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USE OF BIOCERAMIC CEMENT IN THE ROOT PERFORATION: A LITERATURE REVIEW

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ABSTRACT

The root perforation, in spite of being taken as a challenging incident in Endodontics, has display satisfactory outcomes when exposed to proper therapeutic conducts and the usage of materials that have favorable properties. The current study had as goal to conduct a literature review regarding the use of Mineral trioxide aggregate, EndoSequence root repair material and Biodentine in the treatment of root perforation approaching some of the key properties for treatment success. A search was performed in the database of the Public Medline and CAPES Journals Portal, through the keywords: root perforation, Biodentine, mineral tri-oxide aggregate, Endodontics, Endosequence. From the 2,260 papers traced, 581 fulfilled the inclusion criteria. From these 50 were chosen after reading the title and topic, and when they were understood as a whole, 27 references were elected to comprise the research. It was settled that there is no consensus in the literature concerning the material that displays the best characteristics, once none of the materials addressed had all the essential properties higher than the others, this way it is required the execution of further studies aimed at addressing the materials characteristics suggested in the root perforation treatment.

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INTRODUCTION

Root perforation is an unintentional or pathological communication between the pulp cavity and the periodontal tissue arising from iatrogenics, reabsorption or caries (APOSTOLSKA *et al*., 2017; SILVA *et al*., 2017). It is takes as a big challenge to the most renowned endodontic specialists and clinicians, symbolizing one of the most unpleasant accidents during the endodontic treatment (MONTEIRO *et al*., 2015; CAMPOS *et al*., 2016). Pain during the instruments usage and intense and immediate bleeding are mentioned as clinical manifestations; Furthermore, a secondary inflammation and loss of bone insertion represent one of the biggest complications arising from perforation (SILVESTRE *et al*., 2016).

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The treatment has as its aim to offer hermetic sealing and ought to be based immediately through surgical procedures or endodontic path. Because of the possibility of pockets' formation in the surgical method, it is more advantageous to endodontic therapy, particularly in regions of difficult access (CARDOSO *et al*., 2018; SINGLA *et al*., 2018). The treatment's success is directly associated to the perforation's size, location and level, the usage of suitable materials and techniques, presence or absence of inflammation and repair time (SILVEIRA *et al*., 2015). Despite the dental element prognosis in which the root perforation happened being obscure, it is possible to reverse this scenario through good therapeutic practice and using materials that present favorable characteristics (MELO *et al*., 2011). The mineral trioxide aggregate (MTA) is taken as a gold standard material (SILVA *et al*., 2017) in the perforations sealing, because it holds important properties like high pH, biocompatibility, fixation

power even with humidity, periradicular regeneration and osteoinductive capacity (ZACCARA *et al*., 2014; TAHA *et al*., 2016; MANCINO *et al*., 2018; SOLANKI *et al*., 2018). Nevertheless, it displays some confining disadvantages, which are able to intervene in the clinical practice, expressed through the difficult manipulation and insertion on the spot to be filled, short working time and slow prey time (SANTOS *et al*., 2018). With the requirement to enhance the physicochemical properties of the MTA and surpassing the limitations displayed, the EndoSequence root repair material (ERRM) was designed (Brasseler USA, Savannah, GA, USA). It is a pre-mixed material, its appearance is as a condensed mass or pre-loaded syringe, has excellent biological and mechanical properties, easy manipulation, highly biocompatible, hydrophilic,radiopacity,osteogenic and insoluble, prescribed for pulp capping and root's repair procedures (SHOKOUHINEJAD *et al*., 2014). The Biodentine (Septodont, Saint-Maur-des-Fossés, France) was manufactured with the goal of assembling the bioactivity and high biocompatibility of calcium silicate, however, does not include aluminate in the formula, which diminishes the potential health risks. It holds properties as low cytotoxicity, excellent sealing ability, compressive resistance, easy handling, besides keeping the bone-biomaterial interface, so it exhibits clinical indication in root perforation therapy (YOLDAS *et al*., 2016; SILVA *et al*., 2017). The present paper arose from a literature review regarding the use of MTA, EndoSequence ERRM and Biodentine in the root perforations treatment that happened duting the endodontic treatment.

