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Applications of the use of ultrasound in the clinical practice of endodontics

Aplicaciones del uso de ultrasonidos en la práctica clínica de endodontics

Aplicações do uso do ultrassom na prática clínica da endodontia

ABSTRACT

The objective of the study is to characterize the application of ultrasound in the stages of Endodontics, as a facilitating factor. Method: Bibliographic research was carried out using books and articles in Portuguese and English from the portals Latin American and Caribbean Health Sciences Literature (LILACS), Scientific Electronic Library Online (SciELO) and National Library of Medicine (PubMed) and Google Scholar published from 2005 to 2020. Results: Given the material consulted, it was found notorious the effectiveness of ultrasound as an aid in endodontic treatment in its different stages, increasing the chance of success of the cases performed, minimizing unnecessary dentinal wear and potentiating the cleaning of the canal system, both in cases of treatment and endodontic retreatment. Conclusion: the use of ultrasound increases safety in parentodontic surgeries by allowing better operator visibility, resulting in a less invasive surgery.

DESCRIPTORS: Endodontics; Root Canal Treatment; Ultrasound.

RESUMEN

El objetivo del estudio es caracterizar la aplicación de los ultrasonidos en las etapas de la Endodoncia, como factor facilitador. Método: Se realizó una investigación bibliográfica utilizando libros y artículos en portugués e inglés de los portales Latin American and Caribbean Health Sciences Literature (LILACS), Scientific Electronic Library Online (SciELO) y National Library of Medicine (PubMed) y Google Scholar publicados entre 2005 y 2020. Resultados: Dado el material consultado, se encontró notoria la efectividad del ultrasonido como auxiliar en el tratamiento endodóntico en sus diferentes etapas, aumentando la posibilidad de éxito de los casos realizados, minimizando el desgaste dentinario innecesario y potencializando la limpieza del sistema de canales, tanto en casos de tratamiento como de retratamiento endodóntico. Conclusión: el uso de ultrasonidos aumenta la seguridad en las cirugías de parentodoncia al permitir una mejor visibilidad del operador, lo que resulta en una cirugía menos invasiva.

DESCRIPTORES: Endodoncia; Tratamiento de conducto; Ultrasonido.

RESUMO

O objetivo do estudo é caracterizar aplicação do ultrassom nas etapas da Endodontia, como fator facilitador. Método: foram efetuadas pesquisas bibliográficas através de livros e artigos em português e inglês dos portais Latin American and Caribbean Health Sciences Literature (LILACS), Scientific Electronic Library Online (SciELO) e National Library of Medicine (PubMed) e Google Acadêmico publicados no período de 2005 a 2020. Resultados: Diante do material consultado, constatou-se notória a eficácia do ultrassom como auxiliar no tratamento endodôntico em suas diferentes etapas, aumentando a chance de sucesso dos casos realizados, minimizando desgastes dentinários desnecessários e potencializando a limpeza do sistema de canais, tanto em casos de tratamento quanto de retratamentos endodônticos. Conclusão: o uso de ultrassom aumenta a segurança em cirurgias parentodônticas por permitir melhor visibilidade do operador, resultando em uma cirurgia menos invasiva.

DESCRIPTORES: Endodontia; Tratamento de Canal Radicular; Ultrassom.

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ORCID: 0000-0002-9641-6806**INTRODUCTION**

Endodontic treatments have a 97% chance of success, but some circumstances can make them more complex, such as cases in which the canals are atresic, others calcified and with some anatomical variations, which can make treatment difficult and increase risks from some endodontic accident such as a file fracture; excessive dentin loss; perforation and extrusion of the instrument through the apex.^{1,2}

In addition, although the success rate in Endodontics is high, some situations may need retreatment, when it is then necessary to remove all the filling material from inside the conduit, which results in a level of difficulty in manually removing gutta percha, causing the surgeon to waste clinical time. Likewise, in some cases, it is necessary to remove the root canal post, when manual removal is also difficult with the risk of perforations or root fractures.^{1,3}

In view of these complications that can occur in endodontic treatments, the discovery of the use of ultrasound to assist in instrumentation, in access refinement, in the location of calcified canals and in the removal of pulpal calcifications, removal of intracanal obstructions (fractured instruments, root canal cones, silver cones and fractured metallic cones), in the increase of the action of irrigating solutions, in the ultrasonic condensation of gutta percha cones, in endodontic surgeries and in the preparation of the root canal, favors the reduction of accidents.⁴

