

Modern Concepts of Ultrasonic Root Canal Irrigation

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Abstract

The modern concepts of Ultrasonic irrigation in root canals is performed with or without ultrasonic instrumentation. During canal shaping, passive ultrasonic irrigation (PUI) can be used for debridement of Canal residues. Passive ultrasonic irrigation can performed by small file or smooth wire (size10-20) oscillating freely in the root canal to induce the powerful acoustic micro streaming. Compared with traditional syringe irrigation, it removes more organic tissue, planktonic bacteria and dentine debris from the root canal. This article reviews the phenomenon of Ultrasonic Irrigation and its benefits over conventional irrigation process.

Keyword: Endodontics, Irrigant, Ultrasound.

Introduction:

Irrigation is complementary to instrumentation in facilitating removal of bacteria, debris and therapeutic materials such as gutta-percha, sealer and medicaments from root canals. The effectiveness of irrigation relies on both the mechanical flushing action and the ability of irrigants to dissolve tissue. Sodium hypochlorite (NaOCl) has been used as an endodontic irrigant for at least six treatment is chemo mechanical preparation decades (Walker 1936). Irrigation with NaOCl has been shown to dissolve organic tissues and antibacterial in root canals (Bystro'm & Sundqvist 1983). The flushing action of irrigants helps to remove organic and dentinal debris and microorganisms from the canal. Indeed, it has been suggested that the flushing action may be more important than the ability to dissolve tissue (Baker et al. 1975). The flushing action created by syringe irrigation is relatively weak and dependent not only on the anatomy of the root canal system but also on the depth of placement and the diameter of the needle (Abou-Rass & Piccinino1982, Chow 1983). Increase in the volume of irrigant does not significantly improve its flushing action and its efficacy to remove

debris. The purpose of this study was to evaluate and compare the ability of syringe irrigation and ultrasonic irrigation to remove artificial dentine debris from simulated canal extensions and irregularities.

Ultrasound: What Are They?

Ultrasound is a vibration or acoustic wave of the same nature as sound but at a frequency higher than required for production of ultrasound. This phenomenon, uses magnetostriction that converts electromagnetic energy into mechanical energy. Magnetostrictive strips are joined to a stable and alternating magnetic field which leads to vibrations. The other method is based on piezoelectric principle which uses a crystal that changes size when electrically charged. When crystals gets deformed, mechanical oscillation occurs without heat production. Magnetostrictive units produce elliptical movement that are not ideal for endodontic use. Moreover, these units produce lot of heat which requires adequate cooling.¹ The benefits of ultrasonic tip is that it delivers safety, control and high cutting efficiency without getting rotated. This movement is

ideal in endodontic surgery when a preparation for retrograde filling is created.²

Role of Ultrasound in Endodontics:

Ultrasound was first used to prepare cavities. Earlier, ultrasound was used in the concept of minimal invasive dentistry and preparing small cavities. It did not become popular until 1955 when ultrasonic was first used to remove calculus deposits and plaque from teeth surfaces. Although ultrasonic is used for cleaning instruments, it plays a dispensable role in scraping and smoothening the root surfaces of teeth and root canal treatment.^{1,3}

It was in 1957, when Richman first introduced ultrasonic instrumentation to endodontics, for root canal therapy and got good results. Ultrasonically activated K files were not used for root canal preparation until the study done by Martin et al.⁴ Martin and Cunningham defined "Endosonic" as the ultrasonic synergistic system of instrumentation and canal disinfection.⁵ Ultrasounds eliminate smear layer, which appears less effective in improving EDTA activity.^{1,6} Ultrasonics have also shown its efficacy in Canal Irrigation. The effectiveness of irrigation depends on stream action and the chemical ability of the irrigants to dissolve tissue.⁷⁻⁹ With syringes, stream action is relatively weak and depends on both root canal anatomy and the depth of the needle according to its diameter. It has been shown that irrigants can only progress 1 mm beyond the tip of the needle. Increased volume does not significantly improve cleaning action or detritus elimination.¹⁰

Although ultrasonic is used in dentistry for therapeutic and diagnostic applications as well as for cleaning of instruments before sterilization currently its main use is for scaling and root planning of teeth and in root-canal therapy.¹¹⁻¹⁵ The concept of minimally invasive dentistry and the desire for preparations with small dimensions has stimulated new approaches in cavity design and tooth-cutting concepts, including ultrasound for cavity preparation.¹⁶⁻¹⁸ Table No. 1 describes most frequent applications of ultrasonic in endodontics.

