CESPU
INSTITUTO UNIVERSITÁRIO
DE CIÊNCIAS DA SAÚDE

Evaluation of Marginal Adaptation of Biodentine and MTA as Root End Filling Materials in Endodontics

Dante Angeles Romero

Dissertação conducente ao Grau de Mestre em

Medicina Dentária (Ciclo Integrado)

Gandra, 30 de junho de 2020

CESPU
INSTITUTO UNIVERSITÁRIO
DE CIÊNCIAS DA SAÚDE

Dante Angeles Romero

Dissertação conducente ao Grau de Mestre em

Medicina Dentária (Ciclo Integrado)

Evaluation of Marginal Adaptation of Biodentine and MTA as Root End Filling Materials in Endodontics

Trabalho realizado sob a Orientação de Dr. António Augusto Melo Ferraz e Co-orientado por Prof. Doutor Paulo Miller

CESPU
INSTITUTO UNIVERSITÁRIO
DE CIÊNCIAS DA SAÚDE

Declaração de Integridade

Eu, acima identificado, declaro ter atuado com absoluta integridade na elaboração deste trabalho, confirmo que em todo o trabalho conducente à sua elaboração não recorri a qualquer forma de falsificação de resultados ou à prática de plágio (ato pelo qual um indivíduo, mesmo por omissão, assume a autoria do trabalho intelectual pertencente a outrem, na sua totalidade ou em partes dele). Mais declaro que todas as frases que retirei de trabalhos anteriores pertencentes a outros autores foram referenciadas ou redigidas com novas palavras, tendo neste caso colocado a citação da fonte bibliográfica.

CESPU
INSTITUTO UNIVERSITÁRIO
DE CIÊNCIAS DA SAÚDE

Declaração do Orientador

Eu, **António Augusto Melo Ferraz**, com a categoria profissional de **Assistente Convidado** do Instituto Universitário de Ciências da Saúde, especialista de mérito expressamente reconhecido para o efeito pelo Conselho Cientifico do IUCS, tendo assumido o papel de Orientador do Relatório Final de Estágio intitulado **"Evaluation of Marginal Adaptation of Biodentine and MTA as Root End Filling Materials in Endodontics"**, do Aluno do Mestrado Integrado em Medicina Dentária, **"Dante Angeles Romero"**, declaro que sou de parecer favorável para que o Relatório Final de Estágio possa ser presente ao Júri para Admissão a provas conducentes à obtenção do Grau de Mestre.

Gandra, 29 de junho de 2020

O Orientador

_____

AGRADECIMENTOS

A meus caros pais e meu irmão que sempre estão ao meu lado, apoiando-me nas minhas dificuldades e decisões, eles são quem todos os dias me dão força e inspiração para seguir em frente. Agradeço-lhes por todo o esforço que colocaram em mim e por me inspirarem a ser melhor pessoa.

Ao meu caro amigo e binómio Luis a quem agradeço a sua amizade e companheirismo e pelos momentos juntos nos últimos anos cheios de experiências e aventuras.

Às minhas amigas Oriana e Claudia, com quem tive momentos muito bonitos, obrigado por não ser só um mais um amigo, mas sim família.

A meu orientador Dr. António Ferraz, pela ajuda e dedicação neste trabalho e pelos seus ensinamentos durante todo este tempo.

RESUMO

O objetivo de este estudo foi realizar uma revisão sistematica integrativa da literatura sobre a adaptação marginal do Biodentine e MTA como materiais de obturação retrograda em endodontia. Foi realizado uma pesquisa electronica na PUBMED com uma combinação dos seguintes termos: MTA, Biodentine, calcium silicate, root-end filling materials, marginal adaptation. De 74 publicações, foram consideradas 19 como relevantes para este estudo. A maioria dos artigos comparam diferentes marcas e tipos do MTA, sendo que não se encontram diferenças significativas entre elas em alguns deles. O Biodentine tem melhores características físicas tais como o tamanho da partícula e a densidade/porosidade do material. A maioria dos artigos concluem que não há diferença significativa entre a adaptação marginal do Biodentine e MTA. Falta informação sobre se a sangue afeta a adaptação marginal dos materiais. Conclui-se também que o uso de ácido fosfórico só afeta o Gray-MTA e a utilização do laser Nd:YAG na preparação retrógrada não afeta a adaptação dimensional do material. Relativamente à informação sobre adaptação marginal do Biodentine, esta é insuficiente e são necessários mais estudos para uma melhor conclusão.

Palavras chave: MTA, Biodentine, calcium silicate, root-end filling materials, marginal adaptation.

