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Impact of ultrasonic activation on the efficiency of endodontic irrigation: a literature review.

Impact of ultrasonic activation on the efficiency of endodontic irrigation: a literature review
Impact of ultrasonic activation on the efficiency of endodontic irrigation: a bibliographic review

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ABSTRACT: Endodontic irrigation is an essential step for the success of root canal treatment, especially given the limitations of mechanical instrumentation in complex anatomical areas. Passive ultrasonic activation stands out as an auxiliary resource capable of enhancing the action of the irrigant and promoting more effective intracanal cleaning. This study aimed to evaluate the relevance of ultrasonic activation in endodontic irrigation, considering its effectiveness, limitations, and clinical applicability. This is an integrative literature review, with a qualitative and exploratory approach, based on national and international scientific publications. The results indicated that the technique performs better than conventional irrigation, mainly in the removal of debris, smear layer, and biofilms, in addition to promoting better penetration of the irrigant in hard-to-reach areas. Compared to other techniques, its results were found to be consistent and clinically relevant, although not absolute in all scenarios.

It is concluded that passive ultrasonic activation represents an important method for improving endodontic irrigation and strengthening evidence-based clinical practices.
KEYWORDS: Endodontics. Endodontic irrigation. Passive ultrasonic activation. Intracanal disinfection. Integrative review.

ABSTRACT: Endodontic irrigation is an essential step for the success of root canal treatment, especially considering the limitations of mechanical instrumentation in complex anatomical areas. Passive ultrasonic activation stands out as an auxiliary resource that can enhance the action of the irrigant and promote greater intracanal cleaning. This study aimed to evaluate the relevance of ultrasonic activation in endodontic irrigation, considering its effectiveness, limitations, and clinical applicability. This is an integrative literature review with a qualitative, exploratory approach, based on national and international scientific publications. The results indicated that the technique offers superior performance compared to conventional irrigation, particularly in removing debris, smear layer, and biofilms, and in promoting better penetration of the irrigant into hard-to-reach regions. In comparison with other techniques, its results were shown to be consistent and clinically relevant, although not absolute in all scenarios. It is concluded that passive ultrasonic activation represents an important method for improving endodontic irrigation and strengthening evidence-based clinical practices.
KEYWORDS: Endodontics. Endodontic irrigation. Passive ultrasonic activation. Intracanal disinfection. Integrative review.

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1 INTRODUCTION

Endodontic treatment plays a fundamental role in preserving teeth.
committed, with the aim of promoting proper cleaning, disinfection and sealing of
root canal system. However, the success of this treatment does not depend solely on the
mechanical instrumentation, given the anatomical complexity of the canals, marked by
The presence of isthmuses, recesses, accessory canals, and dentinal tubules limits direct contact.
of the instruments with all internal surfaces, thus endodontic irrigation takes on
Its central function is to enhance the removal of debris, microorganisms, and the smear layer in affected areas.
inaccessible to mechanical action, contributing to greater clinical predictability and better
therapeutic prognosis, as highlighted by Zou *et al.* (2024) and Tonini *et al.* (2022).

Different methods of irrigant activation have been studied with the aim of
to enhance intracanal cleaning; among them, passive ultrasonic activation stands out.
also known as *Passive Ultrasonic Irrigation* (PUI), a technique that uses vibrations
Ultrasonic devices are used to intensify the movement of the irrigating solution inside the root canal.
According to Koulgiannis *et al.* (2024), PUI favors phenomena such as microstreaming.
Acoustic and stable cavitation, which promote greater circulation of the irrigant and extend its
ability to reach critical areas of the canal system. Electron microscopy of
Scanning, micro-computed tomography, and computational fluid dynamics indicate
that this technique can improve the penetration of the irrigant into the dentinal tubules and isthmuses,
especially in regions with greater difficulty of access, such as the apical third (Yu *et* al., 2024;
Barbosa *et* al., 2021; Donnermeyer *et* al., 2024).

