

Evaluation of Postoperative Pain after Using Bioceramic Materials as Endodontic Sealers

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Abstract

Purpose: The purpose was to evaluate the postoperative pain after using a bioceramic material as an endodontic sealer with single cone technique, and compare the results with a resin endodontic sealer with the cold lateral condensation technique, and the continuous wave of condensation.

Methods: 30 patients were divided randomly for each group of obturation system: Bioceramic + single cone technique, resin sealer + cold lateral condensation and resin sealer (AH Plus, Dentsply) + continuous wave of condensation. A VAS form evaluated pain, during the 7 days post-treatment. Results: Single cone + Bioceramic referred post-operative pain more frequently than Continuous wave + resin sealer or Lateral condensation + resin sealer. Single cone + Bioceramic also presented the highest percentage of moderate post-operative pain intensity felt during the 7 day evaluation period.

Conclusions: More studies with a larger sample are needed to obtain more conclusive results.

Keywords: Bioceramic; Postoperative; Pain; Root Canal

Abbreviation

VAS: Visual Analogue Scale

Introduction

Pain is an unwanted but common sensation after root canal treatment. There are several factors that can lead to postoperative pain, such as the technique and the obturation material [1].

The aim of this study is to evaluate the postoperative pain after one-visit or two-visit root canal treatment (RCT) on teeth with asymptomatic irreversible pulpitis, pulp necrosis or that needed retreatment using two different endodontic sealers bioceramic (BioRoot RCS, Septodont) and resin sealer (AH Plus, Dentsplay), and applying three different obturation techniques: single cone technique for bioceramic, and lateral condensation and the continuous wave of condensation for the resin sealer.

Materials and Methods

A convenience sample of 30 patients were divided randomly in 10 patients for each group of obturation system: Bioceramic (BioRoot RCS)+ single cone technique, resin sealer (AH Plus, Dentsplay)+ cold lateral condensation and resin sealer (AH Plus, Dentsplay) + continuous wave of condensation. Root canal treatment was carried out by students from the Faculty of Dental Medicine from the University of Lisbon. Teeth were cleaned, shaped, and obturated during the patients' first visit or only obturated on the second visit, when possible. The local anesthesia was achieved by local infiltration with 4% articaine with 1:100 000 epinephrine (Laboratories Inibsa, Barcelona, Spain). After anesthesia, an endodontic access cavity was established by using round diamond burs and Endo Z burs (Dentsply International, York, PA). The rubber dam was applied in all patients for isolation. A resin barrier (Opal Dam®) was used when needed. The working length was determined using an electronic apex locator (Dentaport ZX, Morita, Tokyo, Japan) and periapical radiographs and measured in the computer. Canals were prepared using hand instrumentation till the working length was achieved with 20 K-Flexofiles (Dentsply Maillefer, Ballaigues, Switzerland). A glide path was established with stainless steel hand instruments up to a size #10. The irrigants used were sodium hypochlorite (NaOCl) 2,5% (not less than 10 ml per canal), and citric acid 10% was used in the end with the final cone

following the manual activation technique during 1 minute and then was aspirated and cleaned with NaOCl. Then ProTaper Next engine-driven rotary nickel-titanium files (Dentsply Maillefer, Ballaigues, Switzerland) were used following the manufacturer's instruction to prepare the canal. Glyde™ file root canal conditioner (Dentsply Maillefer) was used as a lubricant. Bioceramic (BioRoot RCS, Septodont) using single cone technique, was applied with a single final ISO gutta-percha points for obturation in a randomized selected group.

The rest of the sample was obturated with resin sealer (AH Plus, Dentsplay), applying the cold lateral condensation with ISO gutta-percha points and accessory points, or applying the continuous wave of condensation (B&L Biotech). The teeth were restored with temporary restorative material, Cavit™ (3M ESPE).

Pain/discomfort assessment

At the end of the visit, all patients were given a modified VAS form to take home, on which they were requested to rate their pain at 24h, 48h, 72h, 96h, 120h, 144h and 168h post-treatment. If they didn't return to another appointment, the results of the VAS scale were asked by phone.