Bacterial infection can cause pulp necrosis to occur. Thus, endodontic treatment aims to eliminate this infection and remove all infected tissues that are found inside the root canal. With this, the ultrasound becomes viable, facilitating the steps and helping to

remove the possible infection.⁵

Currently, ultrasound is being widely used in dentistry, especially in endodontics, many tips were created with different shapes, diameters, sizes, making a great adaptation to the various clinical needs, thus making the procedures more agile and safe.⁴

This is only possible because the method used in the production of ultrasound used in Endodontics is based on the piezoelectric principle, when a crystal is used that changes the dimension when an electric charge is applied to it and the deformation of this crystal becomes in mechanical oscillation, generating a small amount of heat, high quality in the production of ultrasonic waves and high frequency around 40.000 cycles/second, which allows greater control over wear, in addition to allowing better visibility.^{6,7}

Given the above, this study aims to characterize the application of ultrasound in the stages of Endodontics, as a facilitating factor.

METHOD

This is a research elaborated through an integrative literature review, which sought to understand the applicability of ultrasound in endodontic treatment, and for this, electronic databases were used to capture scientific papers related to the topic. This research was elaborated through the following steps: identification of the problematization about the theme, elaboration of general and specific objectives, application of inclusion and exclusion criteria.

Books and articles in Portuguese and English were used, applied in electronic databases: Latin American and Caribbean Health Sciences Literature (LILACS), Scientific Electronic Library Online (SciELO), National Library of Medicine (PubMed) and

Google Scholar published in the period from 2005 to 2020, the survey was carried out in September 2020 and ended in May 2021.

As inclusion criteria, texts available in full are excluded, then works that presented only an abstract. After applying the criteria, the titles and abstracts of the research were analyzed. Those considered irrelevant to the objective of this research were excluded, the relevant ones had their full content evaluated and included in this research. The descriptors were submitted to the Health Sciences Descriptors (DeCS), namely: Endodontics, Root Canal Treatment and Ultrasound. Using the words AND and OR as Boolean operators.

For the search and selection of articles, the PRISMA instrument was used, for the elaboration of the results and discussion topics, the texts obtained underwent a thorough analysis of their content, verifying their methodology and evaluation character. Thus, only studies that went through rigorous evaluation processes and that were similar to the objective and problematic of this research were included. Figure 1 shows the flowchart of the bibliographic research.

RESULTS

The use of ultrasound in the clinical practice of endodontists has been evaluated in the literature. For this evaluation, a bibliographic survey of the theme in the databases was carried out. Where it was possible to obtain a total of 7.366 studies, which were submitted to the inclusion and exclusion criteria, obtaining 590 studies, of which their titles were read and those irrelevant to the research were excluded, and after reading the abstracts. Thus, after selection, 20 studies were inclu-

ded in this research. In Chart 1, it is possible to see a summary of the studies included in the literature review.

DISCUSSION

In 1957, the use of ultrasound in Endodontics was aimed at cleaning and shaping the system of rotational canals and root resection. In the early 1980s, with the publication of several articles by Martin & Cunningham et al. 4 which presented encouraging results regarding the use of ultrasound compared to the manual technique of instrumentation of root canals, the equipment then became very consumed, especially among endodontists. 6

Ultrasonic tips are useful for the re-

finement of access surgery, location of calcified root canals, removal of pulp calculi, removal of fractured instruments, removal of the intraradicular nucleus, location of accessory canals and irrigation activation, parentodontic surgery, aiding in the condensation of the obturator mass and in the opening of the ducts in retreatment, thus enhancing its properties and allowing the professional to proceed in an easier and more agile way. 6,7,8

The ultrasound has several inserts of different shapes and curvatures that facilitate the procedures. In the world market, there are different models of ultrasonic tips and, among the most used in Endodontics, are the Start-X by Dentsply, used from cleaning the pulp

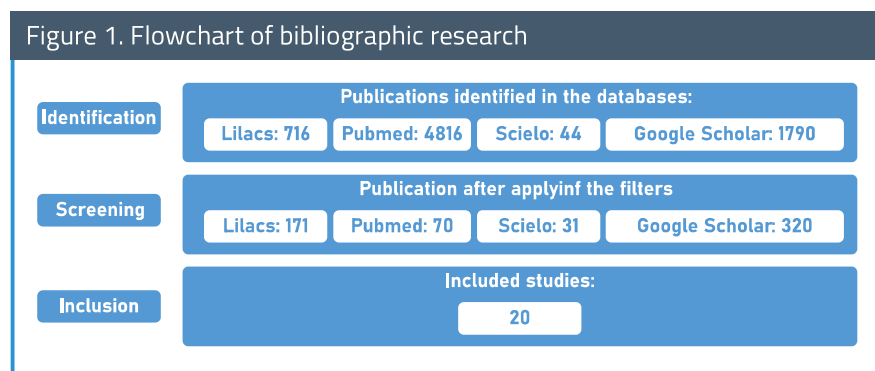
chamber to the removal of nodules, and Helse brand tips which, currently, dominate the Brazilian market, with several tips for each maneuver. 6