Barbosa and colleagues, in 2021, in a systematic review and meta-analysis, observed
PUI's superiority over conventional syringe irrigation in removing debris.
Similarly, Canton *et al.* (2025) reinforce the relevance of ultrasonic activation as
an effective strategy in the final irrigation stage. Pereira *et al.* (2023) and Erkan *et al.* (2022) point out
that the technique can also contribute to reducing postoperative pain and to greater
patient comfort without increasing the risk of complications. These results demonstrate that
The discussion about PUI is not limited to laboratory performance, but also encompasses...
Important clinical outcomes for contemporary dental practice.

Ultrasonic activation still presents aspects that require critical analysis; there is no...
A fully established consensus regarding parameters such as depth of insertion of

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ultrasonic tip, activation time, ultrasound power, and volume of irrigant used.
Comparative studies show that, although PUI performs satisfactorily, other
modalities, such as sonic irrigation, multisonic systems and assisted techniques
laser treatments also demonstrate relevant results in certain clinical contexts and
experimental studies (Baumeier *et* al., 2022; Coaguila-Llerena *et* al., 2022; Bao *et* al., 2024). Yet
Gaps persist regarding the standardization of protocols and the consolidation of clinical evidence.
long-term, especially with regard to periapical healing and success rates.
endodontic, as noted by Tonini *et al.* (2022) and Zou *et al.* (2024).

It is within this context that the central problem of this study arises: how activation
Does ultrasonic irrigation in endodontics influence the disinfection of root canals?
The formulation of this question stems from the need to understand, in a well-founded manner,
To what extent does the technique effectively contribute to improving intracanal cleaning and to...
qualification of therapeutic protocols. The relevance of the topic is justified both by its
Its importance lies both in its clinical aspects and its academic contribution, since the systematization
This evidence can aid professional practice and support evidence-based decisions.
and to indicate gaps that require further investigation.

This work aims to evaluate the relevance of ultrasonic activation in
Endodontic irrigation, through a literature review, considering its effectiveness and limitations.
and clinical applicability; analyze the scientific evidence on the technique; compare its effectiveness.
with conventional irrigation and with other forms of activation; and describe their main
Advantages, limitations, and possibilities for clinical application.

To that end, an integrative literature review will be developed, of a nature...
Qualitative and exploratory, with a survey of studies published in national databases.
and international. Original articles, clinical trials, laboratory research, and other research will be included.
Systematic reviews, meta-analyses, and consensus statements that directly address ultrasonic irrigation.
in endodontics. Analysis of the material will allow the identification of convergences, divergences, and gaps.
scientific knowledge on the subject. Throughout the work, the following will be discussed:
Fundamentals of endodontic irrigation, mechanisms of ultrasonic activation, performance
A comparative analysis of the technique in relation to other methods and its implications for clinical practice.
contemporary.

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2. DEVELOPMENT

2.1 Endodontic Irrigation: Fundamentals, Solutions, and Limitations

Endodontic irrigation is an indispensable step for the success of endodontic treatment.
root canals, since mechanical instrumentation does not reach all the complexity.
anatomical structure of the canal system, due to the presence of isthmuses, recesses, and accessory canals.
and dentinal tubules, a significant portion of the internal surfaces may remain without contact
directly with the instruments, which makes the chemical action of the irrigators essential for dissolution.
organic tissue reduction, microbial reduction, and removal of debris produced during preparation.
biomechanical (Parma & Gonçalves, 2025; Tonini *et al.,* 2022).

Among the irrigating solutions most commonly used in endodontic practice, the following stand out:
sodium hypochlorite, widely recognized for its antimicrobial action and ability to
tissue dissolution, EDTA, indicated mainly for smear layer removal, and

Chlorhexidine, valued for its substantivity, is not capable of being replaced by any single irrigant.
to promote complete disinfection of the root canal system, which justifies the
development of auxiliary strategies aimed at enhancing its action (Parma &
Gonçalves, 2025).