ABSTRACT

This study aimed to conduct an integrative review of literature of marginal adaptation of Biodentine and Mineral Trioxide Aggregate (MTA) as root-end filling material in endodontics. It was done an electronic search through PUBMED using a combination of the following terms: MTA, Biodentine, calcium silicate, root-end filling materials and marginal adaptation. From 74 papers 19 were considerated relevant to this study. Most articles compare different brands and types of MTA, although no significative differences were detected in some of them. Biodentine has better physical characteristics such as particle size and material density/porosity. Most articles conclude that there is no significant difference between the marginal adaptation of Biodentine and MTA. There is a lack of information on whether blood affects marginal adaptation of materials. It is also concluded that the use of phosphoric acid only affects Gray-MTA and the use of the Nd: YAG laser in retrograde preparation does not affect the dimensional adaptation of the material. Regarding the information on marginal adaptation of Biodentine, it is insufficient and needs more studies for a better conclusion.

Keywords: MTA, Biodentine, calcium silicate, root-end filling materials, marginal adaptation.

CESPU
INSTITUTO UNIVERSITÁRIO
DE CIÊNCIAS DA SAÚDE

INDICE

1.INTRODUCTION 1

2.OBJETIVE.....2

3.METHOD 2

4.RESULTS 2

5.DISCUSSION.....11

6.CONCLUSIONS.....14

REFERENCES 15

ANEXOS..... 18

1. INTRODUCTION

Endodontic retreatment usually results successful, but when non-surgical attempts are contraindicated or showed to be unsuccessful surgical endodontic with apical resection and root-end filling material is needed to save the tooth and heal the periapical tissues. (1)

After a long time of using Amalgam as root-end filling material now is know some drawbacks for instance the lack of adhesiveness, microleakage, presence of Mercury, moisture sensitivity and the need for an undercut in the preparation. This lead to the development of new materials as Glass Ionomer Cement (GIC), Composites, Super EBA, Gutta-Percha and now lastly MTA and Biodentine, both tricalcium silicate based which are the most commons materials for root-end fillings. (1)(2)

MTA was introduced in the early 1990s by Torabinejad and since then it gained popularity and become the gold standard because its biocompatibility, good chemical and physical properties. However, the difficult handling and the long setting play a negative role in a moist surgical site. Then recently in 2009 Biodentine become commercial and firstly denominated as “dentine replacement”. It has a very wide applications in dentistry one of them as root-end filling material. (3)(4)(5)

The sealing ability of the root-end filling material will define the success of the endodontic surgery and there are many methodologies to evaluate it. Indirectly marginal adaptation can assess that as an alternative methodology, the presence of gaps between the material and dentinal walls may affect the leakage. (3)

The purpose of this review is to evaluate the marginal adaptation of MTA and Biodentine as root-end filling materials in endodontics in most recent studies.

2. OBJETIVE:

The aim of this study is to perform an integrative systematic review on the marginal adaptation of Biodentine and MTA as root-end filling materials in endodontics.

3. METHODS

A bibliographical search was carried out on MEDLINE/PubMed (via National Library of Medicine) in 20 of December of 2019 using the following search terms: “MTA” OR “Biodentine” OR “Calcium Silicate” OR “Root-end filling materials” AND “Marginal adaptation”. Also, a manual search was performed considering the references within the selected articles. The eligibility inclusion criteria used for article searches were: meta-analyses; randomized controlled trials; prospective cohort studies; and articles and reviews written in English reporting on marginal adaptation of Biodentine® and MTA as root-end filling materials in endodontics. Articles related to cervical or coronal restorations, related to apical plugs or related to perforations were excluded. On the title and abstract, the evaluation of the potentially relevant articles was accomplished independently by two of the authors independently (Dante Romero, A. Melo-Ferraz). Selected articles were individually read and analyzed considering the purpose of this study. The retrieved variables considered for this review were: authors’s names; jornal; publication year, surface analyzed; root-end filling material; method of evaluation; variables, results, main findings.

4. RESULTS

A bibliographical research was performed and identified 74 articles as show in Fig.1; 53 articles were excluded after reading the title and abstract because they did not meet the inclusion criteria. The remaining 21 articles were relevant and they were evaluated with full text reading and 2 of them were excluded, 19 articles were potentially relevant and were included.