MATERIALS AND METHODS

The exploratory investigation was carried out between December 2018 and January 2019, in the subsequent electronic databases: Public Medline (PubMed) and CAPES Periodicals Portal, using the keywords: root perforation, biodentine, mineral-trioxide aggregate, Endodontics, endosequence. The boolean operator "AND" was employed between the terms above. For the papers' inclusion the following criteria were assumed: scientific papers published between 2014 and 2019 concerning the proposed topic, in the languages: Portuguese, English and Spanish, accessible online and fully displayed. As exclusion criteria there were used: bibliographic review, papers that were not entirely available, assignments presented in other formats other than scientific articles and publications and that do not fit the study's goals. After performing the search in the databases with the use of the filter's terms and application regarding the inclusion and exclusion criteria, the papers were selected through the title and abstract with the goal of narrowing the sample. The pre-selected publications were fully read, in an objective way and from a critical assessment, which enabled the relevant studies selection to the research; The duplications faced between the bases were eliminated.

RESULTS

A total of 2.260 articles were traced through the keywords, after the application of the inclusion and exclusion criteria 581 articles were listed. Of these, 531 were deleted after reading the title and theme for not adjusting the study's topic. The 50 selected references were understood as a whole, this way 23 were excluded; 16 because they displayed duplicity between the databases and 07 because they did not strictly adjust with the designated study. Lastly, 27 papers were selected to form the research.

BIBLIOGRAPHIC REVIEW

The root perforation involves the communication between the pulp cavity of the dental element and the periodontal space (DORILEO *et al*., 2014; APOSTOLSKA *et al*., 2017; SILVA *et al*., 2017; ESPALADORI *et al*., 2018). It has as causal element a pathological change like a large dental caries or root reabsorption, or it may happen through an operative surgical accident (HAGHGOO *et al*., 2014; AZIM *et al*., 2014; KAUSHIK *et al*., 2014; LAGISETTI *et al*., 2018). There are factors that make it hard to access to the root canal during the endodontic treatment, predisposing to dental perforation as examples: Errors regarding the canal identification, large caries, pulp calculations, badly positioned teeth, internal root reabsorption, excessive abrasion and debility of the dentin displayed in the danger zones (COSME-SILVA *et al*., 2016).
The microorganisms deriving from the root canal, the periodontium or both, may colonize the spot where the perforation happened, resulting in the contamination of the area and a probable inflammatory response (KAUSHKI *et al*., 2014). As a result of the inflammation, it is possible to happen bone reabsorption, pain, abscess, suppuration, fistula and necrosis, which undermine the treatment's efficacy and consequently cause loss of the dental element (HAGHGOO *et al*., 2014). The root's cervical third and the pulp-chamber floor are the spots most likely to be contaminated because of the closeness with the oral environment and consequent facility for the bacteria's colonization in the area (AZIM *et al*., 2014; KAUSHKI *et al*., 2014).

Root perforation constitutes the second most common cause of endodontic flaws (JEEVANI *et al*., 2014). The prognosis is linked to the perforation's location, extent, time, presence or absence of contamination, suitable treatment, early diagnosis and usage of ideal materials (KERNER and BRONNEC, 2015; COSME-SILVA *et al*., 2016). The diagnosis should be performed right away in order to provide a proper treatment, favoring the prognosis and preventing bacterial colonization (JEEVANI *et al*., 2014). The treatment may be carried out through the surgical method, although, since there is possibility of pocket formation, the non-surgical technique is the most accepted, mainly in areas where the access is hard (LAGISETTI *et al*., 2018; SINGLA *et al*., 2018). The ideal material for the perforation repair success must exhibit proper sealing, having biocompatibility, stimulating the cementogenesis and osteogenesis, being radiopaque, with easy manipulation, not being absorbable, having dimensional stability and not being soluble to tissue fluids (DORILEO *et al*., 2014; DEEPTHI *et al*., 2018; LAGISETTI *et al*., 2018; SINGLA *et al*., 2018). Different materials have been designed for the treatment's perforation, among these we can cite the amalgam, zinc oxide and eugenol cement, calcium hydroxide, resin cements, the hydroxyapatite and glass ionomer (SAMYUKTHA *et al*., 2014). Although, none of the listed materials managed to me*et al*l the ideal properties, which substantiates the increase of studies in the area (JEEVANI *et al*., 2014; PATEL *et al*., 2014). Nowadays, the materials of choice for root perforation repair are the bioceramics, like the mineral trioxide aggregate (MTA), EndoSequence root repair material (ERRM) (Brasseler USA, Savannah, GA, USA) and Biodentine (Septodont, Saint-Maur-des-Fossés, France) (JEEVANI *et al*., 2014). Bioceramics are materials made of

calcium silicate, they have been widely employed in endodontics as root repair material, in pulp coating, as cement sealing and in periapical surgeries, they exhibit relevant characteristics like: biocompatibility, dimensional stability, antimicrobial power and elevated pH (GUO *et al*., 2016).

