RECENT ADVANCES IN ENDODONTIC IRRIGATION TECHNIQUES

Abstract

Chemical and mechanical cleaning of root canal system has prime importance for complete disinfection. Sodium hypochlorite and chelating agents are most commonly used for root canal irrigation however it is less effective in apical third area. Activation of irrigating solution is necessary for cleaning of apical tiny area so that irrigation solutions must come into direct contact with the entire canal wall surfaces. Now various irrigation systems are available to activate the irrigation solution.

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I. INTRODUCTION

Endodontic success depends on eliminating vital and necrotic pulp tissue remnants, microorganisms and microbial toxins from the root canal system. Root canal irrigant is needed to aid in disinfection of canals completely. During and after instrumentation, irrigation aids in the elimination of bacteria, dentin chips, and tissue fragments from the root canal. For optimal action, irrigation solutions must come into direct contact with the entire canal wall surfaces, especially for the apical sections of small root canals. To provide successful delivery, a number of techniques have been advised. Both manual agitation methods and mechanically assisted agitation devices can be used to classify these systems.

II. ROLE OF INTRACANAL IRRIGANTS

Dr. Frank Weine emphasized the importance of effective irrigation in achieving successful endodontic outcomes. Intracanal irrigation serves several crucial purposes:

1. **Antimicrobial Activity:** Some irrigation fluids eliminate microorganisms, reducing their source of nourishment.

2. **Lubrication:** Irrigants lubricate and aid shaping, minimizing instrument fracture risk.

3. **Smear Layer Removal:** Effective irrigation removes debris, exposing dentinal tubules for disinfectants.

4. **Debris Removal:** Irrigation flushes out debris, remnants, and shavings.

5. **Neutralization of Irritants:** Irrigants counteract effects of chemical solutions, ensuring safety.

6. **Prevention of Recontamination:** Continuous irrigation stops bacterial reintroduction.

III. DRAWBACK OF TRADITIONAL IRRIGATION TECHNIQUE

Conventional irrigation with positive pressure system using needle instrument is a standard procedure but found to be inadequate to reach the apical third of root canal and the apical with difficult anatomical features due to

1. Risk of extrusion of irrigant in the periapical region.
2. Inability to irrigate the apical region due to vapour lock effect and dead zone.

To overcome this many modifications have been made in irrigating devices to enhance the penetration and effectiveness of irrigation.

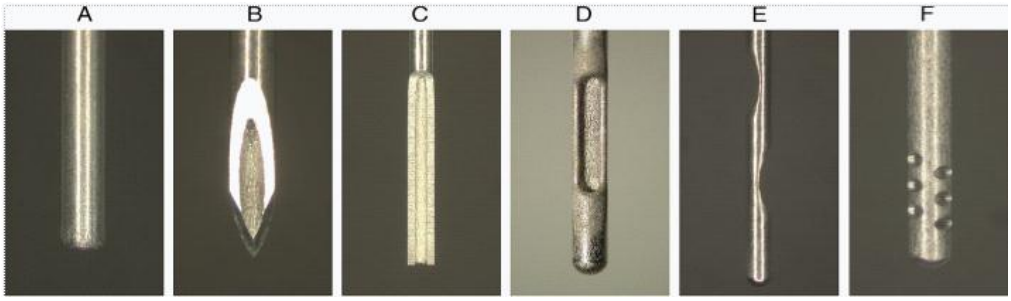
IV. RECENT ADVANCES OF IRRIGATING DEVICES

These systems might be divided into two main groups: manually aided agitation devices and machine-supported agitation approaches.

1. **Manual Irrigation Techniques:** The use of needles for manual irrigation is still commonly recognised. In this method, an irrigant is carried out into a canal using needles or cannulas of different gauges, either passively or while being agitated.

- **Needle Design**

  - **Modifications of Tip of the Needles:** The needles may be open-ended or closed-ended. closed ended needles have side vents on the lateral aspect and this design improves the hydrodynamic action of irrigants and reduces apical overflow of irrigants.



A-C) Open-ended needles: (A) flat (B) beveled (C) notched
(D-F) Closed-ended needles: (D) side vented (E) double side vented (F)multivented

  - **Advanced Irrigating Needles**

- **Max I Probe Needle or Pro Rinse Needle:** It is a modified design of regular manual needle. They feature a rounded tip and sidewindow port dispersal, which prevent solution and debris from being expressed through the apical foramen and allow safer irrigation. They are available in 21-30 gauge.

- **Navitip Needle:** These needles have rounded ends for safety. To prevent bending, they are rigid in the shank area. The final few millimetres allow for easy navigation even in curved canals.