Access and location of root canals

In the endodontic approach, the minimally invasive approach is currently recommended and, therefore, the importance of using ultrasonic tips is justified, aiming at a greater success and longevity of the endodontic treatment. However, the location of root canals is usually difficult due to the possibility of secondary dentin deposition that partially or totally obliterates the entrance of the canals. With the use of ultrasonic tips, it is possible to access the cavity preparation and locate the root canals with less wear on the dentin. 8,9,10

In the in vitro study carried out by Alaçam et al. (2008) to investigate whether the use of an operating microscope and ultrasonic inserts help to locate the second mesiobuccal canal (MV2), 100 extracted maxillary molars were used. The MV2 canal was searched using an operating microscope and final ultrasonic inserts, locating the MV2 canal in 74 teeth. According to the authors, the use of an operating microscope and

Figure 1. Flowchart of bibliographic research



Source: The Authors

Chart 1: Synthesis of bibliographies found in databases

Nº	YEAR	TITLE	OBJECTIVE	METHODOLOGICAL OUTLINE
1	2018	Surgical versus non-surgical endodontic retreatment for periradicular lesions. Cochrane Database of Systematic Reviews	To test the hypothesis that there is no difference in outcome between surgical and non-surgical therapy for endodontic retreatment of periradicular lesions.	Research was carried out through a literature review
8	2019	Minimally invasive endodontic access: literature review	Realizar uma revisão de literatura a respeito do acesso endodôntico minimamente invasivo e sua influência no tratamento endodôntico	Research was conducted through literature review
19	2017	The Efficacy of Passive Ultrasonic Activation of Organic Solvents on Dissolving Two Root Canal Sealers	The aim of this in vitro study was to evaluate the dissolved efficacy of eucalyptus and orange oil solvents associated with passive ultrasonic activation (PUA) in epoxy-zinc oxide resin channel sealers	Seventy samples of each sealant were prepared and further randomized according to solvent and ultrasonic activation time (n = 5). The average weight loss of cements was calculated in percentages and analyzed by the Kruskal-Wallis and Bonferroni post-hoc tests

Source: The Authors

ultrasonic inserts contributed to the location of these canals.⁴

Endodontic Irrigation

The association of instrumentation with irrigation helps to eliminate the remains of necrotic tissue, as well as to expel bacteria and remove fragments in places that were not instrumented, such as accessory canals. In addition, during both manual and rotational instrumentation technique of the canals, a thin layer of debris called the smear layer is created, which, if not removed, can interfere with the accommodation of the endodontic cement with the dentin.¹⁰

There are two types of ultrasound during irrigation, according to the literature: one is associated with the combination of instrumentation and the use of the device, called simultaneous ultrasonic instrumentation (UI); and the other that does not perform this combination is called passive ultrasonic irrigation (PUI). The UI was not very effective due to the fact that it had a large contact with the root canal walls, thus leading to excessive wear of the canal walls.¹¹

According to the study by Van der Sluis et al.,¹⁰ passive ultrasonic irrigation (PUI) works by activating an ultrasonic tip. To enhance the activation of the solution, the tip must be loose, not touching the walls of the channel, allowing it to work freely in the channel because the instrument works by oscillation. With this effect, it induces hydrodynamic agitation, resulting in the bubble effect.

The use of ultrasound is a complement that favors greater results in the final cleaning of the canals compared to irrigation through the use of syringes, proving to be more effective, especially in anatomical areas of difficult access, as it increases the volume of irrigating flow in the canals, thus eliminating a greater amount of debris, in addition to improving the access of the shutter product to the accessory channels.³

Root canal filling

After all the preparation of the canal, the filling is the last step and must be done properly for the treatment to be successful. The filling of the canals is completed through the association of gutta-percha and endodontic cement, which helps to complement places that the other material cannot reach, such as lateral canals, accessory canals and dentinal tubules. However, the endodontic cement is not always able to fill these spaces, so the association with the use of ultrasound can be advantageous.⁴

According to the study by Alcalde et al.,¹² ultrasonic activation reduces the level of bacteria in the canal compared to that achieved with the normal procedure, as the endodontic cement reaches more areas, thus leaving the canals more sealed.

