INFLUENCE OF HEAT ON PHYSICOCHEMICAL AND BIOLOGICAL PROPERTIES OF CALCIUM SILICATE-BASED SEALERS.

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1. INTRODUCTION

Endodontic sealers have been improved to acquire properties that meet the criteria for proper root canal treatment. New characteristics have been added to the sealers, such as hydraulic ability, which enables better flow into the dentinal tubules, promotion of adhesion to root dentin through the formation of hydroxyapatite as a by-product of its setting reaction and reduction of shrinkage, preventing microleakage (CHOPRA; DAVIS; BAYSAN, 2021).

Calcium Silicate-Based (CSB) sealers also brought innovation in the form of presentation by enabling the premixed form, which is more homogeneous and can be administered directly into the root canal, reducing the clinical time (CANDEIRO et al., 2012; DONNERMEYER et al., 2021; YAMAUCHI, 2020; ZHOU et al., 2013). The technique idealized for obturation with these sealers was the single cone technique because it promotes hydraulic action by spreading the cement inside the dentinal tubules, increasing the flow (SFEIR et al., 2021). However, thermoplastic gutta-percha techniques, such as WVC, are still commonly used by dentists, as indicated by a study that found 40% of its use among clinicians, once it can promote better adaptation of gutta-percha to canal walls in root systems with complex anatomy (GUIVARC'H et al., 2020).

In this context, it has been reported that heat can significantly affect some properties of sealers, such as setting time, flow, and film thickness, which can impair their clinical performance. To overcome this adversity, some CSB sealers have developed a high flow version, which is designed for use with warm filling techniques, increasing the flowability (CHEN, B. W. et al., 2020; HADIS; CAMILLERI, 2020; YAMAUCHI, S., 2021). Thus, the aim of this scoping review is to evaluate the influence of heating on the properties of CSB endodontic sealers.

2. METHODOLOGY

2.1. Protocol and report

The protocol of this review was registered in the International Prospective Register of Systematic Reviews (PROSPERO, Number?????), and the study is reported according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist was used as a reference for this review.

2.2. Search strategy and eligibility criteria

Study eligibility was according to the fulfillment of the following PICOS question: Population: calcium silicate-based endodontic sealers; Intervention: Heat application to calcium silicate-based endodontic sealers; Comparison: Performance of calcium silicate-based and others endodontic sealers; Outcome: Physicochemical and biological properties of calcium silicate-based sealers according to ISO 6876 tests; Study design: Clinical and in vitro studies. A customized search strategy was realized on June 30, 2023, for each of the

electronic databases.

2.3. Study selection and data analysis

References were managed using Rayyan™ online program. Studies were selected for posterior full text reading. Two authors, independently, reviewed all full texts and extracted data from the included studies. The following data were recorded and analyzed qualitatively: study characteristics (year, author, country of publication), results of setting time, flow and film thickness according to ISO 6876.

3. RESULTS AND DISCUSSION

The search resulted in 3.774 references identified across the electronic databases. After final screening, 18 articles were included in the review. Most studies have analyzed sealers according to the physicochemical properties listed in ISO 6876, among them the most cited were setting time, flow and film thickness (Fig 1). The analyzed sealers belong to the resin group, zinc oxide and eugenol and calcium silicate-based (Fig 2). All studies showed that the application of heat caused changes in the setting time of practically all sealers studied. When subjected to this high temperature, most sealers undergo some changes in their physical properties. Regarding the setting time, while the resins sealers showed a time decrease in the presence of heat, the calcium silicate-based ones had a time increase in the setting process. The AH Plus® sealer showed great variation in the final setting time after heating, accelerating the process and decreasing on average more than half of its time (AKSEL et al., 2021; CAMILLERI, J, 2015; HERAN et al., 2019; MANN et al., 2022; VIAPIANA et al., 2014; YAMAUCHI, S., 2021). In contrast, newer versions of CSB sealers have the opposite behavior to other sealers, achieving a prolonged setting time after the influence of heat. However, when the humidity factor was taken into account, the hiflow version of Endosequence® sealer had a faster setting time after heating with additional humidity. Calcium silicate sealers tested showed no statistically significant changes in their initial and final setting times after heat application at 100ºC for 1 minute (CHEN, B. et al., 2020). With the exception of BioRoot™, calcium silicate sealers showed better flow when compared to resin cements upon heating in most studies. CSB sealers, despite the reduction in flow, remained within the ISO standards (CHEN, B. et al., 2020; DONNERMEYER et al., 2021). The film thickness of AH Plus® increased beyond that recommended by ISO standards (Camillere et al. 2015). Heat caused increased film thickness for BC sealer and did not affect the thickness of the hiflow version (CHEN, B. et al., 2020). There was stability of physical properties and FTIR spectra at all temperature levels, the setting reaction of calcium silicates was not influenced by heat treatment (DONNERMEYER, 2022). The temperature differences caused no apparent changes in surface texture or in all sealers (YAMAUCHI, S., 2021).