According to Zou and colleagues (2024), conventional syringe irrigation, although
Widely used, it has significant limitations, especially due to its low capacity.
penetration into hard-to-reach areas. This restriction becomes even more relevant when...
They consider the deep dentinal tubules, whose structure favors permeability and can
to allow microbial persistence even after mechanical preparation. In this sense, the literature
It reinforces that the effectiveness of intracanal disinfection depends not only on the choice of irrigant,
but also the ability to distribute it properly throughout the root system
(Pashley, 1996; Zou *et* al., 2024).

Given these limitations, different activation methods have been incorporated into
Endodontics aimed at improving the circulation of the irrigating solution and increasing its contact.
with areas not reached by the instruments, among these strategies, sonic irrigation, the
Negative apical pressure irrigation, laser-assisted systems, and ultrasonic activation.

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Passive methods have stood out as alternatives aimed at improving intracanal cleaning. (Proença & De Barros, 2023; Tonini *et* al., 2022; Erkan *et* al., 2022).

According to Tonini *et al.* (2022), sonic irrigation, represented by systems such as EndoActivator uses low-frequency vibrations transmitted through a plastic tip. flexible, facilitating the movement of the irrigator and increasing the contact of the irrigator with the dentinal walls. With regard to irrigation by negative apical pressure, as in The *EndoVac* system promotes aspiration of the irrigant towards the apex, reducing the risk of... extrusion and enabling safer irrigation in narrow or curved channels, assisted techniques Laser-based methods, such as PIPS and SWEEPS, also present relevant results, especially in However, some clinical outcomes require more sophisticated equipment and greater investment. technical and financial (Proença & De Barros, 2023; Tonini *et* al., 2022; Erkan *et* al., 2022).

Passive ultrasonic activation has become established as one of the most studied approaches. and applied, due to their consistent scientific basis, their clinical applicability and their ability to intensify the action of irrigators without relying exclusively on mechanical action. Directly onto the canal walls, PUI (Phase Intrusion) came to occupy a prominent position in the literature. contemporary endodontics, especially for presenting favorable results regarding removal of *smear layer,* debris and *biofilms* compared to conventional irrigation (Zou et al., 2024; Barbosa *et* al., 2021; Yu *et* al., 2024; Donnermeyer *et* al., 2024).

2.2 Passive Ultrasonic Activation: Principles, Mechanisms, and Technical Parameters

Continuing the discussion on the challenges of endodontic irrigation, the activation Passive ultrasonication stands out as a strategy aimed at enhancing the action of Irrigators inside the root canal system, unlike irrigation conventional, which has limitations regarding the distribution of the solution in complex areas, the PUI uses high-frequency vibrational energy to intensify the dynamics of the irrigator and to promote greater contact with surfaces not directly reached by the instruments, this The technique generally operates at frequencies between 25 and 30 kHz, transmitted by a metallic tip. or a file attached to a piezoelectric device, inserted into the canal previously filled by irrigating solution (Koulogiannis *et* al., 2024; Maciel *et* al., 2025).

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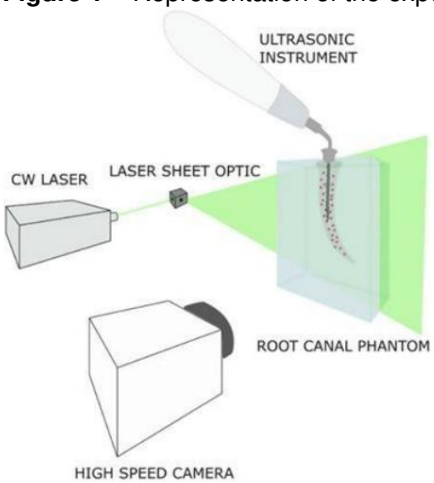
As illustrated in Figure 1, the operating principle of ultrasonic activation
This is related to the vibration of the tip inside the canal, promoting intense movement.
of the liquid around it. This hydrodynamic behavior differentiates PUI from other methods.
static and explains part of its relevance in contemporary endodontics.

Figure 1 – Representation of the experimental setup for ultrasonic activation in endodontic irrigation.