Different methodologies were used for marginal adaptation analysis. From the 19 articles, 12 (63,18%) used only Scanning Electron Microscopy (SEM)(1,6–16), 1 used stereomicroscopy (5,26%)(17), 1 Confocal Laser Scanning Microscope (5,26%)(2), 3 Micro-CT (15,78%)(18–20) , 1 Micro-CT and SEM (5,26%)(21) and 1 used a profilometer and SEM (5,26%)(22)

There are some studies that compares different brands and types of MTA where is concluded that there are not significant differences between them; for instance, BioMTA that was manufactured in Korea has two types but shows not differences against White ProRoot MTA. (9) In the other hand Sue Youn Jim compares and concludes that ProRoot MTA was found with the greatest gap against MTA Angelus and Endocem Angelus (18).

One article compares different root-end filling materials concluded that Biodentine showed the best marginal adaptation (2); meanwhile other article concludes the opposite where Biodentine showed that worse marginal adaptation comparing with MTA. (11)

Another variable was evaluated as blood exposure, one article concludes that there is not difference between blood exposure and normal saline exposure in marginal adaptation of MTA and Biodentine. Moreover, other article concludes there is a negative effect in marginal adaptation because the presence of blood.(12,15)

One article compared marginal adaptation etching and non-etching with phosphoric acid after and before retrograde obturation and concludes that there is a significative difference just in Gray MTA. (21) Other authors found out that there is no marginal adaptation's significant differences in etching or not etching with EDTA 17% in retrograde or orthograde obturation, also other authors compared the mode of visualization (direct vision or optical microscope) and used of Nd:YAG laser in apical

preparation, and the results showed there's no significant differences in marginal adaptation. (10)

Table 1: Descriptive data of included studies

Author(s)/year publised	Journal	Surface analyzed	Root-end filling material(s)	Method of evaluation	Variable	Results (Gap) um	Main findings
Akash Kumar Baranwal et al. (2015)(6)	Journal of Conservative Dentistry	Longitudinal: Length width	ProRoot Gray MTA, ProRoot White MTA and Portland cement	SEM (100X and 400X) Stored at 100% humidity - 24h		ProRoot GMTA - Length: 414 µm - Width: 19,54µm ProRoot WMTA - Length: 645,46µm - Width: 15,88µm Portland cement - Length: 608,54µm - Width: 26,00µm	There is no significant differences.
Abdollah Ghorbanzadeh et al. (2014)(9)	Journal of Dentistry	Transversal and Longitudinal	ProRoot White MTA (WMTA), BioMTA (OrthoMTA and RetroMTA)	SEM Incubation in Phosphate buffer saline (PBS) 1 week and 2 months Stored 100% humidity - 1week Resin replicas Ultrasonic tips		ProRoot WMTA - Transversal: 1,14(±1,35) µm - Longitudinal: 0,83 (±1,35) µm OrthoMTA - Transversal: 1,60(±1,59) µm - Longitudinal: 1,35 (±2,13) µm RetroMTA - Transversal: 1,1(±1,17) µm - Longitudinal: 0,50 (±0,72) µm	There is not significant differences.

Pablo Amoroso Silva et al. (2014) (17)	Original Research Endodontics	Transversal (1 and 2mm)	S26, MBPc, MTA Angelus, Portland cement and Zirconium oxide	Stereo-microscope (50X) Stored at 100% humidity – 24h		Percentages of gaps at 1 mm: S26: 4,31(±2,73)% MBPc: 4,66(±3,69)% MTA Angelus: 6,72(±3,74)% PC/OZ: 4,59(±2,35)% PC/CT: 6,19(±4,57)% Percentages of gaps at 2 mm: S26: 7,88(±2,62)% MBPc: 7,83 (±4,77)% MTA Angelus: 9,84(±4,84)% PC/OZ: 3,08(±2,42)% PC/CT: 4,65(±2,24)%	PC/OZ and PC/CT showed better adaptation than MTA at 2mm from apex.
Livia Soares Zerbitani et al. (2012)(10)	Photomedicine and Laser Surgery	Transversal, longitudinal	MTA	SEM (1000X) Ultrasonic tips	Nd:YAG laser	MTA Angelus - Transversal: 2,66(±1,56) µm - Longitudinal: 4,20 (±1,28) µm MTA Angelus+ Nd:YAG laser - Transversal: 12,07(±1,37) µm - Longitudinal: 4,97(±0,88) µm	No Significant differences between MTA Angelus and MTA Angelus + Nd:YAG laser.
Saravanapriyan Soundappan et al (2014)(11)	Journal of Dentistry	Transversal (1 and 2mm from apex)	ProRoot MTA, Biodentine and IRM	SEM (1000X) Ultrasonic tips Stored at 95% Humidity – 5 days		ProRootMTA - At 1mm: 0,847(±0,298) µm - At 2mm: 0,738(±0,466) µm Biodentine - At 1mm: 1,345(±0,717) µm - At 2mm: 1,489(±0,459) µm IRM - At 1mm: 0,689(±0,699) µm - At 2mm: 1,362 (±0,425) µm	IRM and MTA showed beter marginal adaptation than Biodentine.

