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Literature Review Article

Single-cone obturation technique: a literature review

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Abstract

Introduction: The technique of single-cone obturation is a technique that uses only the master cone. There have been an increase in its use, especially by employing larger cones with larger taper sizes that best match the geometry of rotary nickel-titanium systems (NiTi), not requiring the use of accessory cones, thus reducing the time spent in endodontic obturation. **Objective:** To review the literature on this technique and to compare it with other existing techniques, as well as to elucidate its advantages and disadvantages. **Literature review:** The single-cone obturation technique enables an easier and faster endodontic obturation. However, regarding to the aspects such as the obturation quality, apical microleakage and bacterial penetration, this technique is similar to or lower than others. **Conclusion:** This technique has the advantage of saving time during the filling of the root canal. However, further studies are necessary to evaluate its prognosis, especially in canals with complex anatomy.

Introduction

The goal of root canal filling is to create a three-dimensional sealing in order to prevent the recurrence of bacterial infection. By preventing the leakage between the root canal and the periapical tissues, the procedure should also prevent that any microorganism and toxic bacterial products penetrate into the periapical tissues [2].

Several obturation techniques are used for the filling of root canals: the lateral condensation, Tagger's hybrid, vertical compression, and thermoplasticized gutta-percha techniques. More recently, with the advancement of the rotary instrumentation systems, the single-cone obturation technique has been used.

This technique uses larger master cones that best match the geometry of the nickel-titanium rotary

systems (NiTi) [20]. The use of these gutta-percha points does not require either accessory points or the lateral condensation when the root canal is enlarged with rotary instruments. The technique speeds the root canal filling while minimizes the pressure applied to the root canal walls. The combination of single cone and endodontic cement results in a uniform mass which prevents failures observed among multiple cones [3]. More recently, gutta-percha points of the ProTaper system were launched into the market emphasizing that they are simpler and result in faster obturation. In this system, root canals are shaped with ProTaper instruments and filled with the gutta-percha point size matching the size of the last instrument used. Their manufacturer claims that the ProTaper gutta-percha points perfectly fit within the root canals shaped with the instruments of this system [7].

Lateral condensation and warm vertical compaction show some disadvantages, such as: lack of gutta-percha homogeneity, high percentage of endodontic cement at the apical portion of the root, poor adaptation to the root canal walls, and apical extrusion of the gutta-percha [14]. To overcome these disadvantages, the single cone technique was developed. The use of these cones with endodontic cement may promote the sealing of the root canal without the need for accessory cones; it takes less time than the lateral condensation when the root canal is enlarged with rotary instruments [14]. Because the single-cone technique is simpler than the lateral condensation, the operator is less subjected to fatigue; however, such considerations should be subordinated to the main objective of providing the best treatment for the patient [13].

The aim of this study was to review the literature on the single-cone technique and to compare it with the other techniques, as well as to elucidate its advantages and disadvantages provided to both the general dentist and the endodontist in their daily clinical practice.

Literature review

The single-cone technique was developed in the 1960s, with the standardization of the endodontic instruments and filling points. It was advocated that, after the preparation of the apical stop, a gutta-percha, silver or titanium point was selected and locked at the limit of the root canal preparation. By using a thin and uniform cement pellicle, a single point would promote the root canal sealing. However, the studies demonstrated that the cement pellicle between the point and the root canal walls allowed the leakage of the fluids from both the periradicular areas and oral environment. Consequently, the cement degradation occurred, and microorganisms were installed, leading to endodontic treatment failure [15].

The apical microleakage of the single-cone technique has been evaluated by several authors [1, 5, 7, 11, 16, 18]. By employing 24 maxillary molars, from which only the distal-buccal root was used, Damasceno *et al.* [1] evaluated *in vitro*, through diaphanization, the apical microleakage of the single-cone technique of the ProTaper system compared with TC system without master cone and together with AH Plus cement. The authors found apical microleakage in both techniques used; however, statistically significant differences were not observed between the technique and among the surfaces evaluated.

By using the single-cone and lateral condensation techniques in single-rooted teeth, Holland *et al.* [5] evaluated the influence of the type of endodontic cement and of the filling technique on the apical marginal microleakage. They found that the single-cone technique achieved the best sealing of the root canal than lateral condensation. The authors concluded that the single-cone technique showed less marginal leakage than lateral condensation technique, but it was characterized by overfilling displayed in all cases, which did not occur with the lateral condensation technique.

