REVISTA CIÊNCIAS e ODONTOLOGIA

ENDODONTICS DYNAMIC NAVIGATION GUIDE: A LITERATURE REVIEW

GUIA DE NAVEGAÇÃO DINÂMICA EM ENDODONTIA: UMA REVISÃO DE LITERATURA

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Resumo

Introdução: A metamorfose cálcica da polpa ou calcificação pulpar consiste na obliteração parcial ou total do canal radicular e representa um desafio durante o tratamento endodôntico. A Endodontia Guiada apresenta-se como uma alternativa eficiente na solução de casos mais complexos. **Objetivo:** O objetivo deste estudo foi realizar uma revisão de literatura sobre o guia de navegação dinâmica para tratamento de canais calcificados como forma de tornar o procedimento mais simples, seguro, eficaz e com menor tempo de trabalho. **Materiais e Métodos:** A base de dados utilizada foi PubMed, as palavras-chave utilizadas foram: Cavidade de acesso endodôntico; canais calcificados; navegação dinâmica; endodontia guiada; endodontia minimamente invasiva; sistema de navegação; Navident. **Resultado:** Foram encontrados 63 artigos sobre o tema, mas com os critérios de inclusão e exclusão foram selecionados 23 artigos. **Conclusão:** A endodontia com o guia dinâmico mostrou-se eficaz para o tratamento de dentes com extrema calcificação pulpar, porém são necessários mais estudos sobre esse assunto.

Palavras-Chave: endodontia; calcificação pulpar dentária; cavidade pulpar.

Abstract

Introduction: The calcium pulp metamorphosis or pulp calcification consists of partial or total obliteration of the root canal and represents a challenge during endodontic treatment. Guided Endodontics is presented as an efficient alternative in the solution of more complex cases. **Objective:** The objective of this study was to carry out a literature review on the dynamic navigation guide for the treatment of calcified canals to make the procedure simpler, safer, more effective, and with less work time. **Materials and Methods:** The database used was PubMed, and the keywords used were: Endodontic access cavity; calcified channels; dynamic navigation; guided endodontics; minimally invasive endodontics; navigation system; Navident. **Results:** 63 articles were found on the topic, but with the inclusion and exclusion criteria, 23 articles were selected.**Conclusion:** The dynamic guide proved to be effective for the treatment of teeth with extreme pulp calcification, however, further studies on this subject are needed.

Keywords: endodontics; dental pulp calcification; pulp cavity

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Introduction

The teeth that require endodontic treatment become weakened due to caries or traumatic factors, and during endodontic treatment, the removal of the necessary structure to access the pulp cavity can weaken the tooth by up to 63%, and may be even greater in cases of calcification [1]. The root canal calcification, or sclerosis, can be the result of physiological aging of the tooth, post-dental trauma sequelae, carious lesions, excessive orthodontic force, iatrogenic dental treatment, or regenerative endodontic procedures (calcium hydroxide therapy) [2]. There is a consensus in the literature that endodontic treatment should be instituted in cases of necrosis and presence of signs and symptoms of apical periodontitis[3].Over the years, many magnification devices have been introduced as auxiliary tools for endodontic treatment, such as loupes and dental operating microscope, facilitating the treatment of these teeth[4].Ultrasound has been increasingly used to resolve cases of pulp calcification, several ultrasonic tips have been developed to promote a more accurate cut. Cone-beam computed tomography is another resource frequently used in these cases, as it provides three-dimensional images and guides the clinician towards the correct direction of the root canal[5].

Essentially, there are two types of guides: static (endoguide), or dynamic (dynamic navigation guide). The endoguide refers to a prototype made in 3D prints in the CAD (computer-aided design) system, based on the preoperative tomographic

examination, and may be of the muco-supported or tooth-supported type[6]. The dynamic navigation is an approach recent that has been used in endodontics for surgical and non-surgical treatment[7]. The dynamic guide, which is composed of a thermoplastic model superimposed on the surface of the teeth allows a retentive fixation, of a radiographic marker, which imports CT data into the NAVIDENT system. Another part is attached to the high-speed motor. Both form optical triangulations comprising motion-tracking stereoscopic cameras guiding the drilling process in the planned angle, path, and depth of the access cavities in real time, being monitored by the NAVIDENT system[8].