Ravichandra PV et al. (2014)(2)	Journal of Clinical and Diagnostic Research	Transversal	ProRooT MTA (WMTA), Biodentine and Glass Ionomer cement (GIC).	Confocal Laser Scanning Microscope (10X) Gap area measured a software programme (Leica) Ultrasonic tips Stored in 100% humidity - 1week Immersed in Rhodamine B dye		Gap area: WMTA: 22300,97(±3068) μm^2 Biodentine: 11143,42(±967,75) μm^2 GIC: 33388,17(±12155,903) μm^2	Biodentine showed the best marginal adaptation
Behnam Bolhari et al (2015) (12)	Journal of Dentistry	Transversal	ProRoot MTA, Calcium enriched mixture (CEM), Biodentine and BioAggregate	SEM (X200) Ultrasonic tips Resin replicas Teeth stored in 100% humidity (96 hours)	Presence of blood Normal saline	Biodentine/NS: 0,50(±0,58) µm Biodentine/B: 1,58(±1,73) µm CEM/NS: 1,13 (±0,78) µm CEM/B: 1,36(±1,17) µm BioA/NS: 0,66(±1,11) µm BioA/B: 0,53(±0,88) µm ProRoot MTA/NS: 0,81(±1,14) µm ProRoot MTA/B: 1,36(±1,37) µm	There is not significant differences.
SueYoun Kim et al. (2018)(18)	Basic Research - Technology	Percentage of volume of the gap	ProRoot MTA, MTA Angelus, Endocem MTA and RetroMTA	Micro-CT Apicoectomy done under dental microscope At >95% humidity - 7 days		ProRoot MTA: 0,00472(±0,0110)% MTA Angelus: 0,00134%(±0,0049)% Endocem MTA: 0,00014%(±0,0023)% RetroMTA: 0,00071%(±0,0159)%	ProRoot MTA showed the worse adaptation

Fatemeh Mokhtari et al (2015)(13)	Journal of International Oral Health	Transversal (1mm)	Cold Ceramic and ProRoot MTA	SEM Stored at 100% humidity for 5 days		Cold Ceramic: 5,17(±2,01) µm ProRoot MTA: 6,78(±2,78) µm	There is not significant differences.
Sirisha Gundam et al. (2014)(14)	Journal of conservative Denstistry	Transversal (2mm)	MTA Angelus , GIC and IRM	SEM (2000X) Stored at humidity 100% for 12h 17% EDTA for smear layer removal Ultrasonic tips		MTA Angelus: 0,72(±0,438) µm GIC: 1,778(±0,69) µm IRM: 0,80(±0,51) µm	MTA showed better and significative marginal adaptation than GIC
Khalid Al-Fouzan et al. (2012)(21)	International Journal of Oral Science	Volume, Transversal (axial) and Longitudinal (sagittal)	ProRoot WMTA, GMTA, etched WMTA, etched GMTA	Micro-CT and SEM (50X, 201X, 250X and 4000X) Ultrasonic tips	Etched with phosphoric acid.	**Volume GAP** ProRoot WMTA: 0,0059(±0,002) mm^3 GMTA: 0,053(±0,002) mm^3 EWMTA: 0,0036(±0,001) mm^3 EGMTA 0,0071(±0,004) mm^3 **Axial GAP** ProRoot WMTA: 298,5(±11,02)µm GMTA: 210,7(±12,46) µm EWMTA: 203,2(±9,56) µm EGMTA: 162, 3(±8,71) µm **Sagittal GAP** ProRoot WMTA: 594,5(±12,12) µm GMTA: 910,7(±26,2) µm EWMTA: 543,1(±15,33) µm EGMTA: 492,3(±13,8) µm	Gap significant differences were found between GMTA and etched GMTA

