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Literature Review Article

Removal of filling material in endodontic retreatment: a literature review

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Abstract

Introduction: Removal of filling material from the root canal system is required when a previous endodontic treatment fails, what may result in the permanence of an unfavorable periapical condition. The intent is to completely remove the filling material from the root canal to achieve sufficient cleaning and shaping for successful retreatment. **Objective:** The aims of this article were to provide a systematic review of the different techniques of endodontic filling material associated or not with organic solvents and to analyze them critically in terms of advantages and disadvantages of each technique. **Literature review:** The descriptors used were "gutta-percha", "obturation," and "retreatment" in the following databases: PubMed, MEDLINE, Latin American and Caribbean Center on Health Sciences Information (Bireme), Latin-American and Caribbean Health Sciences (Lilacs), Brazilian Dentistry Bibliography (BBO), and Scientific Electronic Library Online (SciELO). Publications of in vitro/ex vivo and in vivo experiments without language restriction between the years 2010 and 2018 were selected. **Conclusion:** None of the techniques were capable of performing complete root canal cleaning, and the manual method was so effective as the automated method, although it requires longer working time. Furthermore, although this review confirmed that the solvent action did not allow a significant improvement in the removal of the filling material, ultrasound-activated irrigation proved to be an efficient adjunctive device as it could significantly reduce the volume of intracanal residuals.

Introduction

The aim of root canal retreatment is to recover access to the apical foramen through the complete removal of the filling material to achieve sufficient cleaning and modeling of the root canal system, which provides adequate conditions for the success of the final obturation [35].

However, the remaining material in the root canal system is a constant concern since remnants of necrotic tissue and/or microorganisms may be present in gutta-percha and sealer residues impregnated inside the root canal system, which results in persistent inflammation and pain [38, 44].

Removal of the filling material can be accomplished by different techniques, such as using manual endodontic files, reciprocating and rotating nickel–titanium files, and Gates Glidden and Peeso drills. Heated instruments, ultrasound [17], and solvents may or may not be associated with this procedure [12, 20].

Hedströem files have been conventionally used for removing the filling material, which can be used alone or in combination with Gates Glidden drills, which in turn would necessitate a clinical decision of whether to use solvents or not [9]. Nevertheless, this method can be time-consuming, especially when the filling material is well condensed inside the root canal [28].

In case of gutta-percha removal, different rotary systems have been proposed as an alternative to manual instrumentation [22]. Recently, rotational and reciprocating systems have expanded the opportunities for using such techniques, thereby reducing the amount of residual filling material, to optimize clinical time [41].

Ultrasound-activated irrigators have also been used in endodontic retreatment with the aim of reducing the volume of intracanal remnants through continuous movement of the irrigation solution [43].

The objectives of this article were to review and to discuss the literature on comparative studies pertaining to manual and automated removal techniques of endodontic filling material associated or not with organic solvents and activated irrigation agents. A literature search was performed using the descriptors “gutta-percha”, “obturation” and “retreatment” in the following databases: PubMed, MEDLINE, Latin American and Caribbean Center on Health Sciences Information (Bireme), Latin-American and Caribbean Health Sciences (Lilacs), Brazilian Dentistry Bibliography (BBO), and Scientific Electronic Library Online (SciELO).

Literature review and Discussion

The removal of filling materials from the root canal system is a fundamental step for the success of endodontic retreatment and depends on several factors that influence the final quality of the procedure, such as the type of the filling material used, the removal methodology applied, and the time required for each technique to reach satisfactory results. Although several methods have been proposed over the years, further studies are required to evaluate the quality of these techniques to suggest, with scientific basis, the most efficient method for each case.

Comparison between automated systems and manual protocols

Quantity of intracanal residual filling material

One of the factors that may determine the amount of intracanal residue is the technique used to remove the endodontic filling material. When comparing manual protocols with automated devices, some studies have demonstrated that there were no significant differences between the removal methods. Based on the percentage of residues inside the canal systems, all the evaluated methods were found to be equally efficient at this point [1, 10, 11, 16, 19, 23-25].