When the completed forms were returned, the scores for postoperative pain were recorded as numerical values between 0 and 10, and converted to a verbal scale: "no pain", "slight pain", "moderate pain", and "severe pain". Pain intensity was defined as follows: no pain (0); slight pain (0.1 - 2.9): mild discomfort that did not require analgesics; moderate pain (3 - 7.9), which was relieved with analgesics; and severe pain (8 - 10), pain that was not relieved by analgesics. Although none of the patients was prescribed medication after treatment, each was provided with written information about the possible development of pain. The recommended medication for pain control, if required, was ibuprofen 600 mg if needed.

Postoperative pain was assessed as an ordinal variable in two ways: the highest pain intensity recorded during the 7 days post-treatment and daily pain intensity.

Statistical Analysis

Descriptive data were reported as percentage and count of subjects in each group for the categorical variables and as mean and standard deviation for the variable age. The percentage and count of subjects with different highest post-operative pain intensity levels were also computed separately for each group. The respective graphic representations were computed as well, in addition to those representing the highest post-operative pain intensity by day; and highest post-operative pain intensity by day and obturation system.

Differences in the highest post-operative pain intensity between groups were analyzed using K-Sample Median test. Kruskal-Wallis test was alternatively used if the independent variable had more than two categories, as well as to compare obturation system outcome by day. Finally, differences in post-operative pain between Day 1 and subsequent days were also analyzed using K-Sample Median test and Bonferroni correction for multiple comparisons. All statistical analysis was performed using SPSS 23 (IBM) with the level of statistical significance set at 0.05.

Results and Discussion

Statistical analyses

A higher percentage of male patients felt post-operative pain when compared to female patients (41.2%, n = 7 vs. 23.1%, n = 3) and that the highest pain intensity felt during the 7 day evaluation was more frequently classified as slight pain, both in males (29.4%, n = 5) and females (15.4%, n = 2). However, comparison between genders revealed no statistically significant differences for highest pain intensity felt during the 7 day evaluation period.

Regarding age group, only 26.7% of the oldest patients (n = 4) felt post-operative pain, a low percentage when compared to 40% of the youngest patients (n = 6). The highest pain intensity felt during the 7 day evaluation was more frequently classified as slight pain, both for the oldest (20.0%, n = 3) and youngest patients (26.7%, n = 4). Despite apparent differences, comparison between age groups revealed no statistically significant differences for highest pain intensity felt during the 7 day evaluation period.

When considering tooth location, post-operative pain was felt by 33.3% (n = 10) of patients, in both categories. Although patients who treated teeth localized in the mandible showed a higher percentage of moderate pain (13.3% vs. 6.67%), it was due to a 1 patient difference between categories (n = 2 vs. n = 1) and, as such, no statistically significant differences were found between tooth location regarding the highest pain intensity felt during the 7 day evaluation period.

Regarding tooth type, post-operative pain was felt more frequently after root canal treatment of posterior teeth, when compared to anterior teeth (36.4%, n = 8 vs. 25%, n = 2).

Patients who treated posterior teeth were also the only to classify the highest pain intensity they felt as moderate (13.6%, n = 3). Even so, comparisons between tooth type groups did not reveal any statistically significant differences regarding the highest pain intensity felt during the 7 day evaluation period.

Considering single canal and multiple canal teeth, those in the latter category presented post-operative pain more frequently (40%, n = 6 vs. 26.7%, n = 4). The highest pain intensity felt during the 7 day evaluation was more frequently classified as slight pain, both in patients who treated single canal (20%, n = 3) and multiple canal teeth (26.7%, n = 4). However, comparison between single and multiple canal groups revealed no statistically significant differences for highest pain intensity felt during the 7 day evaluation period.

Patients who were submitted to root canal treatment in the present study and had a previous pulp diagnosis of irreversible pulpitis referred post-operative pain more frequently (40%, n = 2) than those who were submitted to retreatment (33.3%, n = 5) or those with pulp necrosis (30%, n = 3). Even though the irreversible pulpitis category revealed the highest percentage of moderate pain between groups (20%, n = 1 vs. 10%, n = 1 for necrosis and vs. 6.7%, n = 1 for retreatment), this was due to only 1 patient. Comparisons between pulp diagnosis groups also did not reveal any statistically significant differences regarding the highest pain intensity felt during the 7 day evaluation period.

