

**REVIEW ARTICLE****Current Trends to Improve Root Canal Disinfection – A Review**Priya Matani<sup>1</sup>, Devendra Chaudhary<sup>2</sup>, Robina Mathew, Bhupindra Chouhan<sup>4</sup>.**Abstract:**

*Endodontics is the art and science that deals with prevention and treatment of pulp and periradicular diseases. The success of root canal therapy relies on chemo mechanical preparation, irrigation, microbial control and complete obturation of the root canals. Hand and rotary instrumentation play a key role in course of treatment systems to mechanically eliminate microorganisms from the accessible parts of the primary root canal by direct mechanical cleaning action. However, the intricacy of root canal morphology provides areas such as curved apical third, narrow isthmi, apical deltas, ribbon-shaped and oval canals, can't be cleaned mechanically, bacteria can endure and flourish in these untouched areas and are the real reason for pulpal and periapical diseases and this presents a challenging objective to the endodontic treatment.*

*It's widely stated, "Instruments Shape, Irrigants Clean". Wide heap of irrigating solutions have been upheld for the sanitization process during root canal therapy. Irrigants have traditionally been delivered into the root-canal space using syringes and metal needles of different size and tip design, but this classic approach typically results in ineffective irrigation. Therefore, many of the compounds used for irrigation have been chemically modified and several mechanical devices have been developed to improve the penetration and effectiveness of irrigation. This article summarizes the chemistry, biology, and procedures for safe and efficient irrigation and provides cutting-edge information on the most recent developments.*

**Key words root canal, disinfection, current trends****Introduction**

Chemical disinfection is an important cornerstone of a successful outcome because it reaches bacteria or fungi present in dentinal tubules and in the crevices, fins, and ramifications of a root canal system. The main goal of instrumentation is to facilitate effective irrigation, disinfection, and filling.

Biomechanical preparation & chemical preparation are used concomitantly in order to debride the root canal system. At the time of biomechanical preparation suitable irrigants are utilized which help in accomplishing debridement and disinfection of the root canal system

Mechanical impacts of irrigants are created by the backward and forward flow of the irrigation solution amid cleaning and shaping of the contaminated root canals, altogether lessening the bacterial load.(2)

Throughout the history of endodontics, endeavors have continuously been made to develop more effective irrigant delivery and agitation systems for root canal irrigation. These systems might be divided into 2 broad categories, manual agitation techniques and machine-assisted agitation devices. The objective of this review was to present an overview of contemporary irrigant agitation methods available in endodontics and to provide a critique of their debridement efficacy.

**Types of irrigant Activation Systems**

Mechanical instrumentation by itself could reduce microorganisms from root canal system even without using irrigants and intracanal dressings (16), but it is not able to assure an effective and complete cleaning (17). Irrigating solutions by themselves without a mechanical preparation, are not able to significantly reduce the intracanal bacterial infection (18). For these reasons, the systems that can improve root canal disinfection through mechanical activation of endodontic irrigants as sodium hypochlorite have been currently researched. Multiple techniques and agitation systems of irrigants have been used over

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time (19) demonstrating more or less positive results (20).

### **Manual Agitation Techniques**

The simplest of all mechanical activation techniques is the manual irrigant agitation, which can be performed with different systems. The easiest way to achieve this effect is moving vertically and passively the endodontic file within the root canal. The file promotes the irrigant penetration (21) and reduces the presence of air bubbles in the canal space (22), but does not improve the final cleaning (20). Another similar technique advises to move vertically a gutta-percha cone until reaching the working length while the canal is filled with irrigant. Even this method, however, does not improve the intracanal cleaning (20,23). Endodontic brushes and specific needles for endodontic irrigation with bristles on their surface is another technique suggested in order to move the irrigant more effectively within the canals. These systems have shown to be valid in the removal of smear layer from root canal walls (24,25), thus they can be indicated during irrigation with EDTA to improve their efficacy at the end of the preparation.