Faced with the difficulties of treating calcified teeth and seeking a method to ensure endodontic treatment, studies are justified to develop new methods, equipment, and techniques for such a procedure, such as the dynamic navigation guide. The objective of this work was to carry out a literature review of endodontic treatment using the dynamic navigation guide.

Materials and Methods

Nesta Through a search in the PubMed database, using the following keywords: Endodontic access cavity; calcified root canal; dynamic navigation guided endodontics; minimally invasive endodontics; navigation system; Navident found 53 articles. Inclusion criteria were: studies published in the last 5 years (2017 to 2022) and studies in English. Only the Pubmed database was used because it contains the majority of articles indexed in English.
After reading the titles and abstracts, 23 were selected for this literature review.

Literature Review

-Pulp calcification

The root Canal Obliteration (RCO), or calcium metamorphosis of the pulp, which according to the American Association of Endodontists consists of a response to trauma (mechanical or occlusion), characterized by the rapid deposition of hard tissue within the pulp complex. However, the pathophysiological mechanism is still unknown. This condition is often found through radiographic finding or change in the external color of the tooth[9].

The well-executed radiographs, with the possibility of using different contrasts, such as digital ones, are important to identify PCO. Only radiographically we cannot conclude that the canal is clinically totally obliterated. The use of magnifications such as loupes and microscopes and ultrasonic inserts can assist in locating obliterated canals. However, in some situations, even with all the resources, cone beam computed tomography (CBCT) is necessary, which facilitates the identification of root canal, their directions, degrees of obstruction and dimensions. With all the difficulty in treating these canals, an adequate diagnosis and careful planning are necessary before starting endodontic treatment [10,11].

The deposition of dentinal tissue starts from the coronal portion of the root canal system and progresses apically. Previously, professionals used touch with files and probes to locate the canals. However, certain magnifications, such as microscopy, increase the visibility of the pulp cavity and some tools, such as ultrasonic inserts, tend to facilitate the location of root canals[12]. These cases require a technological arsenal for successful resolution, due to the risk of treatment failure, as the location of the conduits is challenging, even for experienced specialists. The iatrogenic factors such as excessive wear, deviations from the original path of the root canal and root perforations are examples that can compromise the prognosis of a case and be an indication for tooth extraction[13].

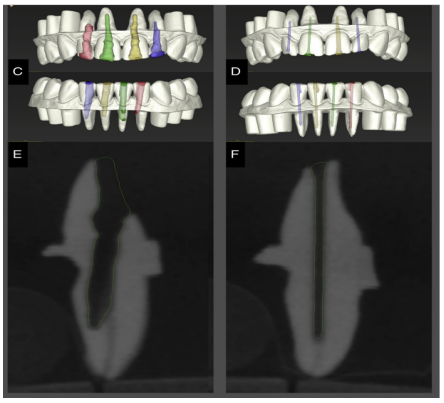
-Static guide

To perform the static guide, a digital impression of the patient's arch is made and recorded in the computed tomography data. Then, a path is planned for the drill to the root site where it will clinically have the first conduit lumen. Finally, a guide is created using computer-assisted software (CAD) and printed on a 3D printer, so that the drill used during the treatment has a static guide so that there is no deviation of the drill. By using a 3D printed guide, the chances of iatrogenic damage to the root are reduced and the probability of finding the root canal is high, as well as reducing treatment time[6].

The nomenclature of Guided Endodontics was first described by [14]Zehnder *et al*. (2016) who brought the term 'guided endodontics' using in a clinical case of a central incisor with OCP and apical periodontitis. Through this study, the use of the static navigation guide with models made in a 3D printer was demonstrated, in order to compare the accuracy of freehand access with access with the static guide. In terms of canal location and tooth structure preservation, canal localization was successful in 10 of 24 cases (41.7%) using the conventional technique and 22 of 24 cases (91.7%) with the guided approach. The loss of tooth

structure in conventional and guided access was 49.9 mm³ and 9.8 mm³, (Figure 1) respectively. Through figure 1, it is possible to observe the greater wear of tooth structure in conventional access compared to guided access.Treatment lasted an average of 21.8 minutes for the conventional technique and 11.3 minutes for guided endodontics, and the success of the guided approach was not influenced by operator experience.