When considering presence of radiolucency, post-operative pain was more frequent when no radiolucent image was present before treatment (34.7%, n = 8 vs. 28.6%, n = 2). This category was also the only to present moderate pain intensity as the highest pain intensity felt during the 7 day evaluation period (1%, n = 3). Despite apparent differences, comparison between presence or absence of previous radiolucency revealed no statistically significant differences for highest pain intensity felt during the 7 day evaluation period.

When it came to session type, patients referred post-operative pain more frequently after a one session root canal treatment (57.1% n = 4), when compared to multiple session treatment (26.1%, n = 6).

The highest pain intensity felt during the 7 day evaluation was more frequently classified as slight pain, both in single session (42.9%, n = 3) and multiple session treatment (17.4%, n = 4). Comparisons between session type groups also did not reveal any statistically significant differences regarding the highest pain intensity felt during the 7 day evaluation period.

Regarding only the highest pain intensity felt by each patient during the whole evaluation period, patients who were submitted to root canal treatment with the Single cone + bioceramic (BioRoot RCS, Septodont) referred post-operative pain more frequently (50%, n = 5) than those who were submitted to Continuous wave + resin sealer (AH Plus, Dentsplay) (30%, n = 4) or Lateral condensation + resin sealer (AH Plus, Dentsplay) (20%, n = 2) obturation systems (Figure 1). Patients who underwent Single cone + bioceramic (BioRoot RCS, Septodont) also presented moderate pain intensity as the highest felt during the 7 day evaluation period (20%, n = 2 vs. 10%, n = 1 for Lateral condensation and 0% for Continuous wave).

Even though, patients who underwent Lateral condensation + resin sealer (AH Plus, Dentsplay) presented post-operative pain frequency less frequently, those who submitted to Continuous wave + resin sealer (AH Plus, Dentsplay) revealed only a slight level of pain regarding the highest pain intensity felt during the 7 day evaluation period.

As illustrated by figure 2, the presence and intensity of pain showed a tendency to decrease over the 7 day evaluation period. On Day 1, 66.7% of the patients (n = 20) did not refer any pain, 23.3% (n = 7) referred slight pain and the remaining 10% (n = 3) referred moderate pain intensity. By Day 3 no patient referred moderate pain intensity and by Day 6 no patient referred any pain whatsoever.

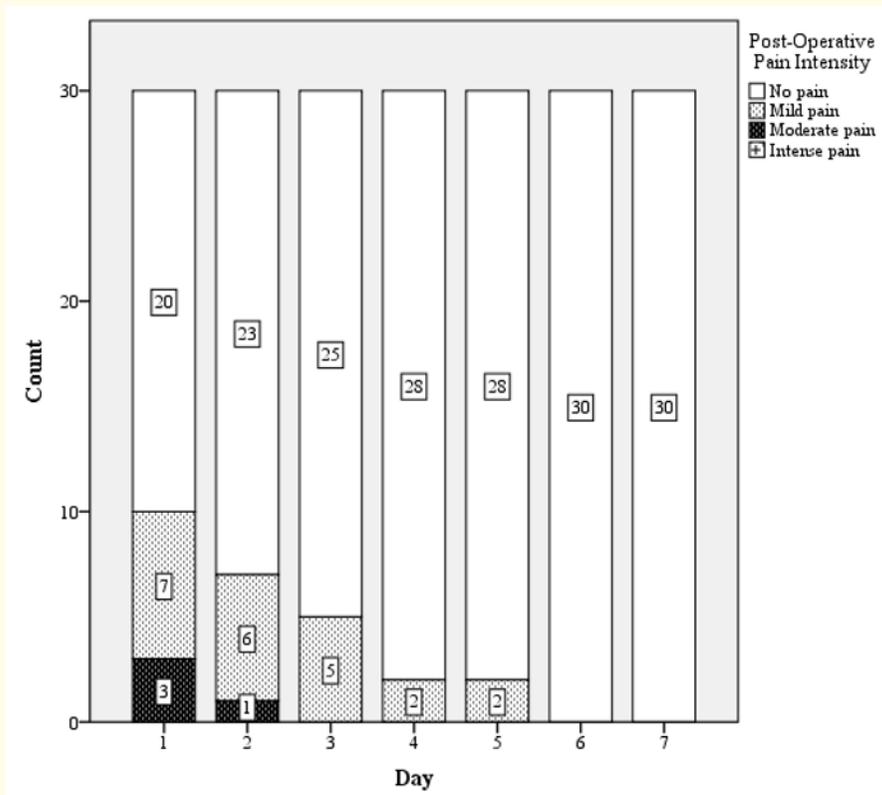


Figure 1: Graphic representation of the post-operative pain intensity (defined as the highest intensity of pain felt in the 7 day evaluation period) distribution by each day of the evaluation period.