Removal of fractured instruments and intraradicular retainers

The use of ultrasound associated with the operating microscope significantly increases the success of removing fractured instruments; even though, in the impossibility of removing the fragment inside the canal, the passage of this one has the best prognosis for the treatment. In cases where there is any intracanal obstruction such as silver cones or instrument fracture at the time of the procedure, ultrasound is recommended so that the clearance success rate is high. Because the insert tips are thin and delicate, removal occurs with less wear on the canal and greater visualization of the operative field.^{2,4}

Ultrasound is advantageous in many cases, allowing the instrumentation of the root canal with minimal wear of the tooth structure. The ultrasonic tip is inserted into the space created between the exposed part of the file and the canal wall, the vibration of the active tip will cause the file to come loose and be removed.³

Among the techniques to remove the fractured instrument is the "Staging Platform" which allows access to

the fractured instrument; is made with a Gates-Glidden drill with a diameter slightly larger than that of the fractured instrument to create a coronal space in the instrument and thus facilitate the access of the ultrasonic tip that will remove it through its vibration.³

Endodontic Treatments

There are a few methods to deobturate the canals. Agrawal et al.¹³ compared three techniques, having collected, as samples, single root premolars with all dry canals with paper tips and applied the lateral condensation technique for obturation with gutta-percha and zinc oxide eugenol as sealer. After that, the collected teeth were divided into three groups for the comparison of deobturation. Group I, ultrasound was used; group II: use of the R-Endo withdrawal file; group III: m-two withdrawal files. With this comparison, it was observed that the group using the ultrasonic tips proved to have a more effective result compared to the other groups.

The research by Purba et al.¹⁴ according to the study above, they evaluated seven deobturation techniques: manual files; ProTaper Universal pickup files; MTwo withdrawal system; R-Endo withdrawal system; ProTaper Universal solvent and ultrasonic withdrawal files; MTwo R with ultrasonic solvent and R-Endo with solvent and ultrasound. For this study, 70 mandibular premolars with single and oval roots needed to be collected, decoronated to a length of 16 mm from the apex and modeling, cleaning and filling performed using the warm lateral compaction technique. Thus, the teeth were divided into the seven groups mentioned and the comparison was made. It was evidenced that no technique completely cleaned the oval-shaped channels, but the MTwo R files with solvent and ultrasonic were more effective in removing gutta-percha from the coronal third, R-Endo was effective in the middle third and R-Endo with solvent

and ultrasonic was effective in the apical thirds, and the ProTaper Universal removal files took less time to remove gutta-percha. Therefore, further studies should be carried out to assess the effectiveness of oval-shaped canals.

In order to evaluate the combination of techniques, Crozeta et al.¹⁵ studied the ultrasound as an auxiliary technique for deobturation after using the file. For this, he separated a sample using the ultrasonic tip and the other sample using the XP-endo Finisher R. 28 distal roots of human mandibular molars with single canals and oval shape were used. Divided into groups, one used - for filling - the AH Plus and the other BC Sealer. After the evaluation, it was possible to observe that the use of ultrasound was effective in both groups of filling material for both AH Plus and BC Sealer, while the XP-endo Finisher R was effective only for AH Plus.

Paraendodontic Surgery

When it is not possible to conservatively eliminate an etiologic agent of an inflammatory process in the periapical region, endodontic surgery and the use of ultrasound are effective, due to deeper preparation, with less risk of perforation and less need for bone removal, in addition to better control by the dentist. Thus, the use of ultrasound is recommended due to precise wear and the good angle of the ultrasonic insert allows for better adaptation, resulting in less wear for access.⁴

The conventional form of paraendodontic surgery, which occurs with drills and micromotor with contra angle, has disadvantages such as difficulty in accessing the periapical region and being able to deviate from the axis of the canal cavity, resulting, therefore, in excessive wear in the vestibular portion

. The use of ultrasound, due to the design of its retro tips, guarantees direct access to the channels, resulting in less bone removal, ensuring better quality of surgery, in addition to being more effective in cleaning by removing a greater amount of smear layer.¹⁶

CONCLUSION

Through the bibliographical study, it was possible to confirm that the ultrasound becomes an excellent equipment for the dentist in the stages of Endodontics, favoring that the professional saves clinical time, in addition to lower risks of accidents. Thus, with this study, the understanding that ultrasound is effective was reaffirmed. However, further studies are needed to better assess the use of the appliance in the endodontic retreatment stage and in the canal irrigation stage.■

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