Inan *et al.* [7] compared the apical sealing among the single-cone Thermafil and cold lateral condensation techniques, in mandibular premolars, through fluid filtration method. The teeth were instrumented up to size F3 of the ProTaper system. They verified that, although the lateral condensation group showed a higher leakage than single-cone Thermafil techniques, this difference was not statistically significant. The authors concluded that the apical sealing through the use of the single-cone technique is comparable with both the lateral condensation and Thermafil techniques.

Pommel and Camps [11] used a fluid filtration system to compare the apical microleakage of single-rooted teeth filled with System B, technical single cone, lateral condensation, vertical condensation and Thermafil. The results of the first 24 hours demonstrated that the single-cone technique provided a greater infiltration and the results after one month showed that System B, Thermafil and the vertical condensation techniques obtained a smaller infiltration than the other two techniques: lateral condensation showed moderate apical infiltration, while the single-cone technique showed a greater infiltration.

Wu *et al.* [16] measured the long-term apical infiltration of the single-cone technique in canine teeth filled with RoekoRSA cement. The infiltration over 4 mm of the apical remnant was measured

after one week and after one year through the model of fluid filtration. The results demonstrated that the apical sealing of the roots of the canine teeth did not show any infiltration after both one week and one year. The authors concluded that in long and straight canals, the single-cone technique with RoekoRSA cement prevent the fluid transportation after one year.

Yilmaz *et al.* [18] compared the apical efficacy of the BeeFil 2in1 and SystemB/Obtura II systems with the single-cone and cold lateral compaction techniques at one and two weeks *in vitro*, by using single-rooted teeth shaped with Mtwo rotary instruments. It was observed that there were no differences in the apical sealing of the root canals filled with the techniques tested and that the teeth filled with these techniques showed higher sealing properties, however, they were not capable of completely blocking the fluid conductance.

The quality of the obturation in root canals filled with single-cone techniques was evaluated by several authors [4, 6, 8, 10, 12, 13, 17]. Gordon *et al.* [4] compared the area occupied by the gutta-percha/cement or the empty spaces in curved canals simulated in resin blocks with curvatures of 30º and 58º and in mesial-buccal canals of extracted maxillary first molars. The specimen preparation was executed by using the Profile .06 system, and the obturation techniques were: size .06 single-cone and size .02 gutta-percha points through lateral condensation. In both techniques the AH 26 cement was used and the time elapsed for each technique was measured. The authors concluded that the size .06 single-cone technique was comparable with the lateral condensation regarding to the amount of gutta-percha occupying the curved canals simulated in resin blocks with curvatures of 30º and 58º. Similar results were recorded for the mesial-buccal canals of the extracted maxillary first molars.

Through single-cone (40 canals) and lateral compaction (43 canals) with rotary instruments of NiTi and AH Plus cement, evaluation in the ortho-radial and mesial-radial radiographs, by using molars, Hörsted-Bindslev *et al.* [6] compared the quality of the root canal obturations. The authors concluded that the lateral condensation technique did not differ from the single-cone technique regarding to the radiographic quality of the obturation. In the ortho-radial radiograph, 52% of the obturation was evaluated as adequate, however, they were evaluated as insufficient in the mesial-radial radiograph. Concerning to the distal canal of the mandibular molars, roots filled inappropriately were observed in this latter technique. It could be inferred that both the lateral condensation and the single-cone technique were not adequate for some root types, particularly those of oval-shaped root canals. Ozawa *et al.* [10] evaluated oval-shaped teeth aiming to determine whether the irregular shape of canals prepared with NiTi rotary instruments could be filled more effectively with the following techniques: thermoplastic technique, single-cone technique by ProTaper system and lateral condensation technique. The authors verified that ProTaper single-cone technique was simpler and faster than the other techniques and that all the techniques studied had little impact on the obturation quality of the apical third.

By using 30 mandibular premolars shaped with Rotary instruments of the ProTaper system, Tadesmir *et al.* [13] compared the gutta-percha percentage at two apical third levels of root canals filled with the single-cone and lateral condensation techniques. Horizontal sections were cut at 2 and 4 mm short of the apical foramen of each tooth, and the image analysis was used to measure the total area of the canal and the area occupied by the gutta-percha. The results demonstrated that at 2mm level, the single-cone technique obtained a significantly higher percentage of gutta-percha than the lateral condensation technique. At the 4 mm level, the gutta-percha percentage was greater than lateral condensation, but this difference was not statistically significant. The authors concluded that the single-cone technique produced a greater percentage of gutta-percha than lateral condensation technique at 2 mm short of the apex.