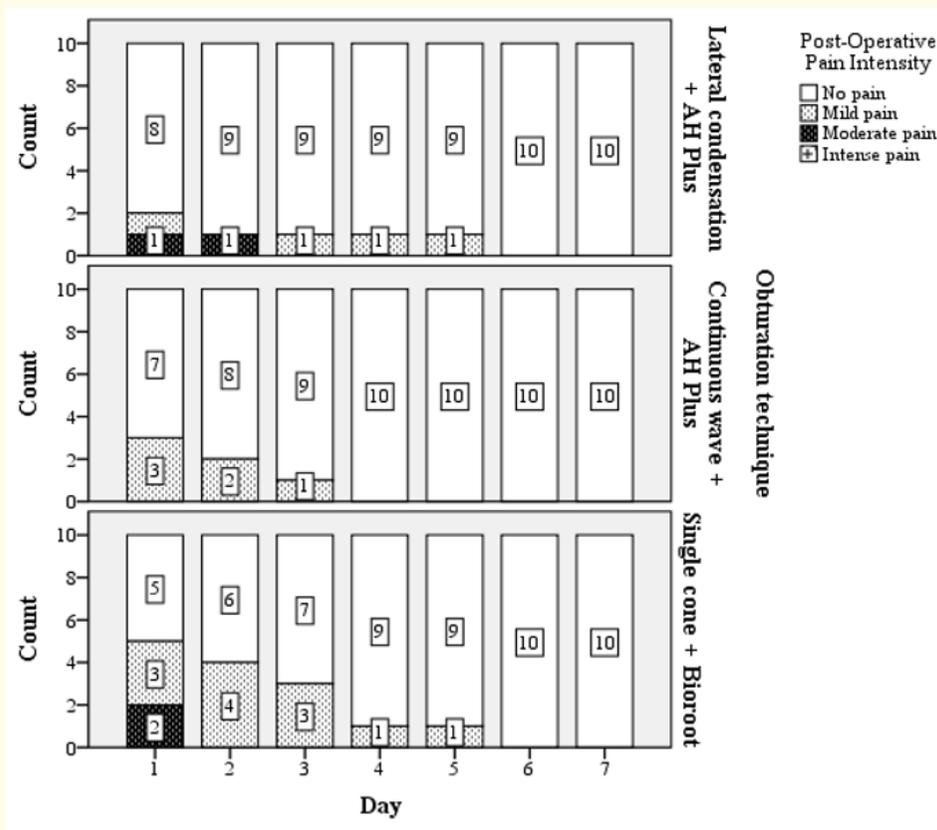


Figure 2: Graphic representation of the post-operative pain intensity (defined as the highest intensity of pain felt in the 7 day evaluation period) distribution by each day of the evaluation period and by obturation system.

Regarding figure 3, the presence and intensity of pain showed a tendency to decrease over the 7 day evaluation period, regardless of obturation system. However, on Day 1, a greater number of patients who did not refer any post-operative pain underwent root canal treatment with Lateral condensation + AH Plus system, when compared to the remaining systems (80%, n = 8 vs. 70%, n = 7 for Continuous wave + AH Plus system and vs. 50% for Single cone + BioRoot™ system). On Day 1, the majority of patients who referred pain classified it as slight, except for those who underwent Lateral condensation + AH Plus system, where slight and moderate pain percentages were equal (50%, n = 1).