### **Machine-Assisted Agitation Systems**

The evolution of the manual systems led to the introduction of instruments that may be rotated by hand-pieces at low speed inside the canal fill with irrigant. Instruments such as plastic files can show a smooth surface and increased taper (26-28), or even a surface with lateral plastic extensions (29-31). Studies on these systems have shown conflicting results. There are better results for the machine-assisted agitation systems than for the conventional irrigation technique with syringe, but worse than other more effective systems (19).

#### **1. Continuous Irrigation during Instrumentation**

Recently a new system for root canal preparation was introduced in the market. This system uses a particular instrument with abrasive surface that enlarges the canal by friction and in a vibrating motion allows the irrigant to flow through the file itself. This system has shown excellent results in terms of anatomy preservation and cleaning ability. It can reach anatomical areas of difficult access as isthmuses, oval canals or C-shaped canals (32). The low cutting efficiency of this system in some cases may limit its use in the root canal preparation. On the other hand, its concept of continuous irrigation was already developed in the past with mechanical

instruments for sonic and ultrasonic preparation (34,35) that could contextually clean by continuous release of irrigant.

#### **2. Sonic Activation**

Sonic activation has shown to be an effective method to disinfect the root canals (36). Most actual systems have smooth plastic tips of different sizes activated at sonic frequency by a hand piece (37). This system seems to be able to effectively clean the main canal, to remove the smear layer and to promote the filling of a greater number of lateral canals (20,38). Another recently introduced technique uses a syringe with sonic vibration that allows the delivery and activation of the irrigant in the root canal at the same time. Sonic activation differs from the ultrasonic because it operates at a lower frequency (1-6 kHz) (39), and for this reason it is generally found to be less effective in removing debris than the ultrasonic systems (20,40-42).

#### **3. Apical Negative-Pressure Irrigation**

In order to deliver the irrigant into the root canal for the entire length and to obtain a good flow of fluid, apical negative-pressure systems have been introduced to simultaneously release and remove the irrigant. These systems comprise a macrocannula for the coronal and middle portions and a microcannula for the apical portion, which are connected to a syringe for irrigation and the aspiration system integrated with the dental unit (43). During irrigation, a tip connected to a syringe delivers the irrigant in the pulp chamber, while the cannula placed in the canal pulls irrigant into the canal, through the aspiration system to which it is connected, and evacuates it through the suction holes.

#### **4. Laser Activation**

The interaction between laser and the irrigant in the root canal outlines a new area of interest in the field of endodontic disinfection. This concept is the base of the Laser Activated Irrigation (LAI) and the so-called PIPS technology (Photon-Initiated Photoacoustic Streaming) (51). The mechanism of this interaction has been attributed to the effective absorption of laser light by sodium hypochlorite. This leads to the vaporization of the irrigant and to formation of vapor bubbles, which expand and implode with secondary cavitation effects. The PIPS technique is based on the power of Erbium:YAG laser to create photoacoustic shock waves within the irrigant introduced in the canal. When activated in a

limited volume of liquid, the high absorption of the laser in hypochlorite combined with the high peak power derived from the short pulse duration (50  $\mu$ s) determines a photomechanical phenomenon (51). A study showed that there was no difference in bacterial reduction achieved by hypochlorite sodium activated by laser compared to sodium hypochlorite only (52).

### Additional Disinfection Systems

In addition to the above-mentioned systems, endodontic research is also oriented towards the identification of alternative solutions that could further refine the disinfection and assist the destruction of biofilms and elimination of microorganisms.

#### a. Photo-Activated Disinfection (PAD)

A new method recently introduced in endodontics is the Photo-Activated Disinfection (PAD). This technique is based on the principle that the photosensitizing molecules (photosensitizer - PS) are able to bind to the membrane of the bacteria. PS is activated at specific wavelength and produces free oxygen, which causes the rupture of the bacterial cell wall on which the PS is associated with, determining a bactericidal action (55). An endodontic system called Light-Activated Disinfection (LAD) was developed. It is based on a combination of a PS and a special light source. The PS attacks the membranes of microorganisms and binds to their surface, absorbs energy from light and then releases this energy in the form of oxygen (O<sub>2</sub>), which is transformed into highly reactive forms that effectively destroy microorganisms. The LAD is not only effective against bacteria, but also against other microorganisms including viruses, fungi and protozoa (56). The PSs have far less affinity for the cells of the body; therefore toxicity tests carried out did not report adverse effects of this treatment (57).

