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Review Article

Root Canal Irrigation Devices: An Update

Rohini Dua[1], Gulsheen Kaur Kochhar[2], Ripin Garewal[3], Annupriya Khanna[4], Akanksha Thakur [5]

Professor and Head[1], Reader[2,3], Senior lecturer[4], PG student[5]

Department of Pedodontics and Preventive Dentistry, National Dental College and Hospital , Derabassi, Mohali, Punjab, India

***ABSTRACT*:**
In hierarchy of cleaning and shaping of root canal, root canal irrigation systems are indispensable aids in dissolving and activating organic debris and destroying microorganisms. Effective delivery of irrigants and its agitation is a prerequisite for successful endodontic treatment. The technological advancements in the last decade has brought foreward the new agitation devices like ENDOACTIVATOR: designed to safely and vigorously energise hydrodynamic phenomenon, ENDOVAC that is based on a true apical negative pressure irrigation, VIBRING is a new sonic irrigation system, RINSENDO is pressure suction technology, QUANTEC-E-IRRIGATION is self-contained fluid delivery unit that is attached to the quantic e- endo system. OZONE THERAPY: has completely revolutionized dentistry with its highly anti-microbial, disinfectant, biocompatibility and healing potential. Regarding the safety factors, capacity of high volume irrigant delivery and ease of application, the newer irrigation devices have changed the insight of conventional endodontic treatment.

Key words: Irrigation, Endoactivator, Endovac, Rinsendo, Ozone therapy

Corresponding Author: Dr. Rohini Dua, Professor and Head, Department of Pedodontics and Preventive Dentistry, National Dental College and Hospital , Derabassi, Mohali, Punjab, India

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INTRODUCTION

Removal of vital and necrotic remnants of pulp tissues, microorganisms, and microbial toxins along with the smear layer from the root canal system is essential for endodontic success.[1,2] Although this might be achieved through chemo mechanical debridement[3], it is impossible to shape and clean the root canal completely, because of the intricate nature of root canal anatomy.[4]

All the instrumentation systems as well as current advancements in the instruments like nickel- titanium instruments and rotary can only clean the central body of the canal. Rest of the canal structures like canal fins, isthmi, and cul-de-sacs are untouched after completion of the preparation[5,6]. These areas are the potential place for tissue debris, microbes, and their by-products which might prevent close adaptation of the obturation material and result in persistent periradicular inflammation.[7]

Irrigation allows for cleaning beyond what might be achieved by root canal instrumentation alone so it is an essential part of root canal debridement.[8] The irrigants which used to be delivered using traditional methods like syringes and needles of different size and tip design proved to be ineffective. In the recent years, a mechanical device which helps in irrigation has been improved leaps and bounds.

Root canal irrigation systems can be divided into 2 broad categories, manual agitation techniques and machine-assisted agitation devices. Manual irrigation includes positive pressure irrigation, which is commonly performed with a syringe and a side vented needle. On the other hand, machine-assisted irrigation techniques include sonic and ultrasonic as well as newer systems like apical negative pressure (ANP) irrigation. This article summarizes the recent developments for the safe and effective irrigation which ultimately help to minimize the bacterial levels resulting in successive endodontic therapy.

MACHINE ASSISTED IRRIGANT DELIVERY SYSTEMS

Machine assisted irrigation system includes: Rotary brushes, Quentec-e-irrigation system, Vibringe System, Endoactivator system, Ultrasonic Irrigation, EndoVac System, Rins Endo System, Photo Activated Disinfection, laser and Ozone based Delivery System.

I. ROTARY BRUSHES:

A rotary handpiece-attached microbrush has been used by ruddle to facilitate debris and smear layer removal from instrumented root canal.The brush includes a shaft or shank and a tapered brush section. During debridement phase, microbrush rotates at about 300 rpm[9].Thesebrushes are not directly used for delivering an irrigant into the canal spaces. They are adjuncts that have been designed for debridement of the canal walls or agitation of root canal irrigant[1]. Recently, a 30-gauge irrigation needle covered with a brush (**NaviTip FX**; Ultradent Products Inc, South Jordan, UT) was introduced commercially.