Amin Salem Milani (2013)(15)	Journal of Dental Research, Dental Clinics, Dental Prospects	Transversal (Quantitative) Qualitative	MTA Angelus	SEM (20X) Incubated 100% for 2 days Ultrasonic tips	Exposure: -Blood -Synthetic Tissue Fluid (STF)	Quantitative: AMTA-Blood exposed: 19,8(±10,1)µm AMTA-STF exposed: 4,5(±3,3)µm Qualitative 45.5% of the sample blood exposed have a perimeter gap more than ¼ but less than ½ of the cavity margin. 72,7% of the sample STF exposed have less or equal to ¼ of the cavity margin.	Presence of blood have a negative effect on marginal adaptation of MTA
Helder Fernandes Oliveira et al. (2013)(16)	Iranian Endodontic Journal	Qualitative	IRM, amalgam, ProRoot MTA, Super-EBA and Epiphany/Resilon	SEM 100X and 500X Ultrasonic tips		Based on SEM images, there is not significant difference in marginal adaptation comparing ProRoot MTA with the others root-end filling materials	There is not significant differences.
Amany E.Badr (2010)(1)	Basic Research - Technology	Longitudinal	Bone cement, Gray ProRoot MTA and Amalgam	SEM 75X and 50X Sample dehydrated in a gradient series of aqueous ethanol (30%, 50%, 70%, 90% and 100%)		Amalgam: 3,48(±0,38) µm GMTA: 1,59 (±0,61) µm Bone cement: 1,47(±0,83) µm	GMTA showed better and significative than amalgam
Khalid Al fouzan et al. (2015)(19)	Journal of Conservative Dentistry	Volume	MTA	Micro-CT. Ultrasonic tips	Apical obturation (Ortograde/ Retrograde) Etched with EDTA 17%	Retrograde MTA (RMTA): 0,224(±0,17) mm^3 Orthograde MTA (OMTA): 0,266(±0,23) mm^3 Etched Retrograde MTA (ERMTA): 0,165 (±0,165) mm^3 Etched Orthograde MTA (EOMTA): 0,218 (±0,292) mm^3	There is not significant differences.

Noushin Shokouhinejad et al. (2014)(7)	Iranian Endodontic Journal	Transversal and longitudinal	White ProRoot MTA and Endosequence Root Repair Material (Putty and Paste)	SEM Ultrasonic tips Stored in PBS – 1 week Resin replicas		Transversal: MTA: 6,40(±3,45)um ERRM putty: 2,73 (±1,67) µm ERRM paste: 0,80 (±0,54) µm Longitudinal: MTA: 2,10(±1,28) µm ERRM putty: 2,83 (±1,16) µm ERRM paste: 8,80 (±1,82) µm	MTA showed better marginal adaptation than ERRM paste.
Vladimir Biocanin et al. (2018)(20)	Basic Research Technology	Volume	Biodentine, BioMTA and FUJI XI (GIC)	Micro-CT Ultrasonic tips Stored in SBF – 4 weeks	Simulated body fluid (SBF) exposure for 4 weeks.	Before SBF Biodentine: 0,01 (±0,03) mm^3 GIC: 0,09 (±0,05) mm^3 BoiMTA: 0,07 (±0,01) mm^3 After SBF Biodentine: 0,01 (±0,02) mm^3 GIC: 0,04 (±0,06) mm^3 BioMTA: 0,08 (±0,06) mm^3	There is not significant differences
M. F. Munhoz et al. (2011) (22)	International Endodontic Journal	Area and Depth	Sealer 26 and MTA Angelus White	SEM (50X- 150X) and Profilometer Placed under optical microscope Stored at 95% humidity – 36h		**Area(media):** MTA/direct vision: 408,13 mm^2 MTA/OM: 407,60 mm^2 Sealer26/direct vision: 1164,90 mm^2 Sealer26/OM: 1759, 90 mm^2 Depth MTA/direct vision: 19,05 (±9,62) µm MTA/OM: 14,57 (±1,66) µm Sealer26/direct vision: 27,46(±6,38) µm Sealer26/OM: 27,46(±6,38) µm	There is not significant differences.
Bolla Nagesh et al. (2016)(8)	Journal Of conservative dentistry	Longitudinal	Endosequence and MTA	SEM	Carboymethil chitosan Chitosan	Chitosan EndoSequence: 1,81(±0,02) µm Chitosan MTA: 2,60(±0,01) µm CMC EndoSequence: 1,40(±0,24) µm CMC MTA: 2,16(±0,27) µm	Endosequence showed better marginal adaptation against MTA

5. DISCUSSION

APICOECTOMY

Surgical endodontics is an option when is difficult or impossible to access to clean and shape the root canal system or if there was not any recovery in periapical tissues that couldn`t be resolved by a non-surgical treatment (6).