In contrast, a recent study showed that the rotary method was more efficient than the manual one, as a significantly smaller amount of material was left inside the root canal using the former procedure [30]. Earlier researches [6, 13, 14] have also corroborated this information, which has reported the inferiority of manual techniques compared with the rotary systems. However, the use of manual methods must not be underestimated, because an earlier study had reported their better performance [47], indicating a significant difference between the use of K-file and Gates Glidden drills compared with the Mtwo rotary system. Manual instrumentation left less residual volume inside the root canals, besides showing similar efficiency in comparison to the Reciproc system.

Although studies have demonstrated that the performance of manual methods is well below compared with rotary systems, it is interesting to use manual files as an adjunct to automated systems to optimize the cleaning quality [32, 46]. The manual method has also been evaluated as a good option

for the removal of extruded material beyond the apical foramen and has been considered as one of the most effective techniques for this function, although no significant difference was found when compared with other methods [18].

Endodontic filling material removal speed

One of the purposes of motor-operated techniques is the optimization of working time. Endodontic filling material removal systems using K- or Hedströem files require more time than mechanized techniques [14, 23, 30, 32, 45]. The manual K-file protocols, even in combination with Gates Glidden drills and solvents, failed to overcome the quickness of the Reciproc, Mtwo, and ProTaper retreatment mechanized systems [47]. However, results of such previous studies are in disagreement with those reported by Medeiros *et al.* [24], who demonstrated higher speed of the manual technique of K-files in combination with Gates Glidden drills and solvents when compared with the rotating methods, both ProTaper Universal in combination with solvents and ProTaper retreatment systems. In addition, they were able to be justify that not just the manual instrument, but also the solvent and action in combination with Gates Glidden drills, favored the cutting and the reduction of resistance of the material through dissolution and friction of the drill.

Comparison of automated systems

Quantity of intracanal residual filling material

The ProTaper retreatment system has been demonstrated to be efficient in the removal of the filling material compared with other mechanized systems, exhibiting significant superiority associated with disintegration using the ProTaper R system in combination with Hedströem and solvent files compared with the Gates Glidden drill technique [43]. Similar results were observed when the ProTaper retreatment system was compared with other rotational (ProTaper conventional, Mtwo, ProTaper Next, D-Race, and Easy ProDesign Logic RT) and reciprocating (WaveOne) systems, and although no statistically significant difference was found among them, the ProTaper R system showed the best overall intracanal cleaning results [4, 29, 30, 32, 33, 46]. On the other hand, some studies have confirmed that the ProTaper R system left a greater volume of residues inside the root canals than the conventional ProTaper systems in combination with Eucaliptol, D-Race, TF Adaptative, Mtwo, ProTaper conventional, and WaveOne Gold systems [6, 8, 14, 16, 24].

In recent years, the efficiency of removal of the filling material from root canals using reciprocating systems has been frequently evaluated. In this regard, the Reciproc system has demonstrated superiority compared with the rotatory Mtwo system, with no significant difference when compared with the manual K-file and Gates Glidden drills. Thus, the reciprocal method has been considered as a better option in retreatment [47]. Similar results highlighting the positive performance of reciprocating systems have been reported, by verifying that WaveOne and Reciproc were as efficient as ProTraper R files in cleaning the root canals, with no significant difference between the three methods, although the ProTaper system demonstrated the best results [33].

Similar conclusions were reported when Reciproc and Tru-Shape were compared, confirming that there was no difference between the two systems and both were equally efficient [48]. Furthermore, Reciproc and ProDesign retreatment systems also demonstrated similar and effective results in the removal of filling material, although the quality of the removal was increased significantly in both groups after combining with the ProDesign Logic 50.01 system [34]. Nevertheless, the Reciproc system demonstrated the least efficiency in cleaning the root canal, showing significant difference compared with the ProTaper, ProTaper retreatment, TF Adaptative, and ProTaper Next systems [8, 29]. WaveOne Gold also demonstrated poor results than the ones of ProTaper retreatment system [31].

