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Porosity, Solubility And Water Sorption Of Two Pulp Capping Materials

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Abstract

Aim: The aim of this research was to examine physical attributes of two calcium silicate-based liner" Mineral trioxide aggregate (MTA), and resin modified calcium silicate (Theracal LC)".

Material and Methods: Ten discs of each tested material were prepared according to manufacturer instructions of each material, then pasted onto molds and allow to set then tested, porosity, water sorption and solubility were measured using mass measurements.

Results: Theracal LC has lower water sorption, solubility, and porosity than MTA (p<0.05).

Conclusion: Theracal LC has better physical properties than MTA.

Keywords: Calcium silicate cement, physical properties, pulp capping materials.

Introduction

The main goal of conservative dentistry is to maintain tooth structure in order to prevent harm to the pulp complex.(1) Vital pulp treatment has been used for over 200 years, and it entails applying a protecting biomaterial (pulp capping agent) to residual not dense layer of dentin on a virtually exposed pulp (indirect capping) or to an exposed pulp (direct capping). Protecting the defective pulp complex from heat and chemical stressors necessitates the use of pulp capping agents.(2)

However, calcium hydroxide (Ca(OH)2) high solubility, poor adhesion, and low physic-mechanical features, which were first described as a pulp capping agent, had become a clinical concern.

As a result, the search for the optimal pulp capping agent has led to other developments .(3)

MTA is hydrophilic and biocompatible cement that is based on tricalcium silicate and produces calcium hydroxide as a result of hydration. MTA is broadly applied as a pulp capping agent and root end filling material because of its good physical

properties. MTA is a combination of purified Portland cement with bismuth oxide to give radioopacity.(4)

MTA, on the other hand, has some drawbacks, like a long setting time, lowly handling qualities, and tooth discolouration. Numerous materials are constantly being developed to overcome MTA's drawbacks.(5) Theracal LC is a new resin-modified light-cured single paste calcium silicate-based material that the company is promoting to be used as a pulp capping agent and a protective liner to be used with restorative material, cement, or other base material. It's simple to use, has good sealing properties, and has low microleakage and solubility. In Theracal LC, calcium release properties have been identified.(6)

Solubility, water sorption and porosity are important physical features of pulp capping materials as deprivation of this material will lead to poor seal and microleakage. (7)

This study compared MTA and Theracal LC in term of porosity, water sorption and solubility. The hypothesis of this study was that physical properties of Theracal LC are better than that of MTA.

Material and Method

Theracal LC(Bisco,USA) and MTA(Dentsply Sirona,Germany) were prepared according to manufacturer instructions, Theracal LC supplied by the manufactured in premixed syringe and required no preparation before use .MTA was prepared by mixing at 1:1 powder to liquid ratio. Material discs (n=10) for each material groups were prepared as follow:

The material were placed in molds of 8mm diameter and 2mm thickness and MTA discs allow to set at (37 c) for 1 day and Theracal disc were curing by light cure for 20 seconds then samples were removed from mold after 1 day. The weight of each disc was measured to determined first mass (I)then directly put perpendicularly in 20 ml of pure water and retained at 37 c ,next 7 days of involvement in water, specimen took out and the mass (S) was determined as specimen suspended in water, The extra amount of moisture on external part of samples was eliminated by moisture filter paper and the mass (M)was documented, lastly discs were dehydrated in oven at 37 c for 24 hours till the mass was constant, and last mass(D)was documented ,See table(1) Each record was done 3 times using an analytical balance(ANDG×20,Japan).

Then the readings were calculated according to the following formula: Exterior volume V"V=M-S", Volume of open pores V_{op}"V_{op} =M-D", and the apparent Porosity P"P=[(M-D)\V]×100"were calculated in cubic centimeters or in percentage. Water sorption A"A=[(M-D)\D] ×100",solubility S"S=[(I-D)\D]×100".(Gandolfi et al.2013) The result were calculated and analyzed using independent T-test.

Results

The volume of open pores varies broadly with statically significant differences ($p<0.05$) with MTA showed the highest values as shown in table (1). The highest value of apparent porosity were measured for MTA. The solubility value presented a broad range of difference between Theracal

LC and MTA, the lowest value was measured for Theracal LC whereas MTA presented the uppermost solubility with statically significant differences "p<0.05". Water sorption showed highest value for MTA with statically significant differences "p<0.05" as shown in table (2), table (3).

Discussion

Solubility (the quantity of material that will dissolve in a given volume of solvent). It is a critical component in determining whether or not materials are suitable for use as restorative materials in dentistry. Because endodontic and restorative materials should establish a long-term seal and limit leaking from the oral cavity and/or the periapical tissue, root healing cements with low solubility are desirable.(8)

Theracal LC gets a protective physical lining despite interaction with dentinal or pulpal fluids, however, due to the durability of dental materials, solubility must be considered. Its solubility is lower than that of MTA as this study show. This result is agreed with Alazrag M.A.Abu-Seida A. M. Ashry S.H.El(2020).(9)

Low solubility of Theracal LC, which is resin based MTA like material, attributed to inclusion of light curable resin and the capability to discharge a modest amount however persistent of calcium ion.(10)