The primary objective of apicoectomy is to treat periapical inflammation by generally removing the cause, generally an infection, and to seal the affected area after cutting 3mm of the root-end and fill with reduces 98% of ramifications and 93% of the lateral canals, which sometimes are responsible of endodontic failure.(10)(11) Where the roll of the material is to prevent the movement or diffusion of bacterial products. (2)

Ultrasonic tips were reported to minimize the perforation risk having better control and ability to stay centered in the canal. Also diamond coated ultrasonic tips reduces the chance for microcracks formation.(10,11)

The SEM analysis was the most common technique used in most of the papers reviewed. (1,6–16,21,22). Good resolution and high magnification are the main reasons for its popularity of this type of analysis; However, the results may be affected by the SEM preparation because of the dehydration and evaporation of the coating process as microcracks and separation of the filling materials. A solution for this problem was the replication technique by some included studies. (12)

MTA

MTA is a remarkable biocompatible material pioneered by Dr. Mahmoud Torabinejad. Is a mixture of three powder ingredients: Portland cement (75%), bismuth oxide (20%) and gypsum (5%). According to the patent, around 70-95% of MTA is calcium oxide and silicone oxide, around of 68% of Portland cement is tricalcium silicate. (23)

During the hydration reaction, it´s form a calcium hydroxide and calcium silicate gel from tricalcium silicate and dicalcium silicate creating an alkaline pH and producing crystals

of hydroxyapatite. The calcium ions leach through dentinal tubules and the concentration will increase with time as the material cures. Also the density/porosity of MTA is estimated 1,882 g/cm^3 and a compressive strength of 51, 22 (±18,92) Mpa. (23) (24) (25)

BIODENTINE

Biodentine is basically a tricalcium silicate ($3CaO.SiO_2$) based material as MTA, which is presented in a capsule form where is in its ideal ratio of powder and liquid. The powder compounds are 80.1% of tricalcium silicate, 14,9% of calcium carbonate, 5% of zirconium oxide and the liquid contains calcium chloride that works as a hydrosoluble catalyzer. The initial setting time of Biodentine is around 6 minutes and the final setting time is estimated 10,1 minutes and it has a density of 2,260 g/cm^3. (23) (24) Grech L et al., studied the physical properties of Biodentine, and published that at the first 24th hour the compressive strength reach's to 200MPa and at 1 month it equalizes the compressive strength of natural dentine (297-300 Mpa). (23)(26) The principal characteristics that some authors highlight are its nice handling and short setting time which MTA haven't. (2)

MARGINAL ADAPTATION

The most common method to calculate the gap between dentine walls and root-end filling material is by SEM, in this study about 76% of papers selected used this method. In addition, Soundappan et al. highlight that the longitudinal sectioning might create fake gaps and the resin replica technique would not be useful to avoid them. The author recommends that it's not necessary to create resin replicas to evaluate the gap. (11) Also Have been shown that percentage of voids have no direct relationship to leakage. (17) But may be an indirect correlation with sealing ability of retro-filling materials. (11)

The hardness and retention to dentinal walls depend on water/powder ratio, temperature, humidity and the quantity of trapped air in the mixture. The marginal adaptation to dentin also is affected by the size of the particle. (17)

MARGINAL ADAPTATION OF BIODENTINE AND MTA

Comparing the size of the particles between Biodentine and the different brands of MTA, Biodentine have smaller size less than 100 µm, and MTA is estimated 1.5-160 µm,. (27)(28) The voids are related to marginal adaptation and porosity of the material, according to Camilleri J et al. de density is bigger in Biodentine than MTA, that means that ther is less space between particles than in MTA. (24)

Most of the articles found there's no significant differences between MTA and other brands and/or types of MTA and different root-end filling materials like Calcium enriched mixture (CEM), Bioaggregate (BioA), Super EBA, Epiphany/Resilon and Amalgam, (6,7,12,13,17,19,27,28) A small group of articles showed that there were materials with better adaptation against MTA, like Portand cement with zirconium oxide and Endosequence Root Repair Material (ERRM). (8,17)

Two different studies compared MTA against Biodentine, showed that there was no significant differences in gaps evaluated, this could be explained for the similar characteristics that these materials have. (12,20) However one article showed that MTA had better marginal adaptation than Biodentine, this can be explained for the different methodologies of the studies, in this last one study, the samples were sectioned at 1 and 2mm from apical, this could lead some microcracks and that could create fake voids, because at 1mm there weren´t differences, and at 2mm were; another observation was the percentage of humidity where the samples were stored after apicoectomy and filling, It was the only article which the samples were stored at 95% of humidity, while in the other articles the samples were stored at 100%. (11) Ravichandra (2014) found Biodentine had better marginal adaptation than MTA, the reason might be the better properties of handling, setting time and density of Biodentine, also this study used a digital program that assess the gap area so it gives more information of the surface evaluated. (2)