The use of other systems such as K3 rotary files has been less frequently reported in the literature. No difference has been observed between K3 files and ProLife, GT, and ProTaper systems, and these systems were equally efficient, demonstrating significant difference only when compared with the Hero system [13]. Similar results were reported by Akpinar *et al.* [1], who showed that the difference between the K3 and R-ENDO systems was insignificant, although the amount of the residual material was found to be less using the K3 system.

Endodontic filling material removal speed

ProTaper retreatment files were specifically developed for the removal of the root canal filling material. The purpose is to facilitate the process

by reducing the working time. The ProTaper retreatment system is the most effective, being significantly faster than the rotary Mtwo systems, ProTaper Universal and solvent, D-Race, ProTaper Next, TF Adaptive, and reciprocating (WaveOne Gold and Reciproc) systems [24, 29, 31, 32, 45]. The effectiveness of this system compared with the Mtwo system has also been demonstrated in other studies, although the difference between the two was not significant, concluding that both performed satisfactorily [30]. However, the ProTaper retreatment system required more run time than the D-Race systems and the Easy ProDesign Logic; the difference between them is statistically significant [6, 30].

Combining the ProTaper retreatment system with the Universal ProTaper system (only in the apical third) increased the time required to perform the removal procedure compared to that one with treatment using only ProTaper Universal files. Nevertheless, the difference between the techniques was not significant [14]. Other methods such as those ones using Reciproc systems have also demonstrated good results in terms of working time, being faster than Mtwo and Tru-Shape [47, 48].

Combination of solvents in the removal of the filling material

Some studies have highlighted that using a solvent does not influence the cleaning quality of the root canal system as there was no significant difference between the amount of residues in the inner walls of root canals when a solvent was used [7, 19]. An earlier study has reported that the combination of eucalyptol and chloroform with the WaveOne system resulted in increase in the amount of residues compared to that one with the ProTaper system, which demonstrated reduction in the amount of residues [7]. An increasing trend of residual volume was observed when the Hedströem manual technique was combined with the solvent [2]. Regarding the SafeSider and ProTaper systems, both the techniques became slower after combining them with the solvent, although the difference was not significant [7, 19]. Furthermore, when the WaveOne system was combined with chloroform, there was significant decrease in working time, making the initial penetration of the instrument easier due to the dissolution of the sealing material [7].

Combination of irrigators with ultrasonic activation during endodontic filling material removal

Muller *et al.* [26] reported that the reduction in the residual volume inside the root canals, after the combination of irrigators with ultrasonic activation, was not significant, thereby concluding that, due to the lack of effectiveness in this method, complementation with manual files would be more recommended. However, several studies have reported that there was significant reduction in the amount of intracanal residues, with clearer root canal cleaning using ultrasound-activated irrigation, confirming it to be an interesting post-preparation strategy not only for disinfection, but also to improve the removal of the filling material, especially in complex root canals [3, 5, 34, 39].

Cleaning the root thirds after endodontic filling material removal

The residual volume of the filling material along the thirds of the root canal can vary depending on the technique, the anatomy of the canal, or even the method and the material used in the previous endodontic treatment [42]. Although the cervical third has already been indicated to present the greatest amount of residue [13, 42], in most cases it is in the root apical third that there is a greater accumulation of residuals [10, 21, 45, 46].

Other studies have shown that the cervical third was the region in which the least amount of residuals was found, and there was statistically significant difference between this region and the other two thirds in this regard [8, 14, 32, 37, 46].

