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Recent Advancements In Endodontic Irrigation Systems

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1. INTRODUCTION:

Successful endodontic treatment depends on the complete removal of the remains of vital and necrotic pulp tissue, micro-organism and microbial toxins from the root cana[1].The main goal of the endodontist is to remove the infected tissue and bacteria from the root canal which allows the healing of periapical lesion or to prevent the infection from periradicular tissue. So the irrigation of the root canal with antibacterial solution is an important step.The efficacy of irrigation depends on working mechanism of the irrigant and ability to bring the irrigant in contact with the element, material and structure.Sodium hypochlorite is effective disinfectant because it dissolves the organic tissue, it eliminates micro-organism, acts as an lubricant and non-toxic[2].Root canal irrigation system is divided into two types, manual agitation techniques and machine assisted agitation devices. Manual agitation is positive pressure irrigation which performed by syringe and side vented needle. On the contrary, machine assisted techniques includes sonic and ultrasonic device as well as newer system like apical negative pressure irrigation and plastic rotary files[3,4]. Syringe irrigation is commonly used by both the general dentist and endodontics, but this system has its own disadvantage[5]. We have advanced technology in irrigation to overcome the disadvantage in traditional system which includes the Endovac, Rinsendo. In this article we are going to review the recent advancements in endodontic irrigation system.

SIGNIFICANCE OF ENDODONTIC IRRIGATION:

Irrigants are the chemical agents delivered into the root canal and they worn to dissolve the tissue remnants, to kill the microorganism, and to clean the root canal effectively and safely without any consequences[6]. They can also help to avoid packing of the hard and soft tissue in the apical root canal and extrusion of infected material into the periapical area. Several irrigating solutions have antimicrobial activity and actively kill bacteria when introduced in direct contact with the microorganisms. However, several irrigating solutions may also have cytotoxic potential, and they may be a reason for severe pain if they entry into the periapical tissues. Combination of products in the correct irrigation sequence contributes to a successful treatment outcome[7] The ideal irrigant solution should have the following properties: It should have the broad antimicrobial action, should

be able to dissolve the necrotic pulp remnants, should inactivate the endotoxins[6].

TYPES OF IRRIGATION AGITATION TECHNIQUES AND DEVICE:

1)MANUAL AGITATION TECHNIQUES

A)Syringe irrigation with needle/cannulas

B)Brushes

C)Manual dynamic agitation

2)MACHINE ASSITED TECHNIQUE

A)Rotary brushes

B)Continuous irrigation during rotary instrumentation

C)Sonic irrigation

D)Ultrasonic irrigation technique

a)Continuous

b)Passive

E)Pressure alternation devices

a)Endo vac system

b)Rins Endo system

F)Photo Activated Disinfection

G)Ozone based delivery system

H)Laser

1)MANUAL AGITATION TECHNIQUE:

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[8]and reduces the presence of air bubbles in the canal space[9] ,but does not improve the final cleaning[10].

A) **SYRINGE IRRIGATION WITH NEEDLES/CANNULAS:**

The technique involves dispensing of an irrigant into a canal through needles/cannulas of variable gauges, either passively or with agitation. The latter is achieved by moving the needle up and down the canal space. Irrigation tip gauge and tip design can have a significant impact on the irrigation flow pattern, flow velocity, depth of penetration, and pressure on the walls and apex of the canal. Irrigation tip gauge will largely determine how deep an irrigant can penetrate into the canal. A 21-gauge tip can reach the apex of an ISO size 80 canal, a 23-gauge tip can reach a size 50, a 25-gauge tip can reach a size 35 canal, and a 30-gauge tip can reach the apex of a size 25 canal. 27 gauge needle is the preferred needle tip size for routine endodontic procedures[11] ,Open-ended tips express irrigant out the end toward the apex and consequently increase the apical pressure within the canal. Closed-ended irrigant tips are side-vented and thus create more pressure on the walls of the root canal and improve the hydrodynamic activation of an irrigant and reduce the chance of apical extrusion[12]

Figure 1

B)ROTARY BRUSHES:

Brushes 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. They might also be indirectly involved with the transfer of irrigants within the canal spaces. Recently, a 30-gauge irrigation needle covered with a brush (NaviTip FX; Ultradent Products Inc., South Jordan, UT) was introduced commercially. NaviTip Fx is a 30-gauge

irrigation needle covered with a brush was introduced commercially by Ultradent company[13,14]. The Endobrush could not be used to full working length because of its size, which might lead to packing of debris into the apical section of the canal after brushing [15].

