

# Mineral trioxide aggregate as root canal filling material: comparative study of physical properties

## MTA como cimento endodôntico: estudo comparativo de propriedades físicas

### Abstract

**Purpose:** This study evaluated some physical properties of two commercial MTA cements regarding its use as root canal filling material.

**Methods:** The compression strength (CS) of the evaluated materials was performed after 21 hours or 14 days of water immersion. The materials' radiopacity (RD) was measured according to aluminum thickness. Regarding setting time (ST), both initial and final times were measured. The solubility (SB) was calculated according to percentage of lost mass after water storage. The pH measurement was performed in three different times (initial, 1 and 24 hours) of water storage. All tests were performed according to ISO 6876-2:2001.

**Results:** Both cements showed that CS and pH were as in accordance with ISO standard. The two cements exhibited RD values higher than the equivalent limit of 3 mm-aluminum. Both materials exhibited SB values within the recommended limit of 3%. ST and pH also are in accordance with ISO 6876-2:2001. Additional SEM surface evaluation showed both amorphous and crystalline phase for both cements.

**Conclusion:** It is possible to conclude that all evaluated materials are in accordance with ISO standard, allowing its use as root canal filling material.

**Key words:** Dental pulp cavity; root canal filling materials; Endodontics

### Resumo

**Objetivo:** Este estudo avaliou as propriedades físicas de dois cimentos MTA disponíveis comercialmente.

**Metodologia:** A resistência a compressão (CS) dos materiais avaliados foi realizada após 21 horas e 14 dias de imersão em água. A avaliação da radiopacidade (RD) dos materiais foi mensurada em função de espessura de alumínio. Com relação à propriedade de tempo de presa (ST), tanto os tempos de presa inicial e final foram mensurados. A solubilidade foi calculada em função da porcentagem de massa perdida após armazenamento em água. Os valores de pH foram mensurados em três diferentes tempos (inicial, 1 e 24 horas) de armazenamento em água. Todos os testes foram realizados de acordo com a norma ISO 6876-2:2001.

**Resultados:** Ambos os materiais apresentaram valores de CS e pH em acordo com os valores da norma ISO. Os dois cimentos apresentaram RD superiores ao limite de 3 mm de alumínio. Ambos os materiais mostraram resultados de SB inferiores ao limite de 3%. ST e pH também estão de acordo com a norma ISO 6876-2:2001. Adicionalmente foram avaliadas as superfícies dos materiais por MEV, e ambos apresentaram fases estruturais amorfas e cristalinas.

**Conclusão:** Concluiu-se que ambos os materiais avaliados estão de acordo com as normas ISO, permitindo o seu uso como material de preenchimento de canais radiculares.

**Palavras-chaves:** Cavidade pulpar dental; Materiais de preenchimento radicular; Endodontia

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## Introduction

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## Methods

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$$CS = \frac{4P}{\phi \cdot D^2}$$

where P"ku"vjg"o czk"o w o "nqcf"cpf"D"ku"vjg" fkc"ogvt"qh"vjg" urgek"ogp0

## Radiopacity

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### Setting time

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### Solubility

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pH

Vjg"r J"y cu"fygt o kpgf"wukpi"c"r J" o gygt"S/622C."Swk o ku." Dtc|kn+0"Vjg"eg o gpv"y cu" o kzgf."cpf"qpg"i tc o"y cu" fknwvgf" kp"fkuvknngf"y cvgt"wpvkn"vjg"vqcn" o cuu"tgcejgf"32"i0"Vjg"r J" xcnwg"y cu" o gcuwtgf"kp"vjg" fkhgtgpeg"vk o gu"ko o gfkcvgn{" chvgt"vjg" fknwvqkq."chvgt"3"cpf"46"j"qh" fknwvqkq0"Cnn"vguvu"ygtg" r gthqt o gf"kp"vtrkncevg0

Scanning Electronic Microscopy

Chvgt" o cprwncvqkq." o cvgtkcnu" ygtg"kpugtvgf"kp" uvckpnuuu" uvgn"tkpiu" \*302" o o" jgkijv"z"32" o o" fkc o gygt+" dgvy ggp" vyq" incuu"unkfgu"Łzgf"ykvj"e/enc o ru."cpf"ngcxgf"vq"ugvvpki" uvqtgf"kp"cedkpgv"cv"5904"ÅE"cpf";7" ' "tgncvkg"jw o kfkv{"hqt" 5"jqwtu0"Vjg"tg"fkuev"qh"gej" o cvgtkcnu"ygtg"Łzgf"kp" o gvcnke" uvwdu"ykvj"ectdqp"vrg" \*Ectdqp"Verg."5O."Uv0"Rcwn."OP." WUC+."cpf"cn"gt"qh"322"z"qh"i qnf"y cu" fgrqukvgf"qxgt"vjg"kt" uwthceg" \*OGF"232."Dcn|gtu"Wpkq."Dcn|gtu."Nkgejvypuvqk+0" Vjg"uwthceg" o qtrjqnqi {"y cu" gxcnwcvgf"ykvj" c" uecppkpi" gngevtqp" o ketqueqrg" \*UGO=" NGQ" 657" XR/" Ectn" \ gkuu" UOV."Qdgtmqejp." Igt o cp{"ykvj" c" 37/mX"gpgti {"dgc o 0" Vjg"ko cigu"ygtg"cpn{|gf"cv"722"Z" cpf"3722"Z" o cipk/Łecvqk0