Source: Adapted from Koulogiannis *et al.* (2024).

Tonini and colleagues (2022) state that two physical mechanisms are
traditionally cited to explain the effectiveness of the technique: acoustic *microstreaming* and
Stable cavitation. *Microstreaming* corresponds to the rapid and turbulent movement of the irrigant.
around the ultrasonic tip, increasing shear on the canal walls and promoting
The removal of the *smear layer,* debris, and bacterial *biofilms .* Stable cavitation, in turn,
It is associated with the formation and controlled collapse of microbubbles within the solution.
A process that releases energy and expands the irrigation system's reach into hard-to-reach areas.
such as isthmuses, anatomical irregularities, and dentinal tubules (Tonini *et* al., 2022).

The depth of insertion of the ultrasonic tip, the vibration power, the time of
Activation and irrigant volume influence the flow pattern generated inside the canal, and
Consequently, the efficiency of intracanal cleaning, the deeper insertions, associated
Moderate activation times tend to favor better circulation of the irrigant, provided that
To avoid undesirable effects such as overheating and apical extrusion, this is relevant.

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because it shows that PUI's superiority stems not only from the technology itself, but also in the way it is applied clinically (Koulogiannis *et* al., 2024).

Computational fluid dynamics reinforces this interpretation by showing that the Ultrasonic activation produces a more complex flow and greater homogeneity of the solution. Irrigators offer greater penetration compared to static methods, especially in the upper third. apical, which explains why PUI has been associated with better results in the removal of Intracanal residues and in extending the reach of the irrigant to anatomically critical areas. (Yu *et* al., 2024).

Yu and colleagues (2024) state that PUI is not without limitations; in canals with extremely complex anatomy or in the presence of dense, multispecies *biofilms ,* its Performance may be inferior to that of multisonic technologies, which operate with multiple Acoustic frequencies and continuous flow of irrigant, such as *GentleWave®* and *Multisonic. Ultracleaning System.* According to Coaguila-Llerena *et al.* (2022), these systems can produce more intense turbulence and promote *biofilm* disorganization under specific conditions. However, Lazzarotto *et al.* (2025) emphasize that such technologies still have limitations. related to high cost, lower availability, and the need for more infrastructure. clinical factors that restrict its widespread incorporation into routine practice.

3 METHODOLOGY

3.1 APPROACH AND PROCEDURE METHODOLOGY

This study was characterized as an integrative literature review. A qualitative approach and exploratory nature, focused on the critical analysis of evidence. Scientific studies on the impact of ultrasonic activation on endodontic irrigation. The choice for this The design was justified by allowing the gathering, organization, comparison, and interpretation of different types of scientific output, such as clinical trials, laboratory studies, reviews systematics, meta-analyses and consensus, enabling a broad understanding and based on the effectiveness, limitations, and clinical applicability of the technique.

The integrative review, according to Mendes, Silveira and Galvão (2008) and Whittemore and Knafl (2005), developed through systematized stages that included defining the problem of research, establishing inclusion and exclusion criteria, searching databases, the Selection of studies, critical analysis of the material, and interpretative synthesis of the findings. The question

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The guiding principle of this study was defined as follows: how did ultrasonic activation influence How effective is endodontic irrigation in disinfecting root canals? This question He guided the entire research process, from selecting sources to organizing the results.

The bibliographic search was planned in a structured way, with a survey of publications in national and international databases relevant to the health and safety field Dentistry, including *PubMed/ MEDLINE, SciELO, LILACS, BMC Oral Health, International Journal of Oral Science, Scientific Reports and Journal of Endodontics,* in addition to Academic repositories that made theses and dissertations available. To ensure their up-to-dateness. Regarding relevance, priority was given to studies published between 2020 and 2025, without prejudice to the inclusion of... of classic works considered relevant to the foundation of the topic.

Regarding the technical procedures, previously defined criteria were adopted. for the selection of material. Original articles, clinical trials, and in vitro studies were included. and ex vivo, systematic reviews, meta-analyses, and consensus statements that directly addressed irrigation. Ultrasonics in endodontics, available in full, in Portuguese, English or Spanish.