Figure 2

C)MANUAL DYNAMIC AGITATION:

An irrigant must be in direct contact with the canal walls for effective action. Its often difficult for the irrigant to reach the apical portion of the canal because of the so-called vapor lock effect[16,17]. The gently moving well-fitting gutta-percha master cone up and down in short 2 to 3 mm strokes (manualdynamic irrigation) within an instrumented canal can produce an effective hydrodynamic effect and significantly improve the displacement and exchange of any given reagent[18].

Following are the factors affecting manual dynamic irrigation:

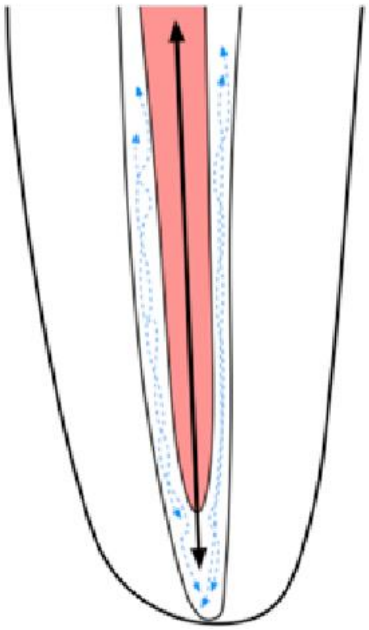
(1) the push-pull motion of a well fitting gutta-percha point in the canal might generate higher intracanal pressure changes during pushing movements, leading to more effective delivery of irrigant to the "untouched" canal surfaces;

(2) the frequency of push-pull motion of the gutta-percha point (3.3 Hz, 100 strokes per 30 seconds) is higher than the frequency (1.6 Hz) of positive-negative hydrodynamic pressure generated by RinsEndo, possibly generating more turbulence in the canal; and

(3) the push-pull motion of the gutta-percha point probably acts by physically displacing, folding, and cutting of fluid under ‘‘viscouslydominated flow’’ in the root canal system. The latter probably allows better mixing of the fresh unreacted solution with the spent, reacted irrigant[18.]

Many devices used for agitation of root canal irrigants that are commercially available.

Figure 3



2)MACHINE ASSISTED AGITATION TECHNIQUE:

The evolution of the manual systems led to the introduction of instruments that may be rotated by handpieces at low speed inside the canal fill with irrigant. Instruments such as plastic files can show a smooth surface and increased taper , or even a surface with lateral plastic extensions [19-21.]

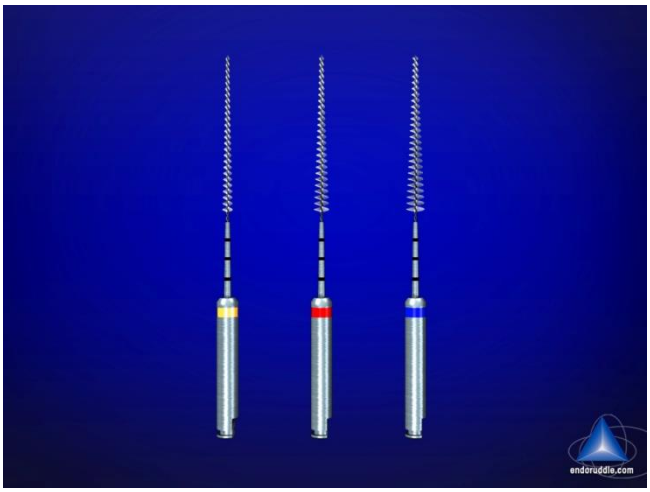
i)

A)ROTARY BRUSHES:

Ruddle brush and canal brush come under this.

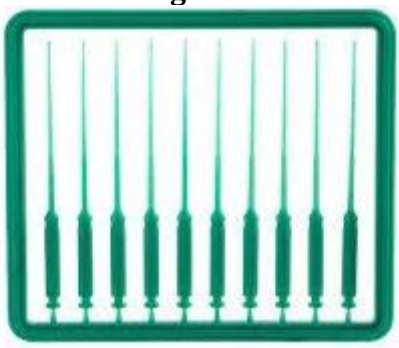
A rotary handpiece-attached microbrush has been used by ruddle to facilitate debris and smear layer removal from instrumented root canal.The brush includes a shaft or shank and a tapered brush section. During debridement phase, microbrush rotates at about 300 rpm. These brushes are not straightly used for delivering an irrigant into the canal spaces. They are adjuncts that has been planned for agitation of root canal irrigation.