Statistical analysis

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gtttu"ygtg"vguvf"hqt"vjg"tgu r qpu" xctkcdngu0"Radiopacity, Setting time and Solubility xcnwgu"ygtg"cuuuguf"wukpi"qpg/yc{"CPQXC."eqpukfgtkpi"vjg" o cvgtkcnu"i tqwru0"Compression Strength and pH" ygtg" cpcn{|gf" d {"vyq/yc{"CPQXC." eqpukfgtkpi"vjg" o cvgtkcnu"i tqwru"cpf" rgtkqf"qh" cpcn{ugu." hqnnqygf"d {"vjg"Vwmg{"jppguv{"ukipkŁecpv" fkhgtgpeg" \*JUF+vguv0"Cnn"cpn{ugu"ygtg" r gthqt o gf"cv" ?20270

Results

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Table 1. Comparison of the compressive strength, radiopacity and setting time of the two MTA materials tested as a root canal filling material.

Materials	Compressive Strength (KPa)		Radiopacity (mm of Al)	Setting Time (min)	
	21 hours	14 days		Initial	Final
MTA-P	23.31±4.32 <sup>a,A</sup>	31.36±16.52 <sup>a,A</sup>	10.7±0.5 <sup>a</sup>	32.00±1.26 <sup>a</sup>	179.83±4.02 <sup>a</sup>
MTA-A	37.16±4.55 <sup>b,A</sup>	44.98±11.28 <sup>b,A</sup>	10.8±0.2 <sup>a</sup>	45.75±0.50 <sup>b</sup>	144.75±0.50 <sup>b</sup>

Different lower case letters show significant differences between materials (P<0.05). Upper case letters show significant differences to periods for compressive strength.

Table 2. Comparison of solubility and pH of the two MTA materials tested as a root canal filling material.

Materials	Solubility (% of lost mass)	pH		
		Initial	1 hour	24 hours
MTA-P	0.09±0.01 <sup>a</sup>	11.88±0.03 <sup>a,A</sup>	11.98±0.02 <sup>a,B</sup>	12.12±0.08 <sup>a,C</sup>
MTA-A	0.12±0.01 <sup>a</sup>	12.23±0.01 <sup>b,A</sup>	12.34±0.05 <sup>b,B</sup>	12.22±0.02 <sup>b,C</sup>

Different lower case letters show significant differences between materials (P<0.05). Upper case letters show significant differences in pH for periods of time.

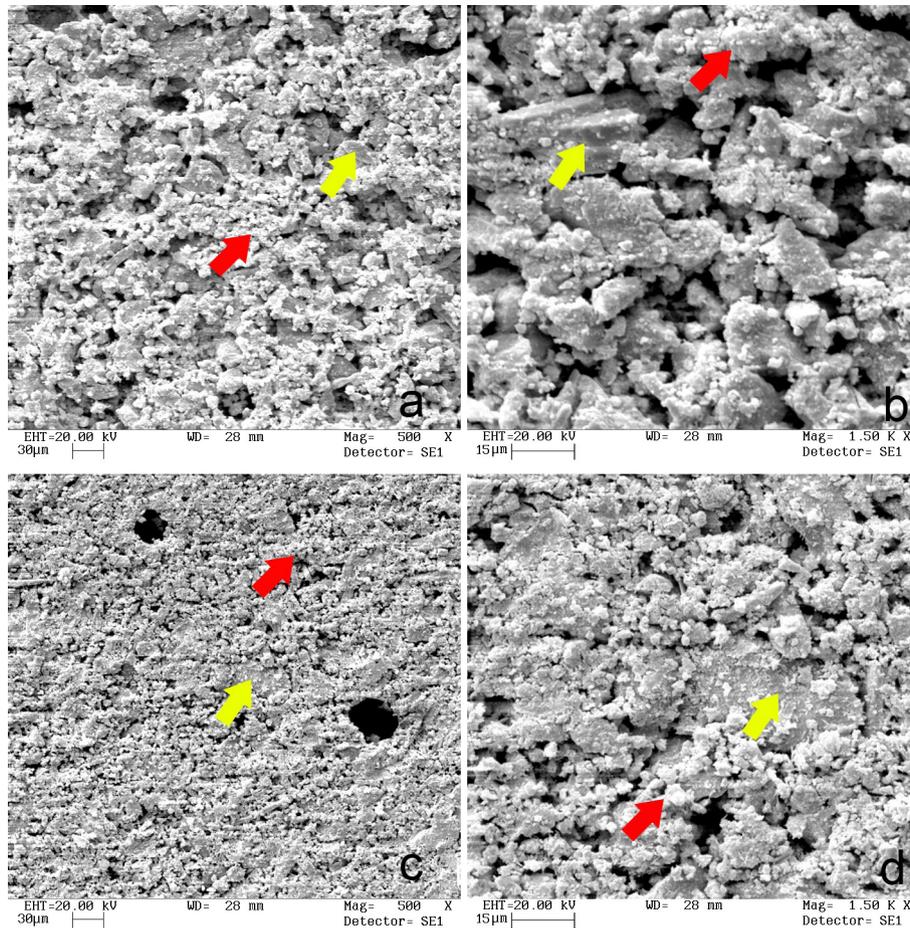


Fig. 1. SEM image of MTA-P (a, b) and MTA-A (c, d) surfaces in 500 X and 1500 X of magnification. High porosity surface can be observed in all materials for both magnifications. Both crystals (yellow arrows) and amorphous (red arrow) phase after setting are present.

## Discussion

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## Conclusions

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