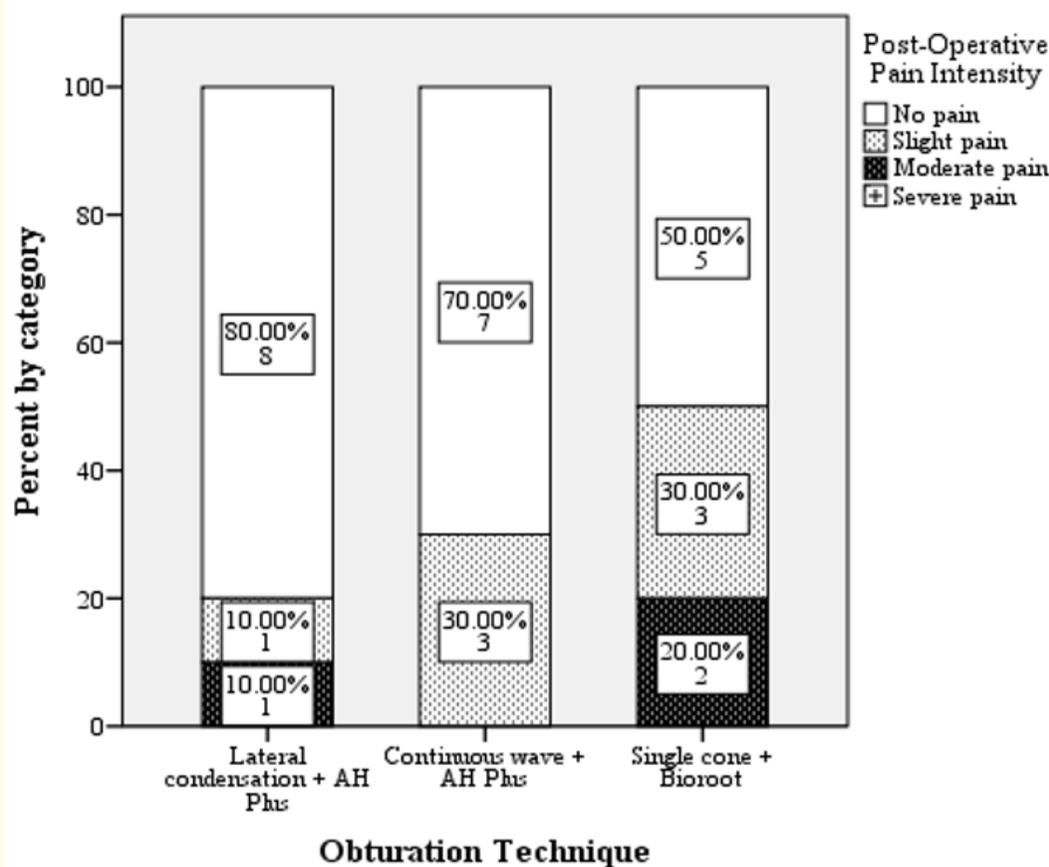


Figure 3: Graphic representation of the post-operative pain intensity (defined as the highest intensity of pain felt in the 7 day evaluation period) distribution by obturation system.

On the other hand, patients who underwent Continuous wave + AH Plus system referred no pain whatsoever by Day 4, unlike the remaining systems, where patients only stopped referring pain by Day 6.

Finally, comparisons between the three obturation systems - meaning overall or between both cold obturation systems - also did not reveal any statistically significant differences regarding the highest pain intensity felt during the 7 day evaluation period. There were statistically significant differences in post-operative pain intensity only between Day 1 and Day 6 and between Day 1 and Day 7 (p = 0.002).

Considering the results, regardless of obturation system, statistically significant pain intensity decrease was, therefore, only seen 5 days after root canal treatment.

Discussion

Factors contributing to postoperative endodontic pain are many, and identifying these factors is critical to minimizing pain experienced by patients between appointments or after treatment.

Although the accurate classification of pain is essential, pain is a subjective feeling, which makes the precise definition of different discomfort categories and detailed description of pain difficult [2,3]. For this reason, the intensity of discomfort experienced by the patients was measured using the verbal and visual descriptors as well as the scale ranged from 0 to 10. It is well known that pain perception is highly subjective and influenced by many factors, and the most effective method of pain evaluation is self-evaluation. Thus, results were based upon the patient's report of post-obturation pain. In the present study, when performing the VAS scale result analysis, pain was taken into account as a categorical variable instead of a continuous variable, since some of the patients were asked the results of postoperative pain by phone and also due to the fact that has also been classified in this manner in other publications.

In this study we wanted to present the results of different obturation materials applying the cold technique. The fact that with AH Plus was applied with the lateral condensation technique comparing to the BioRoot, where the single cone technique was used, can be a limitation in our study, which does not permit the comparison of our results. Different techniques were selected because the best procedure was applied for each material. The bacterial penetration in the single-cone technique was observed by some authors [4-6].

