ANALYSIS OF THE POROSIMETRY OF THE CEMENT MTA-FILLAPEX COMPARED WITH AH PLUS, SEALER 26 AND ENDOFILL

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Resumo

O objetivo desta pesquisa consiste em analisar através da caracterizaçãofísica a porosidadedos seguintes cimentos endodônticos: MTA Fillapex, AH Plus,Sealer 26 e Endofill. Para tal, foram realizadas análises dos cimentos manipulados (corpos de prova) através da técnica de análise da porosimetria de mercúrio.Aporosimetriamostrou que o MTA Fillapex apresentou os melhores resultados: a menor porosidade, o menor volume médio e o menor diâmetro do poro;oSealer 26 dentre os cimentos resinosos apresentou o pior resultado;o Endofill mostrou-se melhor que o Sealer 26.Estes resultados podem estar ligados diretamente aos requisitos de um material obturador ideal. Ametodologia empregada produziu um novo detalhamento à porosimetria dos cimentos estudados, com certeza está ligada as suas características físicas,apontando um caminho para novas pesquisas e uma nova discussão na área.

Palavras-chave: Materiais restauradores do canal radicular. Cimentosdentários.Propriedade fisica.

ABSTRACT

The objective of this research is analyze through the physical characterization the porosity following sealers: MTA Fillapex, AH Plus Sealer 26 and Endofill. To this end, we conducted analyzes of cements manipulated (specimens) using the technique of analysis by mercury porosimetry. The porosimetry showed that the MTA Fillapex showed the best results: a lower porosity, lower volume and lower average pore diameter, Sealer 26 from the resin cements showed the worst result, Endofill proved better than the Sealer 26. These results can be linked directly to the requirements of an ideal filling material. The methodology produced a new detail to the porosimetry of cement studied, sure is linked to their physical characteristics, pointing the way for new research and a new discussion in the area.

Keywords: Restoring materials of the root canal. Dental cements.PhysicalProperties.

INTRODUCTION

We noted several studies in the relevant literature which used, to study the physical and chemical properties of endodontic cements, tests with the established standards. Among them specification # 57 of the American Dental Associations (ADA): Bernardes et al.(2010), Bortoluzzi (2009), Camilleri (2009), Cunha et al. (2008), Fidel et al. (1994, 1995a, 1995b, 2008), Salazar et al. (1996), Savioli et al. (1999a), Savioli et al.(2000), Silva et al. (1994), Silva et al. 1995, Motta et al. (1992); standard ISO 6786: Scelza et al. (2006); specification ISO 6876:2001 and the American National Standards Institute (ANSI) / American Dental Association (ADA) with specification # 57 of ADA: Duarte et al. (2010).

We sought a manner which allows us to discuss filling cements better. We found, by looking at the engineering and science of the materials, a way of studying the "characterization of the materials" which describes the aspects of composition and structure (including defects) of the materials, within a context of relevance for a process, product or property in particular. (MANSUR, 2010). Seeking greater details of the physical characterization of endodontic cements.

REVIEW OF THE LITERATURE

Torabinejad, Watson and Pitt Ford (1993) studied "in vitro" the sealing capacity of amalgam, super EBA and MTA as root filling material using fluorescent dye rhodamine B and evaluating with a microscope. The roots were divided at random into three groups, preparations made in the root and filled with the materials to be tested. All the roots were exposed to an aqueous solution of rhodamine B for 24 hours, and then the roots were sectioned longitudinally and the degree of penetration of the dye was measured through the microscope. The statistical analysis showed that MTA infiltrated significantly less than amalgam and super EBA.

Torabinejad and Chivian (1999) described an experimental material, MTA, which was investigated as a potential alternative restoring material used in endodontics. Several studies in vitro and in vivo have shown that MTA prevents microinfiltration, is biocompatible and promotes the regeneration of the original tissues, when placed in contact with the dental pulp or periradicular tissue. They described the clinical procedures for applying the MTA in pulp with reversible pulpitis, apicification, repairing of root perforations as well as its use as a retrofilling material.

Brandão (1999) studied the physical and chemical properties of the resinous endodontic cements Sealer 26 and of the experimental Sealer plus and MPB compared with those of zinc Oxide-eugenol cement. Tests were made of the flow, setting time and radiopacity, according to the standard of the International Organization for Standardization (ISO) / Draft International Standard (DIS) 6876. All the cements had satisfactory flow, setting time and radiopacity, in accordance with ISO/DIS 6876. The zinc Oxide-eugenol cement was the only one to have an average infiltration above 0.4 mm.