Duplicate works, abstracts without full text, and publications were excluded. Opinions lacking empirical basis and studies not directly related to the topic. investigated. After the initial search, the titles and abstracts were read, followed by analysis. full complement of eligible studies.

The extracted data were organized in a descriptive and comparative manner, considering Author, year, objective, methodological design, main results, limitations, and conclusions. The findings were grouped into thematic categories for critical interpretation, focusing on fundamentals of the technique, in the operational parameters, in comparisons with other methods of activation and the clinical implications of ultrasonic activation.

3.2 INSTRUMENTS FOR COLLECTING RESEARCH DATA

Since this is an integrative literature review, data collection was carried out by through secondary sources, with no primary data production involving human subjects; The instruments used in the research consisted of scientific databases and descriptors. Controlled and methodological criteria for the selection and analysis of studies. The search strategy It was structured based on descriptors from DeCS and MeSH, in Portuguese and in English, combined with the Boolean operators AND and OR. Among the main terms

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Among the terms used by employees, the following stand out: *"endodontic irrigation",* "activation".
passive *ultrasonic irrigation,* activated irrigation, ultrasound
endodontics", *"biofilm"* and *"smear layer".*

These instruments were chosen because they allow for more precise tracking and
comprehensive overview of scientific production related to the topic, in addition to promoting greater rigor in
Selection of evidence. After identifying the studies, the relevant information was...
extracted and recorded systematically, taking into account aspects such as authorship, year of
publication, type of study, method used, main results, and limitations noted.
by the authors themselves. This procedure allowed for the organization and comparison of the data obtained,
favoring the development of a critical and interpretative synthesis on ultrasonic activation in
Endodontic irrigation.

Regarding ethical aspects, it is important to highlight that this research did not involve
Direct contact with participants, application of questionnaires, interviews, field observation.
or any other form of data collection involving human subjects. For this reason, there was no need to submit it
to the Research Ethics Committee, as stipulated in Resolution No.
Resolution 510/2016 of the National Health Council, applicable to research in the human and social sciences.
and, by extension, to investigations based exclusively on bibliographic material and
This is a publicly accessible document. All data analyzed comes from publications.
Scientific sources already available, duly cited and referenced according to ABNT standards,
guaranteeing academic rigor, traceability of sources, and scientific integrity of the study.

4 RESULTS

The analysis of the studies included in this review made it possible to identify that the activation
Passive ultrasonics has been extensively investigated in laboratory research and reviews.
systematic reviews, meta-analyses, randomized clinical trials, and expert consensus. This
The body of evidence makes it possible to examine the technique from different perspectives, such as...
removal of debris, smear layer, biofilms, hydrodynamic behavior of the irrigant
and the clinical repercussions, such as postoperative pain, as well as professional applicability.

The studies analyzed indicate that PUI presents favorable results, especially
when compared to conventional irrigation, although its superiority is not absolute.
in all clinical and experimental settings.

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Table 1 – Summary of selected studies on ultrasonic activation in endodontic irrigation

Author/Year	Type of study	Technique/Comparison	Main Findings
Barbosa et al. (2021)	Systematic review of and activated meta-analysis	PUI vs. non-irrigation	PUI showed greater removal of debris and smear layer compared to static irrigation.
Yu et al. (2024)	Study with dynamics ultrasonic activation	Computational fluid	Greater flow homogeneity and better irrigation penetration were observed in hard-to-reach areas.
Pereira et al. (2023)	Randomized clinical trial	PUI vs EasyClean	PUI was associated with reduced postoperative pain and less discomfort after the procedure.
Erkan et al. (2022)	Clinical trial randomized	ultrasonic, manual and laser	Ultrasonic activation has shown clinical benefit, although sonic and laser techniques have demonstrated better performance in some outcomes related to postoperative pain.
Author/Year	**Type of study**	**Technique/Comparison**	**Main Findings**
Baumeier et al. (2022)	Comparative study	and a slight advantage in the maintained overall consistency.	All techniques improved the removal of residual material; XP-endo showed PUI, EndoActivator apical third, XP-endo Finisher R while PUI
Bao et al. (2024)	In vitro study	Er:YAG laser vs PUI vs specific conditions	The laser proved more effective in disruption of mature *biofilms* under sonic irrigation under in experimental.
Coaguila-Llerena et al. (2022)	Study experimental	Multisonic system vs PUI	The multisonic system showed greater *biofilm* removal in complex channels.
Zou et al. (2024)	Consensus of experts	Intracanal irrigation and medication	It reinforces the importance of activation methods and the need for standardization of clinical protocols.