This technique has been considered less effective in sealing root canal because of the greater volume of cement that can be expected in the absence of condensation and of the possible anatomic variations of the root canal, which cannot always be filled with larger master cones corresponding to the geometry of the NiTi rotary instruments [4].

Porosities in large volumes, contraction, cement dissolution and a lower adaptation of the single cone in the middle and coronal thirds of the canal with irregular shape are the main disadvantages of this technique [7]. Pereira, et al. concluded that the single cone technique has similar or lower results than the lateral and vertical condensation technique when a resin sealer is applied, regarding aspects such as obturation quality, marginal infiltration and bacterial penetration [8]. Pommel and Camps compared the single-cone, lateral condensation, Thermafil and System B techniques and reported that the single-cone technique showed the highest infiltration, similarly to the results found by Yücel and Çiftçi [6,9]. In cases of curved canals, the single-cone technique would probably exhibit the greatest deficiencies compared with the lateral condensation, when using resin cement [10].

In case of bioceramics, due to its wettability and viscosity, the bioceramic could spread into any root canal irregularity and non-instrumented space. Considering this material not as a sealer but as a filling material, the single cone technique is the most suitable procedure. The single gutta cone has the function of delivering the sealer inside the canal, and simplifies the procedure in case of retreatment, since the gutta-percha will be easier to remove.

Another fact that should be discussed when comparing both cold techniques is that single cone technique speeds the root canal filling while minimizing the pressure applied to the root canal walls [8]. The pressure applied with the lateral condensation could be considered a possible factor that could cause pain after treatment, nevertheless, there's no evidence that compares the post-obturation pain after using both techniques.

Due to the fact that lateral compaction applied with resin sealers offers some disadvantages such as time consuming obturation [11], lack of homogeneity with spaces formed between cones [12] and poorly adaptation to the canal walls [13], several variations have been developed. The continuous wave of condensation technique, developed by Buchanan, serves as a hybrid of the cold lateral and warm vertical techniques [14]. The continuous wave of condensation technique involves placing a single master cone and applying the System B Heat source (Analytic Richmond, WA) at 200°C to a depth 3 mm short of working length. The canal is then backfilled with warm gutta-percha with an increment of up to 10 mm in depth [15]. The continuous wave of condensation is less time consuming, provides less microbial coronal leakage [16] and better adapts to grooves and depressions of the canal walls and lateral canals than lateral compaction [17,18]. The seal of the root canal obturation can be improved when using the warm vertical compaction technique.

However, the properties of resin based sealers, like AH Plus, are modified when heated. AH Plus loses the amine groups with the application of heat. These amine groups are setting initiators and are necessary for the polymerization reaction to occur. Camilleri reported in her study that the setting time of AH Plus was reduced considerably, and the film thickness increased when heat was applied. The heat accelerated the setting reaction, which led to an increase in the film thickness of the sealer. Nevertheless, Camilleri also concluded that the use of tricalcium silicate-based sealer, such as bioceramics, is recommended for obturations using cold gutta-percha. This sealer exhibits the formation of calcium hydroxide on hydration and thus would potentially promote bioactivity and adhesion to the canal wall through mineral tags [19].

It is also said that lateral condensation and warm vertical compaction have more probability of apical extrusion of the gutta-percha [8]. Such event has been correlated with increased postoperative discomfort and persistent pain states. In the present study, all cases of apical extrusion were excluded, and those who submitted to Continuous wave + AH Plus revealed the least levels of pain regarding the highest pain intensity felt during the 7 day evaluation period.

Ruparel, *et al.* demonstrated in their study that AH Plus in the fresh form evoke greater calcitonin gene-related peptide (CGRP), a potent modulator of neurogenic inflammation, can lead to pain. Conversely, the group of bioceramics reduced basal CGRP release [20]. AH Plus increases the expression of proinflammatory cytokines such as interleukin 6 and interleukin 8 [21] and decreases mitochondrial activity [22]. Although it is unknown which compound in AH Plus is the causative element, it will be fair to assume that it is a combination of various compounds present in the epoxide and the amine paste that together produce proinflammatory changes [20].