Sarkar et al. (2005) characterized the interactions of MTA with a synthetic fluid tissue composed of a saline solution plugged with phosphate (PBS) in the dentin of the root canal of human teeth, by means of atomic emission with induced plasma source (ICP-AES), of the Scanning Electron Microscopy (SEM) and X-ray Diffraction (XRD). The authors concluded that the dominant calcium ion released from the MTA, reacts with the phosphates in synthetic fluid tissues, producing hydroxyapatite. The capacity of sealing, biocompatibility and dentinogenic activity of MTA are attributed to these physical and chemical reactions.

Bortoluzzi et al. (2006) evaluated the influence of calcium chloride (CaCl2) on the sealing capacity of three MTA cements: ProRoot MTA, MTA – Angelus and White radiopaque cement (WPC), for retrograde filling. Seventy roots of single-rooted teeth extracted were manipulated and filled. The dye infiltration was analyzed in an optical microscope with a micrometer. Statistical tests of Kruskal-Wallis and Miller were used. It was concluded that the calcium chloride (CaCl2) improved the sealing capacity of the three MTA cements.

Gandolfi et al. (2007) compared the apical sealing capacity of two new experimental cements with the MTA, by the fluid filtration method. Thirty single-rooted human teeth extracted were used and retrofilled with MTA and with the experimental cements Tetrasilicate Cement (TC-1 and TC-2). The authors concluded that there was no statistical difference between the two cements and MTA, regarding infiltration. Thus, the two experimental cements had satisfactory characteristics to be used as retrofilled materials.

Tay, K.C.Y. (2007) investigated a new retrofilling material, Ceramicrete, by the fluid filtration method, MVE and XRD. The authors noted that the Ceramicrete had better apical sealing than the Super-EBA and MTA, being an alternate material to be used in retrofilling.

Wang, Sun and Chang (2008) investigated the effect of calcium chloride (CaCl2) on the hardening time, pH and resistance to compression of the tricalcium silicate. The authors noted that the addition of CaCl2 accelerated the hydration of the Ca3SiO5 resulting in reduced hardening time and improved resistance to compression of the cement, being able to be used as filling material.

Bortoluzzi et al. (2009) studied the influence of adding the calcium chloride (CaCl2) at 10%, on the setting time, solubility, disintegration and pH of the white MTA (WMTA) and the white Portland cement (WPC). They made tests of the setting time, in accordance with the specification in 57 of ADA, and the end setting time, in accordance with American Society for Testing and Materials (ASTM), solubility and pH.

The addition of calcium chloride (CaCl2) to the MTA and white Portland cement (WPC) reduced the setting time and solubility of both. The calcium chloride seems to improve the physical and chemical properties of the cements, reducing the setting time and solubility, and maintaining the pH high.

Hsieh et al. (2009) made a study to improve the mixing properties and accelerate the hardening time of MTA. To do so, calcium lactate gluconate (CLG) was added to MTA. The calcium lactate gluconate is a powder with greater solubility than its individual components. The results suggest that the addition of the calcium lactate gluconate provides better sealing capacity, as well as accelerating the hardening and mixing characteristics of the MTA.

Camilleri (2009) added a polymer soluble in water to MTA. The materials were tested so that the cement thickness was in accordance with standard ISO 7676 (2002). It was concluded that the addition of a polymer soluble in water to MTA did not alter the hydration characteristics of the material, and resulted in a material with improved properties suited to use as endodontic cement.

Parirokb and Torabinejad (2010a) made a review in order to submit the studies concerning chemical composition, physical and antibacterial property of MTA. The study showed that MTA has high pH and low resistance to compression. It has certain antibacterial and antifungal properties, depending upon its powder-liquid ratio. It was concluded in this part of the study that MTA is a material which influences the bioactivity of the surrounding environment.

Torabinejad and Pariorkb (2010) made a review of the literature concerning the sealing capacity and biocompatibility of MTA in the period from November 1993 to September 2009. They concluded based upon the evidence available that MTA has a good sealing and is a good biocompatible material.

Camilleri (2010) investigated the mechanism of hydration of calcium silicate cement loaded with different radiopacifiers for use as endodontic filling material. The conclusion was reached that bismuth oxide can be replaced by other radiopacifiers not affecting the hydration mechanism of the material.