Source: Prepared by the authors based on Barbosa *et al.* (2021), Yu *et al.* (2024), Pereira *et al.* (2023), Erkan *et al.* (2022), Baumeier *et al.* (2022), Bao *et al.* (2024), Coaguila-Llerena *et al.* (2022) and Zou *et al.* (2024).

Regarding the first specific objective, which consisted of analyzing the evidence Scientific studies on ultrasonic activation in endodontic irrigation showed that the results... They are predominantly in favor of the technique.

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As demonstrated in Table 1, Barbosa *et al.* (2021) identified superiority PUI's impact on non-activated irrigation in debris and smear layer removal, while Yu *et al.* (2024) demonstrated greater flow homogeneity and better irrigant penetration in hard-to-reach regions. This result suggests that ultrasonic activation increases the effectiveness of in-channel irrigation, especially in areas where conventional irrigation is not effective. It presents a greater limitation.

With regard to the second specific objective, aimed at comparing the PUI with the With conventional irrigation and other activation techniques, the literature reveals a more... broader and analytically more complex, PUI presents a clear advantage over irrigation. conventional syringe irrigation, especially because it promotes greater circulation of the irrigant, better penetration into the dentinal tubules and greater removal of debris. However, when compared Regarding sonic, rotary, laser-assisted, and multisonic techniques, the superiority of PUI depends depending on the outcome being evaluated, the anatomy of the canal, and the methodological conditions of each study.

Table 2 – Comparison between PUI and other activation techniques in endodontic irrigation

Technique	**Advantages**	**Limitations**	**Clinical applicability**
Ultrasonic irrigation passive (PUI)	It improves circulation of irrigator, favors the removal of suitable and *biofilms,*	It depends on parameters. non-effective debris, *smear layer*	High efficiency, gathering by and is superior in all aspects. and greater viability *of*
Technique	**Advantages**	**Limitations**	**Clinical applicability**
	It has a good scientific basis.	scenarios	clinic
Irrigation syringe widely available	Simple, affordable, conventional and	Reduced penetration of the irrigator and smaller complex	High, yet efficient in areas important limitations in intracanal cleaning
Sonic irrigation improves PUI movement in some	Simple and safe technique, inferior performance to clinic outcomes	In general, it presents	Good applicability irrigating
Assisted techniques put laser	High performance in some areas where experimental models and specific	High cost, it is necessary to equipment and restricted *biofilm* disorganization. training	Applicability to more

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Multisonic technologies	availability and greater performance in very in very complex channels. **Source:** Prepared based on Tonini *et al.* (2022), Erkan *et al.* (2022), Baumeier *et al.* (2022), Bao *et al.* (2024), Coaguila-Llerena *et al.* (2022), Lazzarotto *et al.* (2025) and Zou *et al.* (2024).	High cost, greater turbulence and better complex operational channels. Limited performance by the authors	in clinical routine

As summarized in Table 2, the comparison between PUI and other techniques
This demonstrates that ultrasonic activation occupies a prominent position by combining effectiveness, predictability and clinical applicability, compared to sonic irrigation, the studies
They indicate that PUI tends to perform better in disrupting *biofilms* and in removal of intracanal debris, Pereira *et al.* (2023) and Erkan *et al.* (2022) also indicate clinical benefits related to the reduction of postoperative pain, an aspect that broadens the
The relevance of the technique extends beyond the laboratory environment.