Blood exposure was measured recently in two articles, one of them showed that there's no significative difference between the root-end filling materials evaluated (ProRoot MTA and Biodentine) in terms of marginal adaptation and presence of blood.(12) And the other article was found that there's a significative difference that confirm the negative effect of blood presence in the marginal adaptation of MTA.(15) This results can be explained by the strong differences of both methodologies, the different perspectives of how evaluate the marginal adaptation and the way how the variable blood was managed in each study. Behnam did an study where the exposition of blood was mediated by contact with a cotton pellet after filling, and a SEM analysis where the information is recompiled by the largest gap found in samples, while Salem did cover the tooth after and before de filling exposing the internal canals to blood and also did a SEM analysis with the maximal gap width and a qualitative analysis which evaluate the totality of the gap perimeter. (12,16)

Apparently the use of Nd:YAG laser do make dentinal walls more regular and homogeneous but it seems to affect marginal adaptation, the group with MTA retro-filling and no Nd:YAG laser show best adaptation but statistically with no significative differences. (10)

6. CONCLUSION

There is recently not enough investigation about marginal adaption of Biodentine, most of articles that evaluates Biodentine against MTA uses different methodologies and gives different results. Might be better to use a methodology that evaluates the gap volume like a micro CT which is less invasive, avoid the formation of fake gaps and gives the totality information of the gap.

7. BIBLIOGRAPHY

1. Badr AE. Marginal adaptation and cytotoxicity of bone cement compared with amalgam and mineral trioxide aggregate as root-end filling materials. J Endod. 2010;36(6):1056–60.

2. Ravichandra P V., Harikumar V, Deepthi K, Jayaprada RS, Ramkiran D, Krishna M. JN, et al. Comparative evaluation of marginal adaptation of biodentine™ and other commonly used root end filling materials-an invitro study. J Clin Diagnostic Res. 2014 Mar 15;8(3):243–5.

3. Küçükkaya Eren S, Parashos P. Adaptation of mineral trioxide aggregate to dentine walls compared with other root-end filling materials: A systematic review. Aust Endod J. 2019;45(1):111–21.

4. Orosco FA, Bramante CM, Garcia RB, Bernardineli N, de Moraes IG. Sealing ability, marginal adaptation and their correlation using three root-end filling materials as apical plugs. J Appl Oral Sci. 2010;18(2):127–34.

5. Malkondu Ö, Kazandağ MK, Kazazoğlu E. A review on biodentine, a contemporary dentine replacement and repair material. Biomed Res Int. 2014;2014:1–10.

6. Baranwal A, Paul M, Mazumdar D, Adhikari H, Vyavahare N, Jhajharia K. An ex-vivo comparative study of root-end marginal adaptation using grey mineral trioxide aggregate, white mineral trioxide aggregate, and Portland cement under scanning electron microscopy. J Conserv Dent. 2015;18(5):399.

7. Shokouhinejad N, Nekootar MH, Ashortehyazdi K, Zahraee S, Khoshkhounejad M. Marginal adaptation of new bioceramic materials and mineral trioxide aggregate: A scanning electron microscopy study. Iran Endod J. 2014;9(2):144–8.

8. Nagesh B, Jeevani E, Sujana V, Damaraju B, Sreeha K, Ramesh P. Scanning electron microscopy (SEM) evaluation of sealing ability of MTA and EndoSequence as root-end filling materials with chitosan and carboxymethyl chitosan (CMC) as retrograde smear layer removing agents. J Conserv Dent. 2016;19(2):143–6.

9. Ghorbanzadeh A, Shokouhinejad N, Fathi B, Raoof M, Khoshkhounejad M. An In Vitro

Comparison of Marginal Adaptation of MTA and MTA-Like Materials in the Presence of PBS at One-Week and Two-Month Intervals. J Dent. 2014;11(5):560–8.

10. Zerbinati LPS, Tonietto L, de Moraes JFD, de Oliveira MG. Assessment of marginal adaptation after apicoectomy and apical sealing with Nd:YAG laser. Photomed Laser Surg. 2012;30(8):444–50.

11. Soundappan S, Sundaramurthy JL, Raghu S, Natanasabapathy V. Biodentine versus Mineral Trioxide Aggregate versus Intermediate Restorative Material for Retrograde Root End Filling: An Invitro Study. J Dent . 2014;11(2):143–9.