II. The Quantec-E irrigation system

The **Quantec-E irrigation system** (SybronEndo, Orange, CA) is a self-contained fluid delivery unit that is attached to the Quantec-E Endo System. It uses a pump console, two irrigation reservoirs, and tubing to provide continuous irrigation during rotary instrumentation.[10]It has been proposed that continuous irrigant agitation during active rotary instrumentation would generate an increased volume of irrigant, increase irrigant contact time, and facilitate greater depth of irrigant penetration inside the root canal. This should result in more effective canal debridement compared with syringe needle irrigation.

However studies conducted by Setlock et al[11]and Walters et al[12] proved that Quantec - E irrigation did result in cleaner canal walls and more complete debris and smear layer removal in the coronal third of the canal walls and there was no significant difference between standard syringe needle irrigation and irrigation with the Quantec-E pump.[7]

III. SONIC IRRIGATION:

Sonic instruments for endodontics were first reported by Tronstad et al in 1985. Sonic irrigation operates at a lower frequency (1–6 kHz) and produces smaller shear stresses than ultrasonic irrigation.[13]There are several sonic irrigation devices on the market.

The **Vibringe system** is the first endodontic sonic irrigation system that enables delivery and activation of the irrigation solution in the root canal, in only one step. The activation of the disinfectant by acoustic streaming enriches and completes the irrigation procedure and improves the success rate of endodontic treatments. It has been shown that this system significantly improves debridement. It also improves the disruption of the smear layer and biofilm by activating irrigation solutions. It employs a 2-piece syringe with a rechargeable battery. The irrigant is sonically activated, as is the needle that attaches to the syringe.

Rödig et al [12] evaluated the efficacy of vibringe system they concluded that vibringe demonstrated significantly better results than syringe irrigation in the apical root canal third in removing debris. However it was not as effective as the passive ultra sonic irrigation.[7]

The **Endo Activator System** is a more recently introducedsonically driven canal irrigation system.It consists of a portable handpiece and three types of disposable polymer tips of different sizes.[1] The EndoActivator has been reported to effectively clean debris from lateral canals, remove the smear layer, and dislodge clumps of biofilm within the curved canals of molar teethbecause they are smooth, they do not cut dentin.[14]

Vibrating the tip, in combination with moving the tip up and down in short vertical strokes, synergistically produces a powerful hydrodynamic phenomenon. This might be operated 10,000 cycles per minute (cpm) has been shown to optimize debridement and promote disruption of the smear layer and biofilm.[7]

A possible disadvantage of the polymer tips used in the EndoActivator system is that they are radiolucent. Although these tips are designed to be disposable and do not break easily during use, it would be difficult to identify them if part of a tip separates inside a canal. Presumably, these tips might be improved by incorporating a radiopacifier in the polymer.[1]

IV. Ultrasonics

Ultrasonic energy produces higher frequencies than sonic energy but low amplitudes, oscillating at frequencies of 25-30 kHz.[1, 15] Two types of ultrasonic irrigation are available for use. The first type is simultaneous **ultrasonic instrumentation and irrigation (UI),** and the second type is **passive ultrasonic irrigation** operating without simultaneous irrigation (PUI).[14]The literature indicates that it is more advantageous to apply ultrasonics after completion of canal preparation rather than as an alternative to conventional instrumentation.[1,16]

Studies on endosonic systems have shown that teeth prepared ultrasonically with UI devices have significantly cleaner canals than teeth prepared by conventional root canal filing alone.[17,18]Nevertheless, other studies have failed to demonstrate the superiority of UI as a primary cleaning and shaping technique .[19-22] These results might be attributed to the constraint of vibratory motion and cleaning efficacy of an ultrasonic file within the nonflared root canal space.[19,23] In addition, it is difficult to control the cutting of dentin during UI and hence the shape of the prepared root canal. Strip perforations as well as highly irregular-shaped canals were frequently produced.[24, 25] Therefore, UI is not generally perceived as an alternative to conventional hand.[26, 27] On the contrary, the endodontic literature

supports that it is more advantageous to apply ultrasonics after completion of canal preparation .[16]