Comparative analysis also shows that PUI cannot be considered a method.
superior in all contexts. Baumeier *et al.* (2022) demonstrated that the *XP-endo Finisher R* showed a slightly superior advantage in the apical third, although PUI also showed...
consistent results in different regions of the canal. Similarly, Bao et al. (2024)
They found that laser-assisted techniques can outperform PUI in disrupting the organization of mature biofilms under certain experimental conditions. And Coaguila-Llerena *et al.* (2022)
They observed better performance of multisonic systems in canals with more complex anatomy.
complex. These results show that the superiority of each technique depends on the context.
depending on the application, the parameter analyzed, and the anatomical complexity involved.

Regarding the third specific objective, which sought to describe the advantages, limitations, and
Regarding the clinical applicability of the technique, the results indicate that the main advantage of PUI is...
in its ability to enhance the irrigator's action with relative operational simplicity and good scientific support (Barbosa *et al.,* 2021; Yu *et* al., 2024; Zou *et* al., 2024) On the other hand
On the other hand, relevant limitations were also identified, such as parameter dependencies.
well-adjusted technicians and the absence of complete standardization of clinical protocols, aspect already pointed out by Tonini *et al.* (2022) and reinforced by Zou *et al.* (2024).

Other technologies, such as laser-assisted systems and multisonic methods, can
to perform better in certain experimental scenarios, especially in
Complex biofilms and biofilms in more challenging anatomies, albeit at a higher cost and lower cost.
routine applicability (Bao *et al.,* 2024; Coaguila-Llerena *et al.,* 2022). Furthermore, PUI

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It remains an alternative of great clinical interest, especially because it offers a balance between effectiveness, accessibility and feasibility of use in routine dental practice (Maciel *et* al., 2025; Canton *et* al., 2025).

Koulogiannis et al. (2024) demonstrated that the depth of insertion of the tip and the Ultrasonic power influences the flow behavior inside the root canal.
while Yu et al. (2024) demonstrated, through computational fluid dynamics, that the The pattern of movement of the irrigator is directly related to the effectiveness of the technique. although the present review does not allow for the experimental validation of a clinical protocol Ultimately, the findings analyzed make it possible to propose guiding parameters for its clinical application, based on currently available evidence.

Table 3 – Proposed guidelines for the clinical application of passive ultrasonic irrigation based on the literature.

Stage/Aspect	**Guiding parameter**	**Literature basis** in
Technical purpose	Using PUI as a complementary method to that of Conventional irrigation and mechanical instrumentation, the aim of enhancing irrigant circulation and improving intracanal Employing ultrasonic activation, especially in the	Zou *et al.* (2024); Maciel *et al.* (2025) with cleaning .
Moment of use	final phase of irrigation, after biomechanical preparation,	Canton *et al.* (2025); Tonini et al. (2022) as a strategy to optimize canal system cleaning .
(2025); Irrigating	Associating the technique with the use of irrigants established in endodontics, such as sodium hypochlorite solution according to the clinical objective of disinfection removal of the *smear layer*	and EDTA, Parma & Gonçalves and Tonini *et al.* (2022)
Insertion of the ultrasonic tip	Carefully insert the tip or file. ultrasonic, respecting the canal anatomy and avoiding blockage or risk of apical extrusion	Koulogiannis *et al.* (2024); Zou *et al.* (2024)
Adjust the insertion *et al.* (2024)	depth to favor the circulation of the irrigant in regions. Kouligannis	
Stage/Aspect	**Guiding parameter**	**Literature basis** in
	criticisms, without compromising operational safety.	