Absorption of water (the quantity of water adsorbed on the surface and absorbed into the body of the substance). Water absorption heads events such as volumetric alterations, swelling, and tempering of the materials, all of which might undermine their microstructure and, as a result, the restoration's seal.(11) In previous study ,it was reported that long time storage of pulp capping agent in water affect the mechanical properties of the materials. Cattani-lorenta et al(12) found that this change of mechanical and physical properties of pulp capping agent after long time storage in water could be related to water sorption of these material. Water sorption ability has a direct effect on solubility, the material with low water sorption show low slubility.(13) Theracal LC show lower water sorption than MTA. Theracal LC is low solubility and water sorption, these result in agreement with Nagham A.2017.(14)

Porosity is a key characteristic for describing the microstructure of solids. It refers to the volume of empty space in a material, which can include fluid or air, as a percentage of the total volume. (15) The quantity of leakage, the outcome of therapy, adsorption, permeability, strength, and density of capping material are all determined by porosity. Pores serve as a stress concentration area, causing the specimen to become more brittle.(16)

In this study the lowest value of porosity was recorded for Theracal LC . these result in agreement with Gandolfi etal(2014)(17) and Gandolfi M.G. Siboni F. Prati C(2012).(18) Higher porosity of MTA than Theracal LC is related to increase water-powder ratio of MTA that increase calcium release of MTA and increase porosity that correlate with high ion release.

Conclusion

The physical properties of Theracal LC are better than that of MTA.

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Conflicts of Interest

The author reported that there is no conflict of interest

References:

1. Arandi N. Calcium hydroxide liners:a literature review. Clinical,Cosmetic, and Investigational Dentistry.2017;9:67-72.
2. Hilton TJ. Keys to clinical success with pulp capping:A review of the literature.Oper. Dent.2009;34:615-625.
3. Gandolfi et al .Calcium silicate and calcium hydroxide materials for pulp capping: biointeractivity, porosity, solubility and bioactivity of current formulations. Appl Biomater Funct Mater.2014.
4. Marta K, Monika LS .Bio- indctive materials in direct and indirect pulp capping-Areview article. Materials.2020;13:1204.
5. Sung-Min P. et al. Calcium silicate based biocompatible light curable dental material for dental pulpal complex.Nanomaterials.2021;11:596.
6. Dutta A. , Saunders W. Calcium silicate materials in endodontics. Dental updates.2014;41:8.708-722.
7. Siboni F. et al .Properties of neoMTA plus and MTA plus cements for endodontic.IntEndod J.2017;50:S2.
8. Hosam ME,Muhammed SA, Muhammed AM. Evaluation of water sorption,solubility and ph of fluoride and strontium fluoride modified calcium silicate based cement. Al-Azhar Journal of Dental Science.2020;23:3.
9. Alazrag MA ,Abu-Seida A M, Ashry SH El. Marginal adaptation,solubility,and biocompatibility of Theracal LC compared with MTA angelus and biodentin as a furcation perforation repair material. reseah article, BMC Oral health.2020; 20:298.
10. Al-sherbiny IM, Farid MH, Abu-SEIDA AM, Motawea IT, Bastawy HA. Chemico-physical and mechanical evaluation of three calcium silicate based pulp capping materials .Saudi Dent J.2021;33:4.
11. Hosam ME,Muhammed SA, Muhammed AM.Evaluation of water sorption,solubility and ph of fluoride and strontium fluoride modified calcium silicate based cement. Al-Azhar Journal of Dental Science.2020;23:3.
12. Cattani-lorenta et al .Effect of water on the physical properties of resin-modified glass ionomer cement. Dent Mater.1999;15:1:71-78.
13. Misilli T, Gonalol N. Water sorption and solubility of bulk fill composites polymerized with a third generation LED LCU . Braz oral Res .2017;13:1-8.
14. Nagham A. Al-Hayali. Comparison among pulp capping materials in;calcium ion release ,ph change ,solubility and water sorption(An in vitro study).J Bagh college Dentistry.2017; 29:3.
15. Katarzyna S.etal. contemporary Approach to the porosity of dental materials and methods of its measurement .International Journal of Molecular Science.2021;2.
16. Alicia M.etal .porosity of resin cements and resin modified glass ionomer.American Journal of Dentistry.2001;14.

17. Gandolfi etal .Calcium silicate and calcium hydroxide materials for pulp capping :biointeractivity,porosity,solubility and bioactivity of current formulation . Journal of Applied Biomaterial and foundamental Materials.2014; 13:1.
18. Gandolfi MG, Siboni F, Prati C.Chemical-physical properties of theracal, a novel light curable MTA Llike material for pulp capping .International Endodontic Journal .2012;45:6.

Table 1.

Letter	Refer to
I	Initial mass
S	Suspended mass
M	Saturated mass
D	Dry mass

Table 2. Solubility, Water sorption, Porosity of the materials (n=10, per group)

Material	Solubility% Mean +SD	Water sorption% Mean +SD	Volume of open pores (cm^3) Mean +SD	Apparent porosity (cm^3) Mean +SD
Theracal LC	2.4775±0.6229[a]	13.975±1.6364[a]	0.0356±0.00838[a]	21.3488±1.805[a]
MTA	19.487±1.47641[b]	21.787±4.6[b]	0.0871±0.0517[b]	32.79±3.88[b]

Different letters indicating a significant difference($p<0.05$)

Table 3. P value for each test

Physical properties	**P value**
Solubility	0.0208*
Water sorption	0.0220*
Volume of open pores	0.0258*
Apparent porosity	0.0202*

*Significant at $p<0.05$