Figure 4



ii) Canal Brush is another endodontic microbrush that has recently been made commercially available. This highly flexible microbrush is molded entirely from polypropylene and might be used manually with a rotary action. Weise et al., showed that debris was effectively removed from simulated canal extensions and irregularities with the use of the small and flexible CanalBrush with an irrigant[22.]

Figure 5



B)CONTINUOUS IRRIGATION DURING ROTARY IRRIGATION:

(i) The Quantec-E irrigation system (Sybron Endo, Orange, CA) is a self contained fluid delivery unit which is attached to the Quantec-E Endo System . It consist of a pump console, two irrigation reservoirs, and tubing which provide continuous irrigation during rotary instrumentation[23.] Continuous irrigant agitation during active rotary instrumentation would result in generation of 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 in comparision with syringe needle irrigation. Studies conducted by Setlock et al and Walters et al concluded 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[24].

Figure 6

(ii) The Self adjusting file(SAF) system is a shaping and cleaning system designed for minimally invasive endodontic treatment. It is operated with the specific handpiece head (RDT ,ReDent) and an irrigation pump(VATEA pump) that allows continuous flow of irrigant through the hollow file .It is available in two diameter:1.5-2.0. Both are extremely compressible. The 0.5mm file compressed to the dimension of 20 K file and 2.0mm file compressed to the dimension of 35 K file[25.]

Figure 7

C) SONIC IRRIGATION:

Sonic instruments was introduced by Tronstad et al in 1985. It works in lower frequency (1–6 kHz) and produces smaller shear stresses than ultrasonic irrigation. There are several sonic irrigation devices on the market[26]

Vibringe system is the first endodontic sonic irrigation system that permits the delivery and activation of the irrigation solution in the root canal. The activation of the disinfectant by acoustic streaming enhances and completes the irrigation procedure and upgrade the success rate of endodontic treatments. It improves the debridement and disrupts the smear layer[27].It has better irrigation then the syringe irrigation in removing the debris from the apical two third of the rootcanal[28].

Figure 8

Endo activator is a mechanical system which consist of hand piece and various polymer tips .These tips are strong and flexible and donot break easily.They are smooth and they dont cut the dentin. It removes the smear layer, debride the uninstrumented portion of the root canal system, and disloge the biofilm within long, narrow, and highly curved canal of molar teeth. It provides 10,000 cpm per minute[29,30,31]

Figure 9

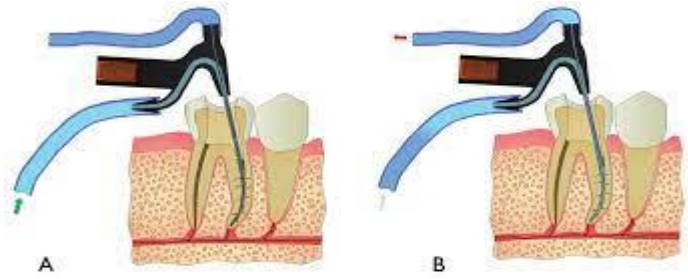
D)ULTRASONIC IRRIGATION:

Ultrasonic energy produces higher frequencies than sonic energy but has low amplitudes, oscillating at frequencies of 25- 30 kHz [32,33]. Two types of ultrasonic irrigation are present one is simultaneous ultrasonic instrumentation and irrigation (UI) and the another one is passive ultrasonic irrigation (PUI), operates without simultaneous instrumentation[34]

i)CONTINUOUS ULTRASONIC IRRIGATION:

Nusstein introduced a needle-holding adapter to an ultrasonic handpiece. During ultrasonic activation, a 25-gauge irrigation needle is used instead of an endosonic file. This enables ultrasonic activation to be performed at the maximum power setting without causing needle breakage . In this needle is activated simultaneously by the ultrasonic handpiece, while an irrigant is carried out from intravenous tubing connected via a Luer-lok to an irrigation-delivering syringe. Irrigant is delivered in apical one third by continuous flow[35,36]

Figure 10



ii)PASSIVE ULTRASONIC IRRIGATION:

The term passive ultrasonic irrigation was given by Weller et al in the year 1980[37]. It is a non cutting technology which reduces creating abnormal shapes in root canal system. During PUI, energy is transmitted from a file or smooth oscillating wire to the irrigant by means of ultrasonic waves that induce two physical phenomena: stream and cavitation of the irrigant solution. The acoustic stream can be defined as a rapid movement of the fluid in a circular or vortex shape around the vibrating file. Cavitation is defined as the creation of steam bubbles or the expansion, contraction and/or distortion of

pre-existing bubbles in a liquid[38].The main goal of this treatment is to remove the pulp tissues,dentinal debris,smear layer and bacteria from the root canal