#### b. Laser

In the Endodontics area several types of laser have been used to improve root canal disinfection: diode laser, gas laser (CO<sub>2</sub>), erbium: YAG laser, neodymium: YAG laser. Bactericidal action of the laser depends on the wavelength and energy, and in many cases it is due to thermal effects that produce alteration of the cell wall of the bacteria, leading to changes in osmotic gradients up to cell death. Some studies have concluded that the laser irradiation is not an alternative, but rather a possible integration to

existing protocols to disinfect root canal (61). The laser energy emitted from the tip of the optical fiber is directed along the canal and not necessarily lateral to the walls. To overcome this limitation, a delivery system that allows lateral emission of the radiation aimed to improve the antimicrobial effect (62), but a complete elimination of the biofilm and bacteria was not yet possible (63). In conclusion, there is still no strong evidence to support the application of high-power lasers for direct disinfection of root canals (64).

#### c. Ozone

Ozone (O<sub>3</sub>) rapidly dissociates in water and releases a reactive form of oxygen that may oxidize cells, thus having antimicrobial efficacy without inducing drug resistance (65). The results of the available studies on its effectiveness against endodontic pathogens are inconsistent, especially against biofilms (66).

### Alternative Antibacterial Systems

#### • Nanoparticles

Nanoparticles of magnesium oxide, calcium oxide or zinc oxide are microscopic particles that have antibacterial properties (67). Nanoparticles synthesized from powders of silver, copper oxide and zinc oxide are currently used and may generate active oxygen species. They are responsible for the anti-bacterial effect by the electrostatic interaction between positively charged nanoparticles and negatively charged bacterial cells (68). In addition, nanoparticles may change the chemical and physical properties of dentin and reduce the bacterial strength of adhesion to the dentin itself (69).

#### • Bioactive Glass

Recently, the bioactive glass or bioactive glass-ceramics have been the object of considerable interest for endodontic disinfection due to their antibacterial properties, but with conflicting results (70).

#### • Natural Plant Extracts

A current trend directed to the use of natural plant extracts takes advantage of the antibacterial activity of polyphenolic molecules generally used for storing food (71) These compounds have a poor antibacterial efficacy, but a little significant ability to reduce the formation of biofilms, although the mechanism by which this occurs is not clear. (6,72).

- **Non-Instrumentation Techniques**

The first trial of a method of cleaning without canal preparation was the Non-Instrumentation Technique (NIT) conceived by Lussi et al. (73). This technique did not provide for the enlargement of the root canals because there was no mechanical instrumentation of root canal walls. In fact, root canal cleaning was obtained exclusively with hypochlorite at low concentration, introduced and removed from the canal by a vacuum pump and an electric piston that created fields of alternating pressure inside the canal. This caused the implosion of the produced bubbles and hydrodynamic turbulence that facilitated the penetration of hypochlorite into the root canal ramifications.

A method for cleaning the entire root canal system has recently been developed using a broad spectrum of sound waves transmitted within an irrigating solution to quickly remove pulp tissue, debris and microorganisms (74). One study showed that this technique is able to dissolve the tested tissues at a significantly higher rate compared to conventional irrigation (5).

### Conclusion

Various irrigation devices have been developed to give the effective cleaning and superior debris removal in order to replace the older needle irrigation method. Many clinical studies have reported the higher efficacy in effective microbial count. However, there is no high level of evidence that correlates the clinical efficacy of these devices with better treatment outcomes. Nevertheless, due to the safety factors, capacity of high volume irrigant delivery and ease of application the newer irrigation devices may change the insight of conventional endodontic treatment.

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