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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
Studies indicate that this technique can improve the penetration of the irrigant into the dentinal tubules and into the
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
ultrasonic tip, activation time, ultrasound power, and volume of irrigant used.

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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 databases. National and international submissions will be included. Original articles, clinical trials, and research will also be considered. laboratory studies, systematic reviews, meta-analyses, and consensus statements that directly address the Ultrasonic irrigation in endodontics. Analysis of the material will allow the identification of convergences, divergences and gaps in scientific knowledge on the subject. Throughout the work, there will be... The fundamentals of endodontic irrigation and the mechanisms of ultrasonic activation were discussed. the comparative performance of the technique in relation to other methods and its implications for the contemporary clinical practice.

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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 irrigators essential for the
Dissolution of organic tissues, microbial reduction, and removal of debris produced during the process.
biomechanical preparation (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 promoting any single irrigant's effectiveness.
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
the deep dentinal tubules are considered, whose structure favors permeability and
This can allow microbial persistence even after mechanical preparation. In this sense, the
Literature reinforces that the effectiveness of intracanal disinfection depends not only on the choice of
irrigation, but also the ability to distribute it properly throughout the system.
root (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.
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

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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 through a point.
A metallic file or file attached to a piezoelectric device, inserted into the canal previously
filled with irrigating solution (Koulogiannis *et* al., 2024; Maciel *et* al., 2025).

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.

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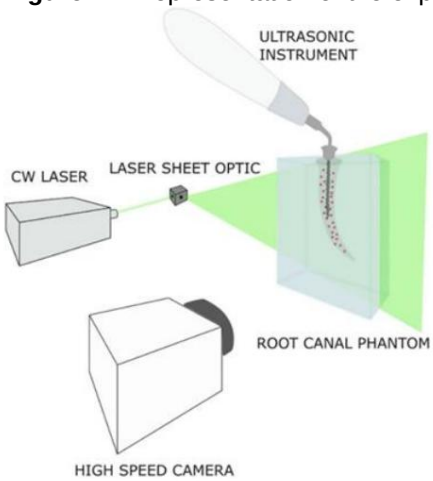
Figure 1 – Representation of the experimental setup for ultrasonic activation in endodontic irrigation.



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 Irrigating agent 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 inside the solution, a process that releases energy and expands the penetration of the irrigator in hard-to-reach regions. access, 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. 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 channels

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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 guiding question of this study was defined as follows: how does ultrasonic activation Did this influence the effectiveness of endodontic irrigation in disinfecting root canals? The question 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.

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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
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 of the 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.

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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 immediately apparent. absolute in all clinical and experimental scenarios.

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 meta-analysis	PUI vs. non-debris irrigation and activated	PUI showed greater removal according to smear layer comparison to static irrigation.
by Yu et al. on (2024)	Study with fluid dynamics and computational	ultrasonic activation.	Greater flow homogeneity and better irrigation penetration were observed in hard-to-reach areas.
Pereira et al. (2023)	Clinical trial PUI vs randomized	EasyClean	PUI was associated with reduced postoperative pain and less discomfort after the procedure.
Erkan et al. (2022)	Ultrasonic clinical trial, randomized	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.

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Author/Year	Type of study	Technique/Comparison	Main Findings
Baumeier et al. (2022)	comparative	a slight advantage in the apical	All techniques improved the removal of residual material; XP-endo showed PUI, EndoActivator and third, XP-endo Finisher R. while PUI maintained global consistency.
Bao et al.	In vitro study (2024)	vs PUI vs disruption of mature Sonic irrigation	The laser showed greater efficacy in Er:YAG laser *biofilms* in given experimental conditions.
Coaguila-Llerena et al.	Study experimental (2022)	removal in PUI channels.	The multisonic system showed greater *biofilm* complex.
Zou et al. (2024)	Consensus experts	medication activation methods and	It reinforces the importance of irrigation and the need for intracanal treatment. 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.

As demonstrated in Table 1, Barbosa *et al.* (2021) identified superiority PUI's impact on non-activated irrigation in removing debris and the smear layer, 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
Passive ultrasonic irrigation (PUI)	It improves circulation of irrigating, favors the removal of debris, *smear layer* and *biofilms,* is superior viability. Suitable and non-effective, predictable, and more viable.	It depends on parameters.	High efficiency, gathering by in all aspects and greater

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Technique	**Advantages:**	Scenario	**Clinical applicability**
	It has a good scientific basis.	**limitations**	clinic
Irrigation conventional, and syringe	Simple, accessible, widely available.	Lower penetration of significant and smaller limitations in intracanal complex	High efficiency, but with cleaning.
Sonic irrigation	Simple and safe technique, inferior improvement in PUI movement in some irrigator	In general, it presents performance to clinics outcomes	Good applicability
Laser-assisted techniques	High performance in some areas where experimental models and specific equipment.	High cost, it is necessary to *biofilm* disorganization training	Applicability is limited to
Multisonic technologies	better availability, and greater use. complexes	High cost, greater turbulence and performance in channels with high clinical complexity. Limited in routine operational	

Source: Prepared by the authors 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).

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

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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 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 movement pattern 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**
Technical purpose	Using PUI as a complementary method to conventional irrigation and mechanical instrumentation, Zou *et al.* (2024); Maciel *et al. (2025)* with the aim of enhancing circulation irrigating and improving intracanal cleaning	
Moment of use	Employing ultrasonic activation, especially in the final phase of irrigation after biomechanical preparation, Canton *et al.* (2025); Tonini *et al.* (2022) as a strategy for optimizing system cleaning . of channels	
solution	Associating the technique with the use of irrigants established in endodontics, such as sodium hypochlorite and EDTA, Parma & Gonçalves (2025); Irrigating according to the clinical objective of disinfection and Tonini *et al* (2022) removal of the *smear layer*	
ultrasonic tip insertion	Careful insertion of the tip or file is performed using the technique (Koulogiannis *et al.,* 2024), respecting the canal anatomy. avoiding locking or risk of apical extrusion	Zou *et al.* (2024)
Adjust the insertion insertion	depth according to Kouligannis *et al.* (2024) to promote the circulation of irrigant in regions	

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Stage/Aspect	Guiding parameter	Literature basis in
	criticisms, without compromising operational safety.	
Activation time	Use controlled and moderate activation time, considering that excessive times may not provide proportional benefit and may increase risk. Kouligannis *et al.* (2024); Tonini *et al.* (2022) of undesirable effects	
Ultrasonic power	Adjust the power of the device in a way that is compatible with the desired hydrodynamic effect, avoiding Kouligannis *et al.* (2024) excessive intensity and possible complications	
Irrigation volume	Ensure sufficient volume of irrigating solution as per Tonini *et al.* (2022); Yu *et al.* to allow adequate circulation during activation (2024) ultrasonic	
clinical practice, especially	Consider PUI as a highly applicable technique Maciel *et al.* (2025); Canton Clinical criterion of when seeking balance *et al.* (2025); Zou *et al.* between effectiveness, accessibility and feasibility of use routine	(2024)
Important limitation	Recognizing that the technique does not exhibit absolute superiority in all scenarios, Bao *et al.* (2024), Llerena *et al.* (2022); and may be surpassed by laser systems or Lazzarotto *et al.* (2025) multisonic under specific conditions	

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

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

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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 care. dental practice, especially in the final stage of endodontic irrigation. For the researchers, the This review 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.

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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