During PUI, the energy is transmitted from an oscillating file or a smooth wire to the irrigant in the root canal by means of ultrasonic waves. The latter induces acoustic streaming and cavitation of the irrigant.[19, 28]Two flushing methods might be used during PUI, namely a continuous flush of irrigant from the ultrasonic handpiece or an intermittent flush technique by using syringe delivery.[29]In the intermittent flush technique, the irrigant is injected into the root canal by a syringe and replenished several times after each ultrasonic activation cycle. The amount of irrigant flowing through the apical region of the canal can be controlled because both the depth of syringe penetration and the volume of irrigant administered are known. This is not possible with the use of the continuous flush regime. Both flushing methods have been shown to be equally effective in removing dentin debris from the root canal in an ex vivo model when the irrigation time was set at 3 minutes.[30]

V. Pressure Alternation Devices

The RinsEndo irrigation system and the EndoVac irrigation system are examples of negative-pressure irrigation.

a. The RinsEndo system: The RinsEndo system irrigates the canal by using pressure suction technology developed by Durr Dental Co. It comprises of a handpiece, a cannula with a 7 mm exit aperture, and a syringe carrying irrigant. The handpiece is powered by a dental air compressor and has an irrigation speed of 6.2 ml/min[31, 32].With this system, 65 ml of a rinsing solution oscillating at a frequency of 1.6 Hz is drawn from an attached syringe and transported to the root canal via an adapted cannula.

During the suction phase, the used solution and air are extractedfrom the root canal and automatically merged with fresh rinsing solution. The pressure Suction cycles change approximately 100 times per minute.[1]

The manufacturer of Rins Endo claims that the apical third of the canal might be effectively rinsed; with the cannula restricted to the coronal third of the root canal because of the pulsating nature of the fluid flow.[1] McGill et al evaluated the effectiveness of RinseEndo system in a split tooth model. They found to be less effective in removing the stained collagen from root canal walls when compared with manual dynamic irrigation by hand agitation of the instrumented canals with well-fitting gutta-percha points.[3]

b. The EndoVac System: The EndoVac apical negative pressure irrigation system has been introduced by Discus Dental Company. It has three components: **The Master Delivery Tip, Macro Cannula and Micro Cannula**. The Master Delivery Tip simultaneously delivers and evacuates the irrigant. The MacroCannula is used to suction irrigant from the chamber to the coronal and middle segments of the canal. The MacroCannula or MicroCannula is connected via tubing to the high-speed suction of a dental unit. The Master Delivery Tip is connected to a syringe of irrigant and the evacuation hood is connected via tubing to the high-speed suction of a dental unit.The plastic macrocannula has a size 55 open end with a .02 taper and is attached to a titaniumhandle for gross, initial flushing of the coronal part of the root canal.The size 32 stainless steel microcannula has 4 sets of 3 laser-cut, laterally positioned, offset holes adjacent to its closed end. This is attached toa titanium finger-piece for irrigation of the apical part of the canal bypositioning it at the working length. The microcannula can be used in canals that are enlarged to size 35 or larger. During irrigation, the delivery/evacuation tip delivers irrigant to the pulp chamber andsiphons off the excess irrigant to prevent overflow. The cannula inthe canal simultaneously exerts negative pressure that pulls irrigantfrom its fresh supply in the chamber, down the canal to the tip of thecannula, into the cannula, and out through the suction hose. Thus,a constant flow of fresh irrigant is being delivered by negative pressureto working length.[36, 35] A recent study showed that the volume of irrigantdelivered by the EndoVac system was significantly higher than thevolume delivered by conventional syringe needle irrigation during thesame time periodand use ofthe EndoVac system resulted in significantly more debris removal at 1mm from the working length than needle irrigation. [35]

Apart from being able to avoid air entrapment, the EndoVac systemis also advantageous in its ability to safely deliver irrigants to workinglength without causing their undue extrusion into the periapex.[35]During conventional root canal irrigation, clinicians must be carefulin determining how far an irrigation needle is placed into the canal. Recommendations for avoiding NaOCl accidents include not bindingthe needle in the canal, not placing the needle close to working length, and using a gentle flow rate.[37] With the EndoVac, irrigant is pulledinto the canal at working length and removed by negative pressure.