The MTA was the first bioceramic conducted and used in the dental perforation treatment. It is primarily formed by tricalcium silicate, silicate oxides, bismuth and Tricalcium aluminate (COSME-SILVA *et al*., 2016; CARDOSO *et al*., 2018). Physical, chemical and mechanical properties regards it as an excellence material in endodontic therapy. It is sold in powder, composing a colloidal gel when mixed with water, the prey time is 2 hours and 30 minutes, establishing a rigid structure (DORILEO *et al*., 2014). It displays hydrophilic characteristics, with the humidity being accountable for the material's prey, prompting the mineralized tissue formation, the cement and periodontal ligament is biocompatible, with low solubility and exhibits good sealing potential, which enables hermetic perforation sealing (ÜSTÜN *et al*., 2015; BAMPA *et al*., 2015; ESPALADORI *et al*., 2018). In spite of the excellent characteristics, the MTA exhibit some limitations, as unpractical handling, granular consistency, long prey time and short work time (TAHA *et al*., 2016). With the purpose of enhancing the MTA characteristics and enhancing the reported difficulties, the bioceramic cements ERRM and Biodentine were elaborated (SINKAR *et al*., 2015). Using calcium silicate, the ERRM is primarily comprised of zirconium oxide, monobasic calcium phosphate and tantalum oxide, commercially it is obtainable in the consistency of mass that is ready for use, supplying a consistent material and making the Clinical management easier (DEEPTHI *et al*., 2018). It is biocompatible, insoluble, hydrophilic and bioactive, does not have aluminum, the prey starts through the contact with humid environment and is able to provide excellent sealing, characteristics that define it as a proper material in the Dental perforations treatment (JEEVANI *et al*., 2014). The Biodentine bioceramic is comprised by calcium silicate, zirconium oxide, tricalcium silicate and calcium carbonate, the commercial presentation is powder and liquid (SAMYUKTHA *et al*., 2014; APOSTOLSKA *et al*., 2017; DEEPTHI *et al*., 2018). It exhibits biocompatibility, dimensional stability, excellent sealing capacity, easy manipulation, short prey time, so is suitable for clinical usage in root's repair (SINKAR *et al*., 2015; RAMAZANI and SADEGHI, 2016). Moreover, it keeps the bone-biomaterial interface, it displays low cytotoxic capacity and good fluidity, which make it easier to insert in the spot to be used (SILVA *et al*., 2017).

DISCUSSION

The root perforation prognosis is affected by the chemical and physical properties of the materials used, independent of etiology or placement, the endodontic therapy ought to be performed with materials that display good characteristics (COSME-SILVA *et al*., 2016; DEEPTHI *et al*., 2018). Azim *et al*. (2014), Jeevani *et al*. (2014), Apostolska *et al*. (2017), Lagisetti *et al*. (2018) and Singla *et al*. (2018) claimed that the perforations should be handled promptly with biocompatible material which generates suitable sealing between the perforation and the adjacent tissues. Ramazani and Sadeghi (2016) after assessing the sealing capacity of MTA and Biodentine declared that there are no considerable differences between the materials, advising for the use of Biodentine like an alternative to MTA in the perforation's repair. Silva *et al*. (2017) noticed that the MTA displayed better sealing in comparison to Biodentine. Bampa *et al*. (2015) assessed the MTA's ability of sealing using three different insertion techniques. The study enabled the observation that irrespective of the technique used it was not possible to prevent the infiltration. That way, they settled the requirement for more studies to be perform in order to enhance the material's sealing property in critical dental spots. Jeevani *et al*. (2014) when comparing the sealing capacity between the Biodentine and Endosequence ERRM noticed that the Endosequence ERRM had better performance. A study conducted by Lagisetti *et al*. (2018) compared the Endosequence ERRM to the MTA and settled that there are no statistical differences between them. Jeevani *et al*. (2014), Samyuktha *et al*. (2014), Taha *et al*. (2016) and Deepthi *et al*. (2018) assert that the difficulty in MTA'S manipulation is a downside of this material, though, Monteiro *et al*. (2017) described, after meeting the manufacturer's guidelines, that there was no difficulties in introducing the cement in the furcal perforation. In line with Apostolska *et al*. (2017), when comparing the MTA to the Biodentine in the furcal perforation repair, it was noticed an easier usage for Biodentine, because of the decreased prey time of almost 12 minutes which decreases the bacterial contamination risk, in addition to display an easy manipulation and being highly biocompatible, features that define it as positive material. Nevertheless, they state that there are few studies in the literature concerning their use as a repair material.