Influence of the filling material

It has been demonstrated that, even with the variety of existing endodontic techniques, complete removal of the filling material inside the root canal system could never be achieved. Besides the technique, the different physicochemical properties of the filling material, such as the adhesion capacity to the dentin walls and fluidity, could influence the penetration and interfere with the removal of the residuals [36]. An earlier study compared BeeFill/AH-26, BeeFill/2 Seal, and gutta-percha/AH-26 only with the ProTaper R methods, and reported no significant difference between the amounts of intracanal residuals in the tested groups, whereas

Mtwo and Hedströem files showed divergent results depending on the filling material [45]. The performance of the ProTaper R system was also found to be constant irrespective of the filling material used, which was efficient in the removal of the Real Seal or gutta-percha/AH-26 [21], as well as in the removal of Hybrid Real Seal, EndoSequence BC Sealer, Activ GP, and AH Plus [11, 21].

Other materials used for filling the root canals are gutta-percha and AH Plus sealer, but the results related to the AH Plus sealer were not positive for easy disintegration [15, 16], as this material has a resinous base, thus allowing greater adhesion to the dentin walls and making the removal more difficult [36].

Apical morphology after endodontic filling material removal

Nica *et al.* [27] considered the ProTaper retreatment system to be efficient and safe, as it could remove 50% of residual volume from the apical third without significantly altering the characteristic anatomy of the region.

Methodology of quantitative analysis of intracanal residual material

Several imaging tests have been used to evaluate the residual volume of the filling material present in the inner walls of the root canals in the filling removal process. This is an important variable in the detection of these residues, as it can influence the findings related to the degree of cleaning of the conduits, which can in turn cause underestimation or overestimation of certain protocols.

The radiographic test has been widely used as it represents the most common technique in clinical procedures. The analysis is generally performed by taking the mesiodistal and vestibular–lingual directions and subsequently comparing the area of the remaining filling material with the total area of the filling material [4, 11, 14, 15, 23, 24, 29, 32, 42, 43]. However, because it produces a two-dimensional (2D) image, radiography may not reveal the actual amount of residues [11]. Studies have also demonstrated the limitation of the radiographic test compared with microscopic tests by indicating that it underestimated the extent of the volume of the filling material that remained adhered to the canal walls [6, 10, 19, 25]. Nevertheless, Santos *et al.* [36] did not observe significant difference between the data presented by radiography and microscopy.

Despite the good results demonstrated by microscopy, the technique also presents certain limitations, as it also does not allow three-dimensional (3D) evaluation, and part of the sample can be lost during the sectioning process [19]. Therefore, computerized microtomography can be considered as an alternative method that can overcome the limitations of 2D images, allowing 3D images of morphology and internal microstructures with high resolution, which can be analyzed at any stage of the procedure without the need for sample destruction [5, 8, 39, 48].

Conclusion

This review and discussion of the literature indicate the following aspects:

- It is not possible to completely clean the root canals in endodontic retreatment, regardless of the filling material involved and the technique used for its removal;
- Even if there is a tendency to decrease the amount of intracanal residuals using automated systems, both manual and motor-driven systems generally have similar efficiency, and a combination of the two techniques is recommended to optimize the cleaning of the root canals. However, manual systems are slower than automated systems;
- When compared with each other, both rotating and reciprocating systems demonstrate similar efficiency in root canal cleansing, although the ProTaper retreatment system excels at the speed of unsealing;
- Using solvents does not have significant influence on the cleaning of the root canals nor on the removal speed of the filling material. The combination of irrigators with ultrasonic activation is effective, which reduces the amount of the material remaining inside the root canal after its use;
- The apical third and the cervical third correspond, respectively, to the regions that present a larger and a smaller amount of the remnant filling material;
- Each filling material has properties that influence the ease of cleaning and may also interfere with the efficiency of the technique used to remove the filling material;
- Conventional radiography, although simulating the clinical reality, is not as effective as microscopy, and computerized microtomography can be used as an alternative to evaluate intracanal residual volume.

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