VI. Endovac Pure

Endovac Pure, a new irrigation system introduced by Kerr. it is the first system of its kind to leverage the apical negative pressure technique.Itcombines a portable base unit with a sterile-packed cartridge and an ergonomically designed handheld controller for ease of use. EndovacPure's Apex cartridge is sterile packed and fully integrates the MacroPure and Micro Pure cannulas for greater ease of use. The EndoVac system is intended for the delivery and evacuation of endodontic irrigation solutions during root canal procedures. On other hand EndoVac Pure™ System is used for the delivery and evacuation of endodontic irrigation solutions as well as removing debris

of injured or necrotic pulp tissue during root canal procedures.[44]

VII. Photo Activated Disinfection

Recently the concept of photo activated disinfection (PAD) in endodontic irrigation has been introduced in order to minimize or eliminate residual bacteria in the root canal. PAD technique employs a non-toxic dye, termed a photosensitizer (PS), and low intensity visible light which, in the presence of oxygen, combine to produce cytotoxic species. The principle on which it operates is that PS molecules attach to the membrane of the bacteria. Irradiation with light at a specific wavelength matched to the peak absorption of the PS leads to the production of singlet oxygen, which causes the bacterial cell wall to rupture, killing the bacteria. [33, 38]

PAD is not only effective against bacteria, but also against other micro-organisms including viruses, fungi, and protozoa. FotoSan is the PAD device recently introduced by CMS Dental. The PS is a watery solution of toluidine blue O (TBO) that attaches to the membranes of microorganisms and binds itself to their surface, absorbs energy from the light and then releases this energy to oxygen (O2), which is transformed into highly reactive oxygen species (ROS), such as oxygen ions and radicals.

The manufacturer's protocol indicates that, after canal preparation, the canal have to be inoculated with the PS solution, which is left in situ for a fixed period of time (60 seconds) to permit the solution to come into contact the root canal and irradiation have to be carried out for 30 seconds in each canal. Schlafer et al found that PAD gave a strong reduction of the number of viable endodontic pathogens both in planktonic suspension and in root canals.[39]

VIII. LASER

It has been documented in neumerous studies that CO2, Nd:YAG, Er:YAG, Er,Cr:YSGG laser irradiation has the ability to remove debris and smear layer from the root canal wall following biomechanical preparation .Numerous studies have shown that Er:YAG is the most appropriate laser for intra canal debris and smear removal. In addition different laser wavelengths have been used directly or as an adjunctive to disinfect canals. Laser light can penetrate areas of canals where irrigating and disinfecting solutions cannot reach, like secondary canals and deep dentinal tubules and also can eliminate microorganisms.[43]

IX. Ozone based Delivery System

Ozone is a triatomic molecule consisting of three oxygen atoms. It is applied to oral tissues in the forms of ozonated water, ozonated olive oil and oxygen/ozone gas. It is unstable and dissociates readily back into oxygen (O2), thus liberating singlet oxygen (O1), which is a strong oxidizing agent which further impose the deleterious effect on microorganisms. Various delivery systems available for endodontic irrigation like Neo Ozone WaterS unit, HealOzone (Kavo) unit, the OzoTopunit.Nagayoshi et al found that ozonated water (0.5–4 mg/L) was highly effective in killing both gram positive and negative micro-organisms.[40]

Gram negative bacteria, such as Porphyromonas (P.) Endodontalis and P.gingivalis were substantially more sensitive to ozonated water than gram positive oral streptococci andC.albicansin pure culture. Notably,when the specimen was irrigated with sonication, ozonated water had nearly the same antimicrobial activity as 2.5% NaOCl.[41] Ozone works best when there is less organic debris remaining. Therefore, the recommendation is to use either ozonated water or ozone gas at the end of the cleaning and shaping process. Ozone is effective when it is used in sufficient concentration, for an adequate time. Ozone will not be effective if too little dose of ozone is delivered or it is not delivered appropriately.[42]

SUMMARY

In order to replace the older needle irrigation methodseveral irrigation devices have been introduced. Few clinical studies have described 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. Due to the safety factors, potentialof high volume irrigant delivery and ease of application the recent irrigation devices may change the understanding of conventional endodontic treatment.

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