12. Bolhari B, Ashofteh Yazdi K, Sharifi F, Pirmoazen S. Comparative Scanning Electron Microscopic Study of the Marginal Adaptation of Four Root-End Filling Materials in Presence and Absence of Blood. J Dent (Tehran). 2015 Mar;12(3):226–34.

13. Mokhtari F, Modaresi J, Javadi G, Davoudi A, Badrian H. Comparing the Marginal Adaptation of Cold Ceramic and Mineral Trioxide Aggregate by Means of Scanning Electron Microscope: An In vitro Study. J Int oral Heal JIOH. 2015;7(9):7–10.

14. Gundam S, Patil J, Venigalla BS, Yadanaparti S, Maddu R, Gurram SR. Comparison of marginal adaptation of mineral trioxide aggregate, glass ionomer cement and intermediate restorative material as root-end filling materials, using scanning electron microscope: An in vitro study. J Conserv Dent. 2014 Nov;17(6):566–70.

15. Salem Milani A, Rahimi S, Froughreyhani M, Vahid Pakdel M. Effect of Blood Contamination on Marginal Adaptation and Surface Microstructure of Mineral Trioxide Aggregate: A SEM Study. J Dent Res Dent Clin Dent Prospects 2013;7(3):157–63.

16. Oliveira HF, Gonçalves Alencar AH, Poli Figueiredo JA, Guedes OA, de Almeida Decurcio D, Estrela C. Evaluation of marginal adaptation of root-end filling materials using scanning electron microscopy. Iran Endod J. 2013;8(4):182–6.

17. Amoroso-Silva PA, Marciano MA, Guimarães BM, Duarte MAH, Sanson AF, Moraes IG de. Apical adaptation, sealing ability and push-out bond strength of five root-end filling materials. Braz Oral Res. 2014;28(1):1–6.

18. Kim SY, Kim HC, Shin SJ, Kim E. Comparison of Gap Volume after Retrofilling Using 4 Different Filling Materials: Evaluation by Micro–computed Tomography. J Endod. 2018 Apr 1;44(4):635–8.

19. Fouzan K Al, Awadh M, Badwelan M, Gamal A, Geevarghese A, Babhair S, et al. Marginal

adaptation of mineral trioxide aggregate (MTA) to root dentin surface with orthograde/retrograde application techniques: A microcomputed tomographic analysis. J Conserv Dent. 2015 Mar 1;18(2):109–13.

20. Biočanin V, Antonijević Đ, Poštić S, Ilić D, Vuković Z, Milić M, et al. Marginal Gaps between 2 Calcium Silicate and Glass Ionomer Cements and Apical Root Dentin. J Endod. 2018 May 1;44(5):816–21.

21. Al-Fouzan K, Al-Garawi Z, Al-Hezaimi K, Javed F, Al-Shalan T, Rotstein I. Effect of acid etching on marginal adaptation of mineral trioxide aggregate to apical dentin: microcomputed tomography and scanning electron microscopy analysis. Int J Oral Sci. 2012;4(4):202–7.

22. Munhoz MF, Marchesan MA, Cardoso DRF, Silva SRC, Silva-Sousa YTC, Sousa-Neto MD. Quantitative 3D profilometry and SEM analysis of the adaptation of root-end filling materials placed under an optical microscope. Int Endod J. 2011 Jun;44(6):560–6.

23. Kaur M, Singh H, Dhillon JS, Batra M, Saini M. MTA versus biodentine: Review of literature with a comparative analysis. J Clin Diagnostic Res. 2017;11(8):ZG01–5.

24. Camilleri J, Sorrentino F, Damidot D. Investigation of the hydration and bioactivity of radiopacified tricalcium silicate cement, Biodentine and MTA Angelus. Dent Mater. 2013;29(5):580–93.

25. Ghasemi N, Rahimi S, Shahi S, Salem Milani A, Rezaei Y, Nobakht M. Compressive strength of mineral trioxide aggregate with propylene glycol. Iran Endod J. 2016;11(4):325–8.

26. Grech L, Mallia B, Camilleri J. Investigation of the physical properties of tricalcium silicate cement-based root-end filling materials. Dent Mater. 2013;29(2):e20–8.

27. Pineada GB, Casa M, Tenorio F, Tueme AD, Case Studies Collection. Septodont. 2010;(17).

28. Komabayashi T, Spångberg LSW. Comparative Analysis of the Particle Size and Shape of Commercially Available Mineral Trioxide Aggregates and Portland Cement: A Study with a Flow Particle Image Analyzer. J Endod. 2008;34(1):94–8.

8. ANEXOS

Fig. 1 : Articles selection Flowchart