Wu *et al.* [17] evaluated the obturation quality in small curved root canals by using bidirectional radiographs and the method of fluid transportation. They evaluated the single-cone and lateral condensation techniques and used either epoxy resin-based or zinc oxide-eugenol cements. The authors concluded that the obturation had similar quality in small curvatures of the root canals either using the single-cone or lateral condensation technique with epoxy resin-based cements. When the single-cone technique was used, a bidirectional spiral instrument could be used to place the cement into the straight part of the canal consequently enabling the completely filling of the space between the single cone and the root canal walls and a minimum or none infiltration would be detected.

Marciano *et al.* [8] performed a study aiming to compare the gutta-percha/cement percentage and empty spaces as well as the influence of the isthmuses in the mesial root canals of mandibular molars, through four different techniques. Sixty mesial roots of the mandibular first molars were prepared up to the size F2 of the ProTaper system and then filled through single-cone, lateral condensation, System B and Thermafil techniques. The percentage of gutta-percha, cement and empty

spaces was calculated at 2, 4 and 6 mm short of the apex. At the 2 mm level, the percentage of gutta-percha, cement and empty spaces was similar among the System B, lateral condensation and single-cone techniques. The single-cone technique revealed significantly lesser gutta-percha, more cement and empty spaces than Thermafil technique at 2 and 4 mm levels. The analysis of all sections (2, 4 and 6 mm) revealed that more gutta-percha and less cement and empty spaces were found in root canals filled with System B and Thermafil techniques. The authors concluded that the gutta-percha, cement and empty space amount is dependent on the obturation technique and the isthmus presence may influence the obturation quality.

Schäfer et al. [12] compared different obturation techniques in marked curved canals by means of percentage of the area of the filled gutta-percha and empty spaces. The time spent for the obturation and the incidence of the material extrusion were also compared. Curved root canals (curvature of 25-35°) of 48 extracted teeth were enlarged with Mtwo rotary instruments and filled as follows: group A – size 0.04/35 single-cone technique; group B – size 0.04/35 cold lateral condensation technique; group C – warm vertical compaction; group D – lateral compaction with standardization of the master gutta-percha point. In all groups, the AH Plus cements were used. The teeth were sectioned horizontally at 2, 3, 4, 6 and 8 mm short of the apex. The total area of each segment of the canal was measured, and the areas of gutta-percha, cement and empty spaces were converted into percentages of the total area. The obturation using the single-cone technique (group A) was significantly the fastest method while the warm vertical compaction (group C) required significantly more time amount than all the others techniques. No differences were obtained among the groups by means of percentage of empty spaces at any level. At all levels, the groups B, C and D significantly produced a higher percentage of areas filled with gutta-percha and smaller amount of cement than group A, and there were no differences among the groups B, C and D regarding to the areas filled with gutta-percha and cement.

The bacterial penetration in the single-cone technique was observed by some authors [9, 14, 19]. By using a model of bacterial infiltration and single-rooted teeth, Monticelli *et al.* [9] compared the apical sealing of two systems of single-cone obturation (ActiV GP and Gutta-Flow) with the vertical condensation technique and AH Plus cement. The authors concluded that both single-cone techniques did not promote a durable apical sealing compared with the bacterial infiltration. The technique of vertical condensation with thermoplasticized gutta-percha AH Plus cement seemed to be more effective in minimizing the bacterial infiltration.

Tadesmir *et al.* [14] compared the sealing capacity of the single-cone, lateral compensation and warm vertical compaction techniques with ProTaper and Mtwo systems in maxillary premolars, by using a model of bacterial infiltration with a suspension of *Enterococus faecalis*. They verified that the techniques demonstrated similar effects of sealing.

Yücel and Çiftçi [19] also compared the bacterial penetration by *Enterococus faecalis* after the obturation with the System B, lateral condensation, Thermafil, ProTaper single-cone and lateral condensation of the ProTaper gutta-percha point techniques in single-rooted teeth. The evaluation was performed after 30 and 60 days. The authors concluded that, based on this methodology, the System B and the lateral condensation of the ProTaper gutta-percha point techniques prevented the bacterial penetration into the root canal at 30 days; however, at 60 days, there were no differences among the obturation techniques.

Discussion

The single-cone technique comprises the use of a single gutta-percha point at environment temperature, with a variable cement thickness depending on the adaptation of the point to the root canal walls [2]. 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 [9]. 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 [15].