- **Stropko Niti Irrigation Needles:** These needles are resilient to clogging and have good flexibility.The suction included in the needle recovers the transmitted irrigant while delivering the solution. They are available in 17mm and 25mm sizes.

2. **Brushes**

- **Endobrush:** It is a spiral brush made of nylon bristles and has a handle that is attached to it. Its diameter remains consistent throughout its entire length. Because the debris is likely to pack at the apical area, it is not employed for debridement up to the working length.

3. **Manual Dynamic Irrigation:** Apical gas entrapment prevents irrigation from properly penetrating up to the apex.After the canal has been well cleaned and shaped, an irrigation

fluid is incorporated, and a gutta-percha mastercone is then inserted. In order to reach the working length, the gutta-percha point should be moved in 3mm coronal-apical motions at a rate of 33Hz, which comprises 100 strokes every 30 seconds.

V. MACHINE ASSISTED

1. Brushes

- **Ruddle brush:** They connect to the rotating handpiece. The brush part is tapered and has a shaft. A central wire core is supported by several bristles. The debris exits the canal in a coronal direction as the device rotates at 300 rpm.

- **Canal Brush:** This extremely flexible microbrush may be used manually with a rotational motion and is made entirely of polypropylene. It works best when connected to a contra-angle handpiece spinning at 600 rpm, though.

2. Continuous Irrigation During Rotary Instrumentation

- **Qantec -E system:** The Quantec-E irrigation system, which is connected to the Quantec-E Endo System, was first introduced by the SybronEndo company. For continuous irrigation during rotating instrumentation, it makes use of a pump console, two irrigation reservoirs, and tubing. It would result in – Increased volume of irrigant, increased irrigant contact time, greater depth of irrigant penetration. This system is more effective in cleaning debris at the coronal 3^{rd} of canals but not in middle and apical 3^{rd} of root canal.

3. **Sonic Irrigation:** In 1985, Tronstad et al. published the first report on the use of sonic instruments for endodontics. It operates at a lower frequency of between (1-6 KHz).

- **Ripsisonic File:** It is made up of steel and can be autoclaved. The non-uniform taper in the files gets larger as the file size increases. These files may unintentionally engage the canal wall during agitationdue to their barbs, which may cause damage to the finished canal preparation.

- **Vibringe:** It was introduced by Dutch company Vibring B.V. The solution is activated via sound waves while being manually delivered by this device. It is a cordless handpiece designed to fit within a unique, single-use 10ml luer lock syringe. It has benefits such as debris removal, disruption of the biofilm and smear layer, and time saving.

- **Endoactivator:** It is a mechanical device with a sonic handpiece. It's ergonomic, cordless, and contra-L. It is used to vigorously induce the hydrodynamic phenomenon while safely activating a variety of intracanal reagents. It operates at 10,000 cpm(cycle per minute), which encourages 3D disinfection.Its tips are coloured according to file sizes, with yellow being 15/2, red being 25/4, and blue being 35/4. They are disposable, single-use devices composed of flexible, non-cutting polymer with depth orientation rings that are 18, 19, and 22 mm long.A strong hydrodynamic phenomenon is created when the tip is vibrated while being moved up and down in

short vertical strokes. Random wave breaks lead to the production of expanding, unstable bubbles that implode and collapse.

- **EDDY:** The 2015 EDDY irrigation tip with Sonic activation was exhibited by VDW. Its soft polyamide take structure oscillates between 5000 and 6000 Hertz. It is a single-use tip that is compatible for most air scalers.

4. **Ultrasonic Irrigation:** In 1957, Richman introduced ultrasound in endodontics.Compared to Sonic irrigation, it produces lower amplitude and higher frequencies (25–30 kilo hertz). An endodontic file vibrates at a rate of 25,000 vibrations per second when an ultrasound handpiece passes sound waves through it.

The irrigant undergoes acoustic streaming and cavitation as a result. There are two types of ultrasonic irrigation:

- **Simultaneous Ultrasonic Irrigation and Instrumentation:** Which is almost never used in clinical practise due to the difficulty in controlling dentin cutting.

- **Passive Ultrasonic Irrigation (PUI), or Ultrasonic Irrigation without Simultaneous Instrumentation:** Here, passive refers to its lack of cutting action. The irrigation solution is first introduced into the canal, after which the ultrasonic tip is passively activated in the canal up to the working length and moving up and down. Ultrasonic waves are used to transfer energy from a smooth or uniformly oscillating source to the irrigant during passive ultrasonic irrigation.

