Review Article

# Sonics and Ultrasonics in Endodontics – A Review

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## Abstract

With the development of science and technology, the modernization of the dentistry took place, the use of sonics and ultrasonics in the dentistry had a long back history but their usage in dentistry is still emerging. The sonic and ultrasonic instruments have various applications in the endodontics such as – access cavity preparation, root canal preparation, irrigant activation, and others. They provide more conservative approach, while removing tooth structures, better safety, and handling. Thus, sonics and ultrasonic have various applications in endodontics. This review article includes advantages, disadvantages, limitations, and application of the different sonics and ultrasonics.

**Keywords:** Access cavity preparation, Sonic in endodontics, Sonics and ultrasonics.

## Introduction

The evolution of dentistry is strongly correlated to the development of science and technology. Over the past few decades, development of many new techniques widened the scope of endodontic therapy. Using ultrasonics in endodontics, the predictability of the treatment and prognosis has improved, when compared to the classical procedures while delivering superior quality and efficiency.[1]

Richman introduced the concept of ultrasonics in endodontics in 1957. While, Martin *et al*. demonstrated the ability of ultrasonically activated K files to cut dentin for the 1st time. Endosonics can be defined as the ultrasonic and synergistic system of root canal instrumentation and disinfection. That leads to the development of low-frequency ultrasonic hand pieces operating from 1 to 8 kHz.[2]

The sonic hand pieces which operate at a frequency range between 1 and 8 kHz were introduced as an alternative to the ultrasonic devices as they are less expensive and easily sterilized.[3] In addition, they require less maintenance as they are operated by the compressed air outlet of a dental unit. These instruments offer a practical alternative to ultrasonic instrumentation (UI).[4]

Biophysical effects of ultrasonics include acoustic microstreaming and cavitation. Acoustic microstreaming results in the production of large hydrodynamic shear stresses around the file which are more than capable of disrupting most biological materials. While in cavitation, microscopic bubbles formed will collapse and explode, resulting in areas of pressure and heat production.[5]

Advantages of ultrasonics are it provides a more conservative approach while selectively removing tooth structure. Ultrasonic tips do not rotate, thus enhancing safety and control, while maintaining a high cutting efficiency. Ultrasonic files are versatile, flexible, and affordable. They can be bent in endless variety of angles and lengths to accommodate the specific characteristics of the root. However, it lacks tactile sensation and hand pieces are large and heavy.[6]

The understanding of basics of ultrasonics and sonics, methods of its clinical use allow us to consider effectiveness, safety, limitations, and rationale of dental UI.

The most frequent applications of ultrasonics in endodontics are access cavity preparation, root canal preparation, irrigant activation, root canal obturation, broken instrument retrieval, retrograde preparation, MTA and calcium hydroxide placement, and sealer application. While, sonics are used in root canal preparation, irrigation, root end preparation, and sealer application.

The aim of this review literature is to analyze and discuss the applications of ultrasonics and sonics in endodontics.

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**Received:** Jan. 12, 2022; **Accepted:** Feb. 23, 2022; **Published:** Mar. 03, 2022



**How to cite this article:** Angitha S, Hiwale S, Manan R, Azhar S, Ganapathy S, Singh D. Sonics and Ultrasonics in Endodontics – A Review. J Res Adv Dent 2022;13(3):98-101.

**Access this article online**

**Website:** www.jrad.co.in

**DOI:** https://doi.org/10.53064/jrad.2022.13.3.165

## Applications

### Access cavity preparation

Ultrasonics instruments help in identifying the canals which have been occluded by calcification or secondary dentin. Ultrasonics tips have greater control over the visual root canal access. It is commonly used in locating the MB2 canal of the maxillary molar by removing secondary dentin. Ultrasonics can break the calcification and make good access for the cleaning and shaping procedure.[1] When pulp stone occludes the root canal orifice, ultrasonic tips used with a brush-like motion without gauging the floor can smoothen away the pulp stone. The tips should be used effectively and set from a maximum to average intensity, alternating the irrigation phase and dry phase to avoid overheating.