Parirokb and Torabinejad (2010b) made a review in order to submit a full list of electronic and printed articles concerning studies with animals, clinical applications, disadvantages and action mechanism of MTA. The results show that MTA is a promising material for root filling and closing perforations, direct pulp capping, formation of apical barrier in teeth with necrotic pulp and open apexes. MTA has known disadvantages as: hardening time, high cost and potential for discoloring.

Duarte et al. (2010) made a study in vitro evaluating the radiopacity, setting time, flow, thickness of the film, solubility, dimensional alteration of the pure AH Plus cement and with 5% and 10% of calcium hydroxide. In accordance with the requirements of standard ISO 6876:2001 and ANSI / ADA and specification # 57. Addition of 10% of calcium hydroxide reduced the flow compared with pure AH Plus. The addition of 5% and 10% of calcium hydroxide increased the solubility. The addition of calcium hydroxide led to greater thickness of the film. Addition of 5% of calcium hydroxide did not affect most of the physical properties of the cement AH Plus.

Camilleri (2011) evaluated MTA and Portland cement in their dimensional variances related to environmental conditions, absorption of liquids, solubility and leaching stored in Hanks Balanced Saline Solution (HBSS). It was concluded that MTA was very susceptible to environmental conditions. The addition of bismuth oxide to MTA increased the solubility of the material and caused deterioration of its material stability. Many studies are required to establish the appropriate porosity of the material and its ideal dimensional stability.

Vitt et al. (2013) made a study which evaluated certain physical and chemical properties (mixing, flow, solubility, water absorption and work time) of the cement MTA-Fillapex (Angelus, Londrina, Brazil) compared with AH Plus; (Dentsply, Konstanz, Germany). The flow and work time was tested in accordance with ISO 6876:2001 and the flow time in accordance with American Society for Testing and Materials C266. The solubility and water absorption increased significantly over time for both cements in a period of 28 days ($P < 0.05$). It was concluded that MTA-Fillapex had suitable physical properties to be used as endodontic cement.

The objective of this study consists of analyzing through physical characterization specifically the porosity of the cements chosen. Seeking to find a new perspective for the study of this property.

MATERIAL & METHODS

The experiments were executed in the Laboratório de Tecnologia de Pós (LATEP) of the Instituto Nacional de Tecnologia (INT). (Post Technology Laboratory)

The endodontic cements studied were: AH Plus (Dentsply), MTA-Fillapex (Angelus®), Sealer 26 (Denstply), Endofill (Dentsply). They followed the instructions for use and mixing described by the manufacturers.

The molds of the test specimens were made having on average 38 mm in diameter and 6 mm in thickness, following the methodology proposed by Correa and Ogasawara (2006).

The cements were mixed obeying the specifications of the manufacturers. After the mixing, the material was inserted in the dies with the aid of a mixing spatula or by direct injection in the case of MTA-Fillapex. Immediately after the filling of the dies, a glass plate was placed, in order to make a slight compression of the samples obtaining smooth surfaces and facilitating their reading. The time required for the start hardening of each cement having elapsed, the test specimens were removed from their dies and maintained in a humidifier during 24 hours at the temperature of 370°C for the complete hardening.

After preparing the test specimens for the cements, the physical characterization was executed of the mixed cements and we used the porosimetry tests.

For the Porosimetry test the mixed cements were placed individually in the porometer, using the appliance Autoscan -33.

RESULTS

The experimental results obtained from the porosimetry of the mixed cements are displayed in Table 1.

DISCUSSION

We noted regarding the total porosity (Graph 1), the cement Sealer 26 had the greatest porosity, then came Endofill, AH Plus and the least porosity was for MTA-Fillapex.

Regarding the average pore volume (Graph 2), it accompanied the results seen previously, with the cement Sealer 26 having the greatest volume, then came Endofill, AH Plus and MTA-Fillapex had the least volume.

Regarding the average pore diameter (Graph 3), we also noted that the cement Sealer 26 had the largest diameter, then came Endofill, AH Plus and MTA-Fillapex had the smallest diameter.

We thought that the resin which took part in the mixing of the cements acted in reducing the pores, which can be said for MTA-Fillapex and AH Plus, but was not observed for Sealer 26 with the worst results of total porosity, volume and pore diameter. In this study MTA-Fillapex had the best porosimetry results: least porosity, least volume and smallest pore diameter.