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Activation time	Use controlled and moderate activation time, considering that excessive times may not bring proportional benefit and may increase the risk of undesirable effects. Kouligannis *et al.* (2024); Tonini *et al.* (2022)	
Ultrasonic power	Adjust the power of the device to be compatible with the desired hydrodynamic effect, avoiding excessive intensity and possible complications. Ensure sufficient volume of irrigating solution. (Koulogiannis *et*	
Irrigation of volume	*al. ,* 2024) to allow for proper circulation during ultrasonic activation	Tonini *et al.* (2022); Yu *et al.* (2024)
	Consider PUI as a technique with high clinical applicability, especially when seeking a balance between efficacy, accessibility, and feasibility of use (Maciel *et al. ,* 2025); Canton). Routine clinical selection criteria.	*et al.* (2025); Zou *et al.* (2024)
Important limitation	Recognizing that the technique does not present absolute superiority in all scenarios, Bao *et al.* (2024). Coaguila—and multisonic systems under specific conditions, Llerena *et*	may be surpassed by laser or *al.* (2022); Lazzarotto *et al.* (2025)

Source: Prepared by the authors based on Zou *et al.* (2024), Maciel *et al.* (2025), Canton *et al.* (2025), Tonini *et al.* (2022), Parma & Gonçalves (2025), Koulogiannis *et al.* (2024), Yu *et* al. (2024), Bao *et al.* (2024), Coaguila-Llerena *et al.* (2022) and Lazzarotto *et al.* (2025).

Since this is an integrative literature review, the application of this work... Course completion occurred within the academic and scientific context, through systematization, Critical analysis and discussion of the available evidence on the impact of ultrasonic activation. in endodontic irrigation.

The application's theme focused on understanding the effectiveness of ultrasonic irrigation. passive, in comparisons with other activation techniques and in the importance of standardization of the clinical protocols. The research results were organized and presented in a way contributing to the expansion of knowledge in the field of endodontics, offering subsidies for academic training, clinical reflection, and the development of future studies.

FINAL CONSIDERATIONS

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The present study aimed to evaluate the relevance of ultrasonic activation in endodontic irrigation, through an integrative literature review, considering its Efficacy, limitations, and clinical applicability. Based on the analysis of the selected studies, It is understood that this objective was achieved, since the consulted literature allowed... to identify consistent evidence regarding the role of passive ultrasonic activation as a technique to aid in enhancing intracanal irrigation, especially when compared to irrigation conventional.

The analyzed results indicated that passive ultrasonic activation contributes to to improve irrigant circulation, promote the removal of debris, *smear layer* and *biofilms* and To increase the penetration of the solution into hard-to-reach areas of the root canal system. It was also found that the technique has clinical relevance, including in outcomes such as the reduction of postoperative pain, although its superiority is not absolute in all cases. scenarios.

When compared to sonic, rotary, laser-assisted, and multisonic techniques, the PUI has shown consistent performance and broad applicability, but studies also They showed that some methods may have an advantage in specific conditions. especially in more complex experimental models.

This study contributes to the field of Endodontics by gathering, organizing, and critically discussing... Recent evidence on ultrasonic irrigation is contributing to a better understanding of... mechanisms of action of the technique and its position among the different activation methods Available resources provide input for evidence-based clinical reflection, by to demonstrate that PUI represents an effective, accessible, and viable alternative for routine dental practice, especially in the final stage of endodontic irrigation. For the researchers, the review It contributes by highlighting important situations, especially regarding the standardization of

clinical protocols and the need for long-term research that evaluates, with greater precision, clinical protocols and the need for long-term investigations that assess, in greater detail, the need for long-term research that evaluates the results of clinical protocols.

Robustness, outcomes such as periapical healing, and therapeutic success.

The effectiveness of ultrasonic activation depends not only on the technique itself, but also how it is used in clinical practice. This shows that, to achieve good results, it is Care is needed in the application process. Although this review did not test a protocol. In clinical practice, the studies analyzed allowed for the gathering of important information that can to serve as a basis for a more standardized, secure, and evidence-based application.

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It can be concluded, therefore, that passive ultrasonic activation occupies a relevant place among the auxiliary methods of endodontic irrigation, representing an important resource for the improving intracanal cleaning and strengthening clinical practices based on evidence, including with regard to proposing guidelines for its clinical application.

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