The selection of the tip for use depends on the task to be performed. For the gross dentin removal, an ultrasonic tip such as the BUC-1, BL-1, or CPR-2D can be used. These tips have suitable length, more resistance to fracture, and an abrasive grit. These tips should not be placed in direct contact with porcelain crowns and facing as its brittle nature can cause ceramics to fracture and even become dislodged when ultrasonic tip contacts.[7]

Zogheib *et al*. studied the effects of ultrasonic refinement on endodontic access cavity walls. The results of this study showed that the most of the coronal extension of dentinal defects observed after access cavity preparation were already present, except for two coronal extensions of dentinal defects newly formed in the ultrasonic group.[8]

### Root canal preparation

Ultrasonic filing allows three-dimensional preparation of the canal walls. The action with ultrasound is that of a propagating oscillating wave drawing the file through the root canal. According to the study by Martin *et al*., when the ability hand files and K-type files to remove dentin from canal were compared, the ultrasonic energized file removed a significantly high amount of dentin in a fixed time period.[9]

The ultrasonic preparation of the root canal shows high irrigation potential, high efficiency dentin removal, and less operator fatigue. However, it cannot provide tactile sensation and it is hard to locate the file tip accurately during the preparation. Thus, a precise preparation of the canal is difficult to achieve. To overcome such disadvantages, a new ultrasonic root canal preparation system such as Root ZX has been developed that electronically monitors the location of the file tip during whole instrumentation procedures.[10]

The action of an ultrasonic tip significantly improves disinfection in flattened canals and cleaning in the retreatment of flattened root canals where Nickel-titanium instruments fail to do so. The flatsonic ultrasonic tip has found to be effective in the preparation and retreatment of flattened canals. Flatsonic tip has a diameter of 0.25 mm, a flat inverted arrow design, and a smoother surface. The combination of rotary instruments with ultrasonic tips can increase canal volume and thus reducing the non-instrumented areas of the canal system.[11]

### Irrigant activation

To improve the cleaning and disinfection of root canals especially with anatomical irregularities, a variety of irrigant agitation or activation methods have been proposed, the most widely used one being ultrasonic activation.[12]

Ultrasonic irrigation is of two types, one where irrigation is combined with simultaneous UI and another without simultaneous instrumentation, called as passive ultrasonic irrigation (PUI). During UI, file is intentionally brought into contact with the canal wall. However, it is not as much of effective in removing simulated pulp tissue or smear layer from the root canal when compared to PUI. This can be due to the decrease in acoustic streaming and cavitation.[13]

The recently introduced Irrisafe files (Acteon Satelec) are an adaptation of the K-files to the requirements of irrigant activation. They have almost no taper, blunt tip, a larger pitch, round edges to minimize or even prevent unintentional dentin cutting.[14]

### Root canal obturation

One by-product of ultrasonic energy is heat energy. When this heat energy is transmitted by an ultrasonic tip or file, gutta-percha can be softened enabling obturation. A very limited number of studies have investigated the ability of ultrasonic heat energy to soften and compact gutta-percha during obturation for achieving a denser root filling.[5] The recommended obturation technique while using the ultrasonic techniques consists of initial placement of a gutta-percha cone to the working length followed by cold lateral condensation of accessory cones using a finger spreader. The ultrasonic spreader is then placed into the center of the gutta-percha mass 1 mm short of the working length and activated at intermediate power to prevent charring of root surfaces and fracture of the ultrasonic spreader. After activation, the ultrasonic spreader is removed, and an additional accessory cone is placed, followed by energizing with an activated ultrasonic spreader.[7]

When compared to cold lateral condensation, using an ultrasonic lateral condensation technique resulted in a denser filling, with fewer voids, and less apical microleakage. Warm vertical compaction of gutta-percha, whether using a traditional heat source or ultrasonic vibrations showed similar sealing ability. Baumgardner and Krell demonstrated that the ultrasonic condensation of the gutta-percha mass is more homogeneous and shows fewer voids compared to condensation without ultrasonic activation.[6]

### Retrieval of broken instruments and posts

Several techniques and devices have been used for the removal of broken instruments. However, the combination of ultrasonic techniques and the dental operating microscope is consistently reported to be successful and safe for the removal of broken instruments from root canals.[15] Recent studies demonstrated the use of an ultrasonic file removal method that can be considered as a variation of the Ruddle technique. This technique uses modified Gates Glidden burs to create

a "staging platform" at the coronal aspect of the fractured instrument. Then, fine ultrasonic tips of various lengths are used to trough around the coronal part of the instrument to expose it, followed by ultrasonic vibration of the instrument fragment to loosen it.[6]