According to some studies calcium silicate-based premixed sealer formulations can be considered safe for warm root canal filling techniques, justifying the correct development for this purpose. Despite the extended setting time, the high temperatures do not affect their physicochemical structure.

On the other hand, the application of heat increased the flow in most calcium silicate sealers, especially in premixed formulations. Providing a greater spread of the sealer inside the dentinal tubules, favoring the quality of the endodontic obturation (AKSEL et al., 2021; DONNERMEYER et al., 2021). A possible justification for the different behavior of the premixed formulations is the timing of water absorption and the onset of the setting reaction. Mass loss was recorded after thermal treatment, indicating evaporation of the contained water. As premixed sealers do not contain

water in their formulation, such effects are not possible. Water absorption from surrounding structures occurs clinically after the thermal process (DONNERMEYER, 2021). Regarding the solubility of sealers, studies have shown high rates for calcium silicate-based sealers, both immersed in distilled water and phosphate-buffered saline, especially in the first 24h. However, it showed high release of calcium hydroxide leading to hydroxyapatite formation after contact with body fluid, boosting bone repair and plays a role in eradicating microorganisms still present after chemo-mechanical preparation of the infected root canal system. Thus, a calcium hydroxide replacement can be considered beneficial and compensate for disadvantages such as high initial solubility. (DONNERMEYER, 2022)

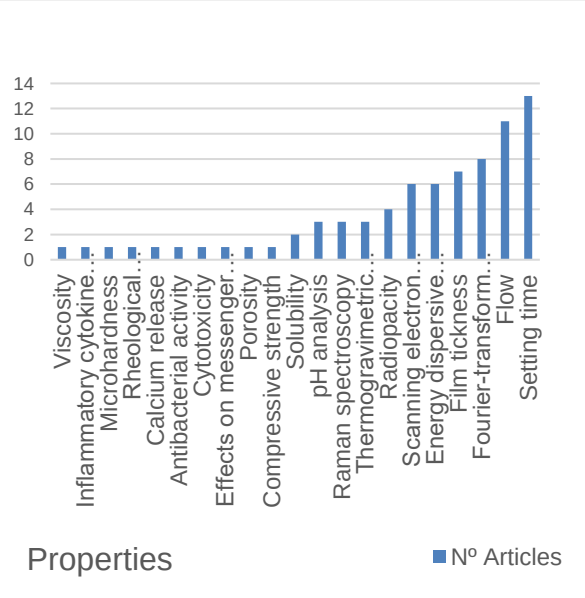

Figure 1 - Properties tested according to the number of occurrences in articles.

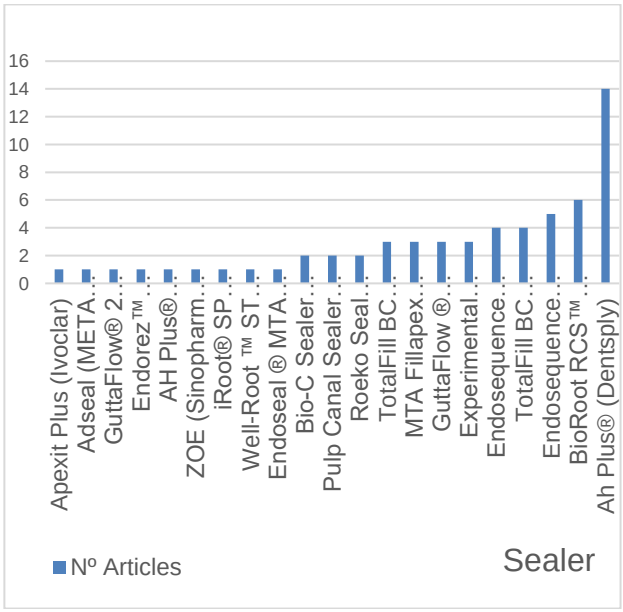

Figure 2 - Sealers (commercial brands) according to the appearance in the experiments.

4. CONCLUSIONS

Healing endodontic calcium-silicate based sealers accelerated setting time, decreased flow and increased film thickness. However, the extent of these changes in physical properties varied across products and can negatively affect the quality of the root canal filling when used with the warm vertical condensation technique.

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