Figure 1: Comparison between freehand and endoguide access. Houge greater wear of tooth structure in conventional access on the left compared to guided access on the right.

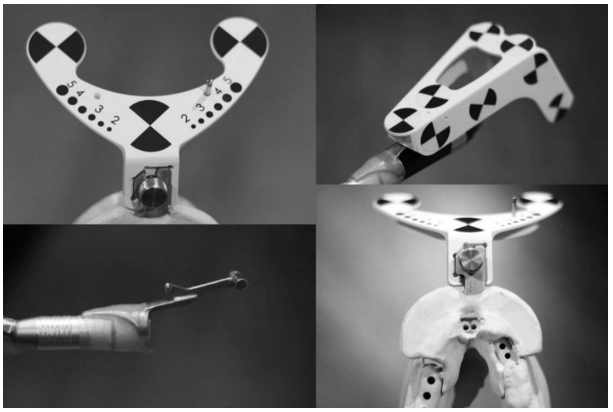


Connert *et al.*, 2019

-Dynamic guide

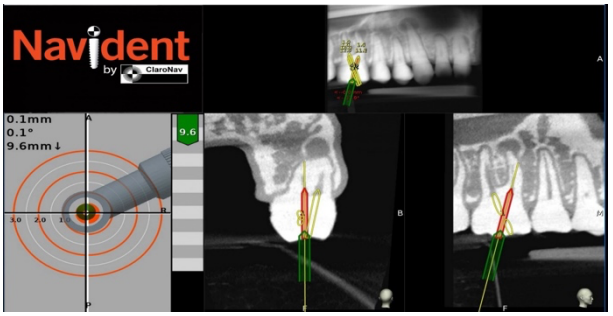
To use the dynamic navigation guide, the NAVIDENT system is used, for this it is necessary to heat the thermoplastic model and place it on the surface of the teeth to allow retention of the radiographic marker and a handle with a black and white label (Figure 2) . In figure 2, it is possible to observe the arsenal of the Navident system. The data sets go to software that does the planning and uploads to a computer on a mobile unit for operator assistance. Another black and white perforation label is affixed to the high speed motor. Both optical references of the markers are calibrated and recognized by the optical triangulation system comprising stereoscopic motion tracking cameras guiding the drilling process at the planned angle. The path and depth of the access cavities are monitored in real time by the computer-assisted dynamic navigation system's portable computer[8] (Figure 3). In figure 3, it is possible to observe the software used and the way in which the line is drawn to locate the root canal.

Figure 2: NAVIDENT system labels, arsenal used in the system.



Zubizarreta-Macho et al., 2020

Figure 3: NAVIDENT operating system. Software and model how the drawing is made for locating the root canal.



Zubizarreta-Macho et al., 2020

-Comparison of the dynamic navigation guide with the static guide:

The dynamic guide, as well as the static guide, were developed for use with low rotation drills, however the Navident system has a calibration for high rotation drills, which improves the operative time because it has better penetration in the enamel region, positively affecting access accuracy. The study by[15], also showed that the static guide has an average deviation of 1.2 mm, generating approximately 4° of inclination, which can lead to loss of tactile orientation of access to the root canal. Thus, the dynamic guide demonstrated greater precision by presenting positional precision in real time, improving the optimization of results for the patient.

In the [16]study the success rate of root canal localization was established at 94.5% and all were performed using a computer and the static guide at 98.1%. These results may be influenced by the small number of studies on the dynamic technique of computer-assisted navigation (two studies) in relation to the greater number of studies on the static guide technique (12 studies). In addition, the

endoguide technique appeared before dynamic computer-assisted navigation, which had more time to be refined and grounded in studies. Anyway, regardless of the computer-assisted navigation technique analyzed, a higher success rate of root canal localization was obtained than conventional endodontic access. Therefore, computer-assisted static and dynamic navigation techniques should be recommended due to their high rates of effectiveness in locating the root canal, reducing iatrogenesis, especially in cases of pulpal calcification.