Silva *et al*. (2017) state that mineralized tissue formation at the spot where the perforation happened is a key indicator regarding the treatment's success. Rifaey *et al*. (2016) by provided the osteogenic potential between the ERRM and the MTA, settled that the ERRM promoted better osteoblasts differentiation. Silva *et al*. (2017) noticed that the MTA led to the formation of mineralized tissue with larger thickness and area, in comparison to Biodentine. Nevertheless, Biodentine exhibited good histopathologic outcomes and may be taken as a repair material. Calcium silicate-based materials can have their physical and chemical properties changed when exposed to acidic pH, mainly when local acidosis is prompted by tissue or bacterial inflammation. Wang *et al*. (2015) evidenced a decrease in the microhardness of the Endosequence ERRM and MTA in acid evironment. Deepthi *et al*. (2018) conducted an in vitro study in which was noticed that MTA and Endosequence ERRM microhardness and microstructure were strongly changed in acidic environment in comparison to Biodentine, decreasing adhesion to the dentin, material's hardness and sealing capacity. Mancino *et al*. (2018) claimed that Biodentine offers effective sealing when used in an acid environment. The dental perforation placement is a relevant factor in the perforation prognosis (MANCINO *et al*., 2018). Azim *et al*. (2014) and Lagisetti *et al*. (2018) affirmed that the closer to the oral cavity, harshest the prognosis is because of the bacterial contamination arising from the oral environment. In a case report mentioned by Kaushik *et al*. (2014), Biodentine was the chosen material to a perforation's repair situated at the cement-enamel junction due to mechanical properties, short prey time and excellent sealing, after 6 months of follow-up, the patient reported favorable outcomes in the healing of periodontal tissues. However, as a result of the absence of scientific evidence, further studies are required in order to highlight their characteristics over other materials.

In accordance with Azim *et al*. (2014) the coronary situated perforations display unfavorable prognosis, with the furcal perforation as the worst prognosis when compared to the other spots. Alsulaimani (2018) states that the furcal perforation is a serious issue in dental practice, being taken as a challenging accident. Jeevani *et al*. (2014), Lagisetti *et al*. (2018) and Monteiro *et al*. (2018) agree that the prognosis of the furcal perforation is questionable, due to the area displaying smaller dental structure, in addition to being close to the gingival sulcus and for that reason, it is taken as a "danger zone."

Alsulaimani (2018) asserts that the size of dental perforation is directly associated with the trauma that can cause to the adjacent tissues, negatively impacting on the prognosis, the smaller the perforation is, the smaller the trauma will be and with easier repair as well. After conducting a study, Alsulaimani (2018) settled that the periodontal tissues displayed a more favorable response to the MTA when it was put in smaller perforations, the greater the perforation was, the more critical the treatment would be. With the goal of promoting the recovery of the dental element affected by the perforation, the material of choice must encourage the repair and should be biologically neutral (TAHA *et al*., 2016). So toxic materials and pulp tissues ought to be spared (SAMYUKTHA *et al*., 2014). When assessing the cytotoxic effect of MTA, ERRM and Biodentine to the periodontal ligament fibroblasts, Samyuktha *et al*. (2014) established that there was not noticed any statistical difference between the 3 materials. Taha *et al*. (2016) when assessing the MTA and ERRM biocompatibility in the connective tissue of rats determined that the ERRM was comparatively more irritating, displaying higher biocompatibility after 6 weeks of usage.

Conclusion

Through the current paper, it may be noticed that there is still no consensus in the literature concerning the most appropriate material to be employed in the root perforation therapy, once among the materials studied none displayed all the desired properties higher than the others. However, the MTA because of the longer time in the market, reports more studies, while the ERRM and Biodentine were recently released, so they did not exhibit long-term studies. For that matter, it is relevant the implementation of research which have as purpose to report using scientific evidence, the behavior of the materials available for the practice.

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