramic materials, one of the important ones is its alkaline nature [16]. The ability of the material to attain a high pH after setting has a major contribution in creating an environment which is conducive to its osteoinductive and osteoconductive activity [17]. These in turn contribute to the healing of the damaged area. The present study was thus undertaken to evaluate the pH of this new MTA which in turn would indirectly validate its clinical usage as a repair material.

The standard procedure of pH testing was followed [8] and the readings of pH were measured after 3 hours, 24 hours and 48 hours. The highest initial Ph of the samples after 3 hours was found to be 8.77 and the maximum pH was observed to be 10.59 after 24 hours. After this, f a decline in pH values was seen at 48 hours wherein the maximum pH recorded was 10.31. The mean values of pH were found to be 8.69, 10.52 and 10.28 for 3 hours, 24 hours and 48 hours respectively. The pH values of bioceramic materials available in the market have been analysed by several researchers over the years and the values have ranged from 10 - 13 [5,6,19]. The alkaline pH not only creates a suitable environment for the formation of calcified structures but also provides a high level of antibacterial activity which further promotes healing potential [2,6].

Considering the values obtained with other similar materials, it can be interpreted that the new MTA is sufficiently alkaline in order to exhibit its osteoinductive, osteoconductive and antimicrobial properties. Having said that, it is appropriate to mention that these properties are also dependent on the other physical properties of the material such as setting time, marginal seal, ion release, push out strength

etc. Future studies need to focus on evaluation of other physical and biological properties of this material as well in order to elaborate our knowledge and further validate its clinical usage.

Conclusion

Within the parameters set in this study, it was concluded that new MTA seems to be promising enough for its osteogenic potential as it obtained a high alkaline pH after 24 hours of mixing. However, long term clinical evaluation in patients with follow-ups is required to support the laboratory findings.

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