We found that the porosimetry information - total porosity, average volume and pore diameter - is possibly linked to the physical properties of the cements such as: impermeability, humidity and the conditions of obliterating the canal both laterally and vertically (GROSSMAN, 1983) and that MTA-Fillapex had the best performance in this context.

Regarding Endofill, it had a better result than Sealer 26. We thought that as it is a zinc oxide-eugenol base cement it would have a worse performance than the resinous cements, which was not fully so.

We perceived from all that was presented, that the methodology employed produced a new detail for the porosimetry of the cements studied, which is certainly linked to their physical characteristics, indicating a direction for further research and a new discussion in the area.

CONCLUSIONS

Considering the methodology employed, the results obtained in the study and after discussing them, the following conclusions were drawn:

1. The porosimetry study showed that MTA-Fillapex had the best results: the least porosity, the least average volume and the smallest pore diameter; followed by AH Plus with the second least porosity and the second least average pore volume. Among the resinous cements Sealer 26 had the worst result with the greatest porosity, the greatest average pore volume and the largest diameter. These results can be linked directly to the requirements of an ideal filling material;

2. The methodology employed produced a new detail for the porosimetry of the cements, which is certainly linked to their physical characteristics, indicating a direction for further research and a new discussion in the area.

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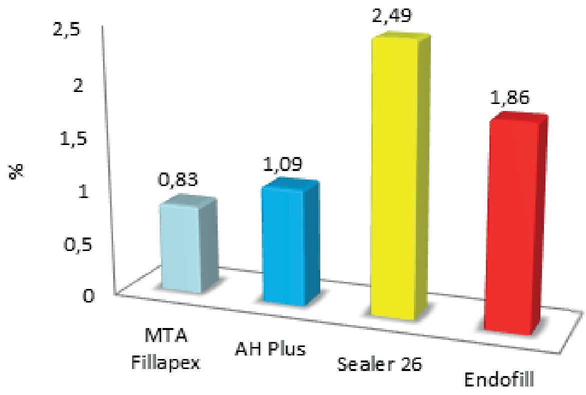
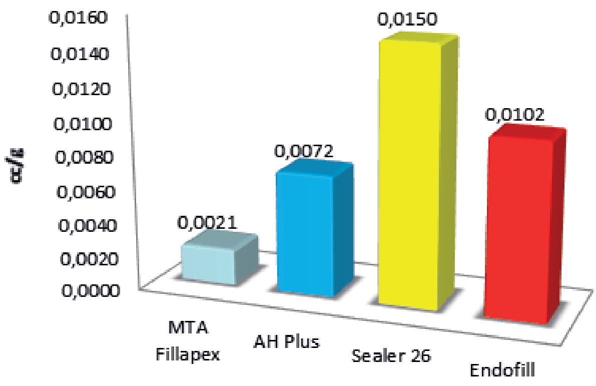
Tables and graphs

Table 1 – Porosimetry of mixed cements.

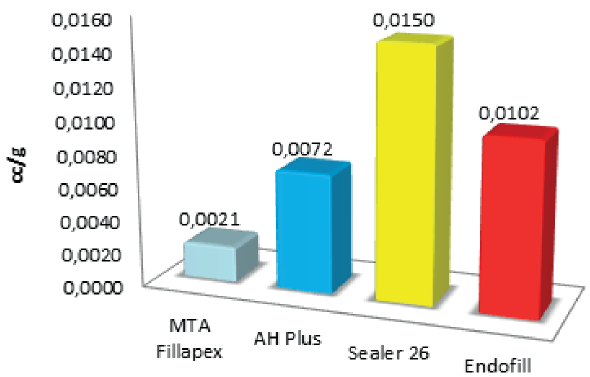
CEMENT	POROSITY (%)	AVERAGE PORE VOLUME (cc/g)	AVERAGE PORE DIAMETER
MTA Fillapex	0, 8300	2, 121 x 10^{-3}	1, 087 x 10^{-2}
AH Plus	1, 0900	7, 162 x 10^{-3}	1, 410 x 10^{-2}
Sealer 26	2, 4900	1, 502 x 10^{-2}	1, 239 x 10^{-2}
Endofill	1, 8600	1, 024 x 10^{-2}	1, 632 x 10^{-2}



Graph 1 – Total porosity of the mixed cements



Graph 3 – Average pore diameter of the mixed cements



Graph 2 – Average pore volume of the mixed cements