Alternative techniques using the abrasive action of ultrasonics have also been used to erode and eliminate silver points and other obstructions; however, removal of stainless-steel obstructions and posts made of non-precious metals cannot be removed with this technique. Care should be taken with all tips used for 1–2 min to remove fine file fragments as significant increase in temperature can occur within this time period.[7]

## Surgical endodontics

U1ltrasonically driven microsurgical retrotips became commercially available in the early 1990s. Since then, this new technique of retrograde root canal instrumentation has been established as an essential adjunct in periradicular surgery. SEM studies have revealed that ultrasonic root end preparation is more effective at removing superficial debris within the cavity when compared to rotary instrumentation. Dye leakage studies showed that the use of UI may result in an increased incidence of root face cracking, which could increase the possibility of apical leakage.[16]

Several *in vivo* studies reported excellent success rates when the root end preparation was performed using ultrasonic retrotips, thus demonstrating improved outcome compared to the traditional techniques. It is recommended that the ultrasonic unit be set at medium power and the cavities be prepared to a depth of 2.5–3 mm. This depth allows for a minimum thickness of material that can still provide an effective apical seal. The cavity walls should be parallel and follow the anatomic outline of the pulpal space.[6]

## Ultrasonic non-vital bleaching

The action of an internal bleaching agent is dependent on its ability to penetrate into dentinal tubules and by means of oxidation-reduction reaction. Ultrasonic activation of an irrigant, 1% NaOCl or 17% EDTA, in the pulp chamber can significantly increase dentine permeability. The irrigant is placed in the pulp chamber and then ultrasonically activated for 15 s and this procedure repeated. An ultrasonic tip is used without touching the cavity walls. After this procedure, the bleaching agent can then be applied.[1]

## MTA placement

The use of ultrasonic to aid in the placement of MTA was first described by Witherspoon and Ham. It was demonstrated that, with the adjunct of ultrasonic, a significantly better seal with MTA was achieved. Placement of MTA with ultrasonic vibration and an endodontic condenser improved the flow and compaction of MTA. Furthermore, the ultrasonically condensed MTA appeared denser radiographically, with fewer voids. Ultrasonic energy will vibrate and generate a wavelike motion, which facilitates moving and adapting the MTA cement to the canal walls.[6]

Ultrasonics are used for placement of MTA in canals both orthogradely and retrogradely. After placing the MTA with the ultrasonic tip, the tip is activated and MTA material is moved down using a 1–2-mm vertical packing motion. Direct ultrasonic energy will generate a wavelike motion and facilitates moving and adapting the cement to the canal walls.[4]

## Sealer application

The use of ultrasonic activation at different levels facilitated better dentinal sealer. Ultrasonic activation proved to positively influence the sealer penetration, hence, promoting the longevity minimizing the chances of microleakage. Further studies should be conducted to analyze the entire canal rather than a portion with bigger sample size as penetration depth of sealer may be important in the future endodontic treatment outcomes. Ultrasonic activation improved dentinal sealer penetration which can promote confinement of microorganisms present in the dentinal tubules. In addition, sealer plugs inside the dentinal tubules provide a mechanical interlocking, hence, improving the retention of the filling material along the root canal walls.[17]

The ultrasonic activation of the sealer did not seem to influence the presence of voids, which probably is more related to the inability of the lateral compaction technique to allow a homogeneous layer of sealer on the entire root canal wall.[18]

## Removal of intracanal medicaments

Most studies reveal that the complete removal of calcium hydroxide using instrumentation, conventional irrigation, or activated irrigation methods is not possible regardless of the technique. Some studies show no advantage of PUI in removing calcium hydroxide, while other studies show PUI to enhance its removal. The choice of irrigant may also affect calcium hydroxide removal efficacy, with calcium chelating irrigants such as 17% EDTA and 10% citric acid enabling greater removal of calcium hydroxide.[7]

Motiwala *et al*. compared two different methods of ultrasonic activation of file and rotary master apical file in the removal of oil-based calcium hydroxide from root canal system. Both methods were equally effective in all the thirds of canal. However, none of the techniques were able to completely remove the it.[19]

# Conclusion

Sonics and ultrasonics have been introduced more than a decade but there use in dentistry is still limited. There is a need to understand the advantages of sonic and ultrasonic instruments over the conventional instruments.[20] Although, they also have their limitations. The sonic and ultrasonics are beneficial to use but it also depends on the clinical judgment of the clinician and the skills.[21]

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