Figure 11

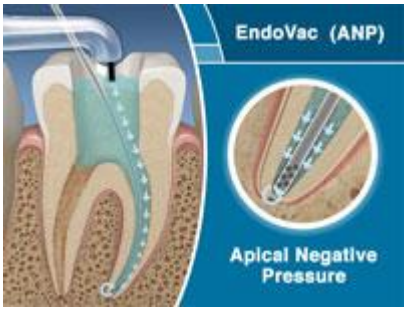
E)PRESSURE ALTERATION DEVICES:

There are apparently dilemmatic phenomena associated with conventional syringe needle delivery of irrigants. It is desirable for the irrigants to be in direct contact with canal walls for effective debris debridement and smear layer removal. Its difficult to reach the apical portion of the canal due to air entrapment[39] when the needle is placed away from the canal. If the needle is placed so close to the apical formen increased chance of irrigant extrusion from the foramen causes iatrogenic damage to the periapical tissues. Concomitant irrigant delivery and aspiration through the use of pressure alternation devices provide a plausible solution to this problem[40]

A)ENDOVAC SYSTEM:

Endo Vac apical negative pressure irrigation was given by Discus Dental Company. It uses suction technique which wash out the debris and encourage the flow of irrigation in apical two third of the canal. 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 highspeed 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 to a titanium finger-piece for irrigation of the apical part of the canal by positioning it at the working length. The micro-cannula 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 and siphons off the excess irrigant to prevent overflow. The cannula in the canal simultaneously exerts negative pressure that pulls irrigan tfrom its fresh supply in the chamber, down the canal to the tip of the cannula, into the cannula, and out through the suction hose. Thus, a constant flow of fresh irrigant is being delivered by negative pressure to working length. Endo vac has the ability to safely deliver the irrigants to working length without causing extrusion into the peri apical region[41,42.]

Figure 12



B)RINS ENDO SYSTEM:

Rins Endo was introduced byDurr Dental Co.its based on pressure suction technology with aproximately 100 cycles per minute[43.] Its components are 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. 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 through an adapted cannula. During the suction phase, the used solution and air are extracted from the root canal and automatically merged with a fresh rinsing solution. The pressure-suction cycles change approximately 100 times per minute. The manufacturer of RinsEndo 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. 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[44.]

Figure 13

F)PHOTO ACTIVATED DISINFECTION:

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.PAD is also effective against viruses,fungi and protozoa[45,46.] 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[47]

Figure 14

G)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 so-called 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 Water-S unit, HealOzone (Kavo) unit, the OzoTop unit. Nagayoshi et al.found that ozonated water (0.5–4 mg/L) was highly effective in killing both gram positive and negative micro-organisms[48.]

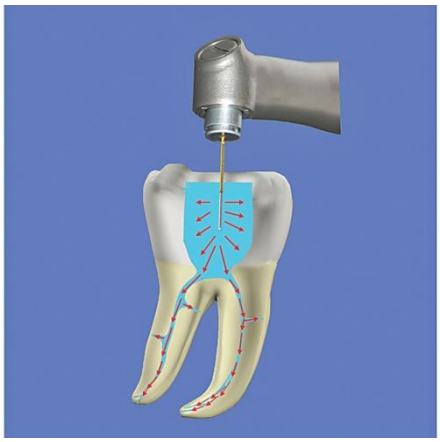
Figure 15

H)LASER:

Lasers have been recently proposed to activate irrigation solutions by the transfer of pulsed energy[49,50.] Laser-activated irrigation by Er:YAG and Er,Cr:YSGG laser light has been suggested to be more effective in removing dentin debris and smear layer.

The use of laser is to enhance the antimicrobial action of sodium hypochlorite[51,52]. Numerous studies have found that Er:YAG is the most appropriate laser for intra canal debris and smear removal. 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[53] , but a complete elimination of the biofilm and bacteria was not yet possible[54] . In conclusion, there is still no strong evidence to support the application of high-power lasers for direct disinfection of root canals[55.]

Figure 16



2. CONCLUSION:

Various irrigating device has been evolved in order to replace the previous syringe irrigation.Clinical studies have described the higher efficacy in effective microbial count. Though, there is no high level of evidence that correlates the clinical efficacy of these devices with better treatment outcomes. Due to the safety factors, capacity of the high volume irrigant delivery and ease of application the newer irrigation devices may change the insight of conventional endodontic treatment.

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