Discussion

The root canal obliterations are a challenge in endodontic clinics, cases with signs and symptoms require planning for adequate treatment, and resolution by tomographic means and endodontic guides has been the focus of investigation in studies[9,10]. Most of the time, calcifications are discovered through radiographic findings or due to patient complaints such as color change in the tooth structure and/or symptoms. The treatment approach is still much discussed in the literature. However, there is a consensus that endodontic treatment should only be instituted in cases of signs and symptoms.[3,17,18]

The deposition of dentinal tissue tends to occur in the crown-apex direction, making treatment complex even for experienced specialists.[11,12] However, even with all the arsenal, such as ultrasonic inserts and an operating microscope, these cases are still prone to failure, requiring high-resolution tomographic examinations to assist in the treatment.[13]

In order to circumvent the limitations that calcification cases impose, some studies have shown the efficiency of treatment with the static guide, demonstrating a reduced clinical time in case resolution, operator safety at the surgical moment of access and greater comfort for the patient.[6,14,19] In addition to resolving calcifications, studies have evaluated the effectiveness of these guides in the installation of fiberglass posts and in periradicular microsurgery.[16,19]

The studies when comparing the free hand technique with the guided access, verified greater maintenance of the dentin structure, with the latter providing a better prognosis of the treatment, reducing the excessive wear of the dental structure, consequently avoiding the weakening of the tooth, in addition, the use of the static guide provides the elimination of multiple radiographs during root canal negotiation.[3,11,19] However, some disadvantages were exposed for guided access, such as the time from the identification of the need for treatment to the moment of execution of the access was long and financially high for the patient, not being viable for symptomatic patients who need immediate or low treatment. income. The studies also emphasize that the greatest contraindication would be the limitation of the patient's mouth opening, since the drill space added to the motor head requires approximately 30 mm of excursion. Another contraindication mentioned in the studies for the use of static guide are cases with curvature that makes it impossible to use guided access.[6,19]

Caution is required when using the static guide, accidents such as perforations can occur due to incorrect fitting of the guide to the tooth, incorrect fixation in the cortical bone or movement of the same during drilling with the drill, so it is prudent to verify that the guide has been correctly fixed. to avoid accidents.[20, 21]

Dynamic navigation is another modality of access to calcified canals, however there are still few studies in the literature on this subject, and more primary studies are needed to assess the effectiveness of this form of treatment. Despite few studies, the literature highlights some advantages of dynamic navigation over the static guide, such as: simplicity of planning, it provides better irrigation during the procedure, reducing the risk of overheating of the tooth structure, possibility of being performed in patients with limited opening by mouth.[7]

In recent systematic reviews, other advantages of the dynamic guide in Endodontics were evidenced, in addition to providing access to calcified canals, it can also be used in periradicular microsurgery. Among other advantages mentioned in the studies, there is a reduction in the time to perform the procedure, lower operating cost, indicated for symptomatic patients who need to resolve in the shortest possible time, in addition, it is not necessary for the operator to be experienced, they should only have knowledge of the NAVIDENT system used.[8,16] A recent systematic review by[22], corroborates the previously mentioned systematic reviews and highlights that the guided dynamic navigation system can safely and effectively resolve cases such as obliterated canals, canals in need of retreatment and microsurgery , however it is Caution is needed, due to the reduced number of studies and for encompassing case reports and in vitro studies, the evidence of this review was considered low.

Based on the present literature review, it was possible to perceive that when comparing the two systems of static guidance and dynamic navigation, expressive advantages over the systems were verified, both proved to be effective in solving complex cases of calcifications.[12,19,23]However, as dynamic navigation is a recent modality, more primary studies are needed for more robust evidence. Through this work, it was possible to verify that the primary studies published in the literature on dynamic and static guides are mostly in vitro studies or case reports, the literature lacks future studies such as randomized clinical trials, with rigid and well-designed methodologies for verify the effectiveness of these systems and possibly generate secondary studies with higher levels of evidence.

Conclusion

The guided endodontics has been shown to be very efficient for endodontic treatments in teeth with calcium pulp metamorphosis. The dynamic guide proved to be efficient and is being even more widespread in the clinical day-to-day of endodontists. And despite few studies regarding the dynamic guide, it obtained a high success rate and operator safety and patient comfort.

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