Role of Ultrasonic In Irrigation Process:

Advancements in canal shaping instruments and techniques have led to a much greater emphasis on root canal irrigation process. Cleaning process with high volume of irrigation and frequent exchange of sodium hypochlorite provides more success. But, total removal of organic and inorganic canal debris from apical third continues to be a challenge. Ultrasonic use to activate irrigant in the canal has shown to be a clinically proven and efficient adjunct to cleaning and shaping instrument sequences and is used by many endodontic specialists. Ultrasonic activation of irrigants produces at least 2 helpful effects:^{19,20}

1. Cavitation, defined as the formation of thousands of tiny bubbles which rapidly implode, producing a "shock wave" removing biofilm.
2. Acoustic streaming which produces shear forces that will help extricate debris from instrumented canals.

Instruments used for ultrasonic irrigation:

- Irrisafe file resembles a K-type file and has thin parallel tip with non-cutting, rounded flutes. These flutes affect acoustic streaming, but does not engage the dentin or transport the canal.
- 31-gauge NaviTip are more effective in irrigation the canal is filled with sodium hypochlorite with 2 side ports offset to each other, and capped at the end.
- Luer Vac adapter - The irrigant may then be evacuated out with a Luer Vac Adapter. This clinically and scientifically accepted method of passive ultrasonic irrigation helps push the ultrasonic from luxury into necessity status.^{21,22}

Comparison between Passive Ultrasonic Irrigation(PUI) and Hand Irrigation:

The amount of debris was significantly less in PUI irrigated root canals than in hand irrigated root canals. For PUI irrigated canals the amount of debris was 95% less than in untreated canals and for hand irrigated canals the amount of debris was 67% less than in untreated canals.

Table No. 1: Most Frequent Applications of Ultrasonic in Endodontics

Sl.no	Application
1	Access refinement, finding canals with calcification and pulp stone removal
2	Removal of intra canal obstructions (separated instruments ,root canal posts, silver points, and fractured metallic post)
3	Increased action of irrigating solutions.
4	Ultrasonic condensation of gutta-percha.
5	Placement of mineral trioxide aggregate (MTA).
6	Surgical endodontics: Root-end cavity preparation and refinement and placement of root-end obturation material.
7	Root canal preparation.

The percentage of clean root canal area at the 2 mm level was 29% for hand irrigated canals and 80% for PUI irrigated canals and at the 3mm level 43% for hand irrigated canals and 81% for PUI irrigated canals. No significant difference was found between the percentages of tissue area in the untreated canals of both groups. The area of the root canal after instrumentation and irrigation was not significantly different between the groups.²²⁻²⁵

Benefits of PUI in General Practice:

- ✓ Increased tissue dissolving (chemical) and dispersion (mechanical) of NaOCl (increased contact area between NaOCl and pulp tissue).
- ✓ Improved sealing of root canal filling.
- ✓ Could lead to a higher healing rate of endodontic treatment due to more efficient removal of dentine debris and pulp tissue and bacteria from the root canal and better sealing of the root canal filling, however this has never been evaluated.
- ✓ Cheap, simple and fast procedure.

Conclusion:

PUI removed significantly more pulp tissue and dentine debris from the apical root canal than hand irrigation. PUI is a more effective irrigation system than hand irrigation in vitro and in vivo. Different irrigation systems during PUI (continuous flush, intermittent flush) have different working mechanisms with remarkable advantages for the intermittent flush. Water is not as effective as NaOCl

as irrigant during PUI. PUI with NaOCl result in a more energetic streaming of the irrigant. Better irrigation leads to better sealing of the root canal filling PUI removes Ca(OH)₂ better from the root canal than hand irrigation. PUI is a simple and cheap method to improve endodontic treatment in general practice.

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How to Cite: Dalai DR, Bhaskar DJ, Agali CR, Singh N, Singh H. Modern Concepts of Ultrasonic Root Canal Irrigation. *Int J Adv Health Sci* 2014; 1(4):1–4.