5. **Multisonic Irrigation**

- **Gentlewave (No Instrumentation):** It is a multisonic ultra cleaning equipment that facilitates irrigation by employing several sonic waves. The gentle wave handpiece, which is placed inside the pulp chamber, sealing the tooth from the oral cavity, and is operated from a computer console, starts multisonic waves at the tip. A 45 ml/min irrigant spray is released from this. Its single-use handpiece supplies a stream of treatment solution into the pulp chamber while at the same time using built-in suction to remove extra fluid from the chamber. A water rinse is added between the 3% NaOCl and the 8% EDTA phases of the fluid.

6. **Pressure Alteration Devices**

- **ENDO VAC:** This technique induces vapor lock and offers unique smear layer removal, disinfection, and cleaning. Because this system uses suction rather than exerting significant positive pressure inside the root canal, it is known as "negative pressure."It is composed of three components:

  - **Macrocanula:** It is made of flexible polypropylene plastic. It has an open end that is ISO size 55 with a 2% taper and a diameter of 0.55 mm. It is employed to remove medium-sized debris. At the middle third of the root canal, it is moved up and down as deeply as possible.

- **Microcanula:** It is made of stainless steel. It has a closed end. Its diameter is 0.32mm. It contains 12 lateral holes that are each 0.1 mm in diameter and 1 mm from the apex. It is used to remove tiny particles and to get beyond an apical vapour lock.It can takenupto working lentgh to aspirate debris and irrigants.

- **Master Delivery Tip (MDT):** It has a connection to an irrigation syringe. It is employed to remove large-scale debris. It is aimed towards the axial wall or pulp chamber wall.

Macrocanula and microcannula are connected via tubing to a syringe of irrigant and the high speed suction of a dental unit.

7. Other

- **Laser Activated Irrigation:** A secondary cavitation effect on itracanal fluids is produced by the laser thermal effect, which causes the expansion and implosion of the water molecules in the irrigant solution.To accompolish this, a stationary fiber tip is positioned 5 mm from the canal's apex in the middle portion of the canal. The most modern Er:YAG laser irrigation method is PIPS and SWEEPS laser assisted irrigation.

  - **PIPS (Photon Induced Photoacoustic Streaming):** The Er:YAG laser, also known as the SSP (Super Short Pulse) laser, produces non-thermal photoacoustic waves that are absorbed by cleaning and debriding solutions introduced into the canal. The pulp chamber is equipped with an irrigation fluid and a laser tip that emits pulsed laser light. As a result of the fluid being heated over its boiling point by laser light, vapour bubbles are created. Before collapsing, the vapour bubble explodes. This starts the second bubble's expansion. Due to the turbulent photoacoustic agitation of the irrigants and 3D fluid movement caused by this, the debris is pumped out of the canal.

  - **SWEEPS (Shock Wave Enhanced Emission Photoacoustic Streaming):** It is an advancement of PIPS. Er:YAG lasers are employed. A series of bubbles are created using the SWEEPS method, which eventually give way to secondary bubbles and cause shockwaves to occur along with an enhanced photoacoustic current. The narrow canals receive shockwave and more photoacoustic current, which improves cleansing and bactericidal effects.

  - **Biolase/Waterlase:** For this, a radial firing tip (RFT) Er, Cr: YSGG laser is used. Rather of using end firing points, this RFT delivers laser energy as a broad cone, covering the root canal walls. Two sizes of these tips are offered: RFT2 with a 275 um diameter and an initial working length of 1 mm. The middle and apical thirds are intended to be used by RFT3.This facilates entry of the emitted laser energy into the dentinal tubules reaching bacteria that have penetrated deep into the dentin.

- **Photo Activated Disinfection (PAD):** A two-step process is involved.In Step 1, a non-toxic dye called toludine blue/methylene blue is introduced into the canal until it reaches the working length. And in Step 2, it is activated by light, the photosensitizer

absorbs the light and produces O2 species (ROS), which attack the target bacterial cells and cause cell lysis.

- **Ozone (O_3):** Ozone is an unstable natural gas that quickly dissociates in water to create an active form of oxygen with antibacterial properties. There are numerous delivery methods for endo irrigation, including Neo ozone, Water-S unit, and Healzone. It functions best when there is less organic waste still present.

VI. SUMMERY

To replace the traditional needle irrigation technique, various irrigation devices have been created to provide efficient cleaning and enhanced debris removal.For the most effective irrigation, it's essential to consider the different alternatives' methods of action. Newer irrigation devices may alter the perception of traditional endodontic therapy due to safety concerns and the ability to provide enormous volumes of irrigant.

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