In this clinical trial there's a greater number of patients who did not refer any post-operative pain underwent root canal treatment on Day 1 with Lateral condensation + resin sealer (AH Plus, Dentsplay) system, when compared to the remaining systems. On the other hand, patients who underwent Continuous wave + resin sealer (AH Plus, Dentsplay) system referred no pain whatsoever by Day 4, unlike the remaining systems, where patients only stopped referring pain by Day 6. However, patients who were submitted to root canal treatment with the Single cone + bioceramic (BioRoot RCS, Septodont) system referred post-operative pain more frequently. Single cone + bioceramic (BioRoot RCS, Septodont) also presented the highest percentage of moderate post-operative pain intensity felt during the 7 day evaluation period. Nevertheless, comparisons between the three obturation systems - meaning overall or between both cold obturation systems - also did not reveal any statistically significant differences regarding the highest pain intensity felt during the 7 day evaluation period or pain intensity by day.

In the present study, patients were classified in single or multiple visit endodontic treatment, where the instrumentation was made in a different appointment from the obturation in case of multiple visit treatment. Manfredi, *et al.* concluded that there is no evidence to suggest that one treatment regimen (single-visit or multiple-visit root canal treatment RCT) is better than the other. Neither can prevent all short- and long-term complications. On the basis of the available moderate-quality evidence, it seems likely that the benefit of a single-visit treatment, in terms of time and convenience, for both patient and dentist, has the cost of a higher frequency of late postoperative pain (and as a consequence, painkiller use) [23]. Sathorn, *et al.* also concluded that there's lack of evidence indicating a significantly different prevalence postoperative pain of either single or multiple-visit root canal treatment [24]. However, although in this study the split of the instrumentation and the obturation appointment was tried, in order to avoid this confounding effect, comparisons between session type groups also did not reveal any statistically significant differences regarding the highest pain intensity felt during the 7 day evaluation period.

In this study, the root canals were prepared with Ni-Ti rotatory files. Arias, *et al.* in their prospective in vivo study suggested that a higher incidence of postoperative pain should be expected after manual root canal preparation [25]. The instrumentation that uses rotation seems to reduce significantly the amount of debris extruded apically when compared with the manual system (Reddy and Hicks, 1998) and bacteria [26] which may worsen the inflammatory response and result in peri-radicular inflammation, a lower incidence of postoperative pain should be expected.

Although in this study it was considered that the entire treatment was performed by a single operator in order to reduce the bias, the fact that operators were not clinicians at a private practice limited to endodontics can be considered a limitation because they had less experience.

Other factors have been considerate in the evaluation of postoperative pain, such as the gender, the age of the patient, the location of the tooth, the number of root canals, pulpal status, presence of radiographic periapical radiolucency, and need of medication after treatment. The comparison between these factors revealed no statistically significant differences for higher pain intensity felt during the 7 day evaluation period.

In order to take into account, the effect of obturation system and the other independent variables simultaneously, regression analysis would be a more adequate alternative for the statistical analysis. Although this would require a much larger sample, any possible interaction and/or confounding effect could then be measured.

Conclusion

In conclusion, within the limitations of the current clinical study, according the highest post-operative pain intensity, Single cone + bioceramic (BioRoot RCS, Septodont) presented the highest percentage of moderate post-operative pain intensity felt during the 7 day evaluation period and Continuous wave + resin sealer (AH Plus, Dentsplay) revealed the least levels of pain regarding the highest pain intensity felt during the 7 day evaluation period.

According to pain intensity by day, patients who were submitted to root canal treatment with the Single cone + bioceramic (BioRoot, Septodont) system referred post-operative pain more frequently. Continuous wave + resin sealer (AH Plus, Dentsplay) system referred no pain whatsoever by Day 4, unlike the remaining systems, where patients only stopped referring pain by Day 6. Nevertheless, comparisons between the three obturation systems - meaning overall or between both cold obturation systems - also did not reveal any statistically significant differences regarding the highest pain intensity felt during the 7 day evaluation period or pain intensity by day. Conforming to the present results, both null hypotheses are accepted.

Although it was not the purpose of our study, comparing the cold and warm techniques, this clinical trial suggests that patients submitted to root canal treatment with Continuous wave + resin sealer (AH Plus, Dentsplay) revealed the least levels of pain regarding the highest pain intensity felt during the 7 day evaluation period.

More studies with a larger sample are needed to obtain more conclusive results.

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Conflict of Interest

There is any financial interest associated to this article.

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