In the study of Yilmaz *et al.* [18] single-cone and lateral cold condensation techniques exhibited similar levels of fluid conductance in periods of one and two weeks in vitro and they are found to be higher than System B/Obtura II techniques. The formation of empty spaces inside the obturation while using the warm vertical compactor and the vertical contraction of the heated gutta-percha are the possible reasons for the lowest results of warm vertical compaction techniques [18]. Wu *et al.* [17] found that canals with small curvatures have similar quality obturations by using single-cone and lateral condensation techniques. In this

study, a bidirectional spiral instrument was used to place the cement, favorably placing the cement towards the lateral walls and preventing the apical extrusion. However, according to the manufacturer, it only can be employed in the straight part of the canals [16]. The single-cone technique depends on a sufficient volume of cement to be inserted into the root canal. When a either a lentulo or bidirectional spiral is used to place the cement, the space between the cone and the root canal walls is fully filled and a minimum or none infiltration is detected [17]. When the canal is filled by a single canal covered by endodontic cement or whether the cement volume inside the canal is insufficient, the single-cone technique may exhibit infiltration [9]. When a bacterial infiltration model was used, the canals filled with ProTaper single-cone technique showed a significantly higher bacterial penetration than cold lateral condensation of the ProTaper gutta-percha point, Thermafil and System B for 30 days [19]. The poor sealing observed with single-cone ProTaper gutta-percha technique may be related to the fact that the gutta-percha is not compressed, but only inserted into the working length with a large amount of cement [19]. Pommel and Camps [11] 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 [19]. On the other hand, the results of the study of Holland *et al.* [5] showed that the single cone technique exhibited a better sealing than the lateral condensation technique; however, the teeth exhibited straight and relatively large root canals. In cases of curved canals, the single-cone technique would probably exhibit the greatest deficiencies compared with the lateral condensation, especially if it is performed with the aid of NiTi spacers [5]. Tasdemir *et al.* [14], by comparing the sealing capacity of the single-cone, lateral condensation and warm vertical compaction techniques with two instrumentation systems through a model of bacterial infiltration and concluded that the techniques showed similar effects of sealing. The association of a single gutta-percha point in canals shaped with ProTaper and Mtwo rotary systems may provide a sealing capacity similar to all obturation techniques [14]. Tasdemir *et al.* [13] concluded that the single-cone technique may produce a better sealing (by measuring the percentage of the filled gutta-percha) than lateral condensation, at 2 mm short of the apex. This fact is understandable, since the single gutta-percha point had the same diameter and taper of the last instrument used during the preparation of the canal. These results confront the study of Marciano *et al.* [8], which revealed that the single-cone technique obtained significantly less gutta-percha, more cement and empty spaces in comparison with Thermafil technique at 2 and 4 mm levels. This evidence that the single-cone technique may result in empty spaces in irregular shape canals, for example, in the mesial canals of mandibular molars which were employed in this study.

Gordon *et al.* [4], Ozawa *et al.* [10] and Schäfer *et al.* [12] also concluded that the single-cone technique was faster than lateral condensation. Hörsted-Bindslev *et al.* [6] reported that the lateral condensation does not differ from single-cone technique regarding to the quality of the radiographic obturation. On the other hand, Monticelli *et al.* [9] reported that none of the two single-cone systems assured a durable apical sealing against the bacterias, while the vertical compaction technique reached this type of sealing. Damasceno *et al.* [1] demonstrated that the ProTaper single-cone and thermoplasticized TC system technique showed apical microleakage and that the highest infiltration allowed by the single-cone technique is because of the fact that the gutta-percha point is not compacted but only inserted within the working length; of the use of the beta type gutta-percha, which is more consistent and less adhesive; and of the little condensation of the apical third due to the diameter of the compactors which, often, do not reach this third [11]. On the other hand, Inan *et al.* [7] demonstrated that the apical sealing of the single-cone technique is comparable to that of the Thermafil and lateral condensation. In this study, the teeth used had straight canals, but the posterior teeth generally have straight and curved canals with complex anatomy, which may present highest challenges. New studies are necessary to determine whether the use of the single-cone technique in canals with more complex anatomy would result in an adequate sealing [7, 13].

Conclusion

After the literature review, it can be concluded that the single-cone technique shows as advantages the possibility of a faster endodontic treatment obturation. However, regarding to the aspects such as obturation quality, apical marginal infiltration, and bacterial penetration, the studies demonstrated that the technique is similar to or lower than the other techniques. Therefore, further studies are necessary to evaluate the prognosis of the treatments performed with this technique, mainly in root canals presenting complex anatomy.

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