Recent advances in irrigation systems

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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 has a key part 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 & are the real reason for pulpal and periapical diseases and this presents a challenging objective to the endodontic treatment.

It's really stated, "Instruments Shape, Irrigants Clean". Wide heap of irrigating solutions have been upheld for the sanitization process during root canal therapy. A plenty of irrigants are available Such as saline, hydrogen peroxide, sodium hypochlorite, chlorhexidine, EDTA, ethelene, Q-mix, ozonated water, MTAD or in mixes of the above. The effectiveness and safety of irrigation depends on the means of delivery. Generally, irrigation has been performed with a plastic syringe and an open-ended needle into the canal space. A growing number of novel needle-tip designs and equipment are developing with an end goal to better address the difficulties of irrigation. The purpose of this article is to illuminate the methods for safe and effective irrigation and provides cutting-edge information on the latest advancements.

Keywords: Irrigation, Root canal, Irrigant.

Introduction

Irrigation is a valuable aid in rendering the canal system free of necrotic pulp tissues, biofilms, bacteria and bacterial products and also serves as a physical flush to remove dentinal debris. This creates an environment favourable to successful obturation, and ultimately to clinical success.(1)

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)

Irrigants have an antimicrobial action by inactivating bacterial lipopolysaccharides and also have tissue-dissolution effect, without damaging periapical tissues **(Fig. 1)**. For a long time different methods have been proposed and created to make root canal irrigants more effective in removing debris and microorganisms from the root canal system.(3)

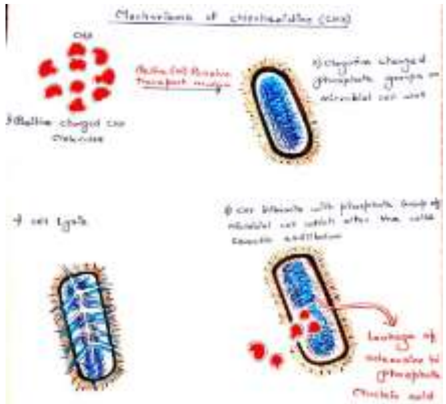


Fig. 1: Mechanism of action of Chlorhexidine

These systems can be characterized into two wide classes: manual and rotary agitation. Traditional manual irrigation methods incorporate metal and plastic syringe needles of different size and tip design, and manual dynamic agitation with brushes, files or gutta-percha points. This exemplary approach brings about inadequate ineffective irrigation, particulary in peripheral areas for example, anastomoses between canals, fins, and the most apical part of the principle root canal. Therefore, many of the compounds utilized for irrigation have been chemically altered and several rotary irrigation devices such as endovac system, sonic and ultrasonic vibrations have been developed to enhance the penetration and effectiveness of irrigation when contrasted with that of conventional syringe needle irrigation.(4) The most frequently used irrigants in endodontic treatment are Sodium Hypochlorite, Hydrogen Peroxide, the combined use of both, Chlorhexidine, Citric acid, Iodine-potassium-iodide, Alcohol, and EDTA solutions **(Fig. 2)**. Using a combination of products in the correct irrigation sequence contributes to a successful treatment outcome. More recently, a few new irrigating solutions for example Bioglass, MTAD, Q- mix, Tetraclean and some more have been supported for disinfection.[5]

Fig. 2: Normal Saline, Sodium Hypochlorite, Chlorhexidine & Edta

Syringes: Plastic syringes of different sizes are most commonly used for irrigation. Large volume syringes potentially are more difficult to control for pressure and accidents may occur. Therefore, to maximize safety and control, use of 1 to 5mL syringes is recommended instead of the larger ones. All syringes for endodontic irrigation must have a Luer-Lok design. Separate syringes should be used for each solution Because of the chemical reactions between many irrigants.

Needles: 25-Gauge needles were commonly used for endodontic irrigation a few year ago, now they were replaced by 27-Gauge, 30-Gauge and 31-Gauge needles for routine use in irrigation (Fig. 3). As 27 Gauge corresponds to International Standards Organization size 0.42 and 30 Gauge to size 0.31, smaller needle sizes are preferred. Several modifications of the needle-tip design have been introduced in recent years to facilitate effectiveness and minimize safety risks.

Fig. 3: Plastic Syringes For Irrigation

Vibringe system: It is an irrigation device that combines manual delivery and sonic activation of the solution. The vibringe is a cordless handpiece that fits in a special disposable 10ml luer–lock syringe that is compatible with irrigation needle. The vibringe features single- button operation, battery charge indicator, auto shut off with a two minute timer & white LED light for user feedback.

Irrivac needle pressure system: The irrivac is available in both a positive needle pressure version and a negative pressure version; one positive pressure irrivac for dispensing sodium hypochlorite and gross material evacuation and one negative pressure for final cleaning and irrigation with sodium hypochlorite. This system incorporates titanium handpieces, solution reservoirs & specialized tubing which are inactive to caustic irrigants. The negative needle pressure dispenses solution through the tubing funnel onto the needle, then streams down the canal & at last suctioned up & expelled.

The positive needle pressure dispenses solution through the needle while suction funnel suction off the irrigant solution from top of the canal. **Quantec irrigation system**–supplements rotary root canal instruments & is a convenient independent irrigation system. The peristaltic pump conveys irrigant by means of the handpiece as the root canal is being set up by rotary files. **Stropko Irrigator**-This irrigation system joins the delivery & recuperation of irrigant in one probe. The needle delivers the solution and a suction held in the same recovers the conveyed irrigant.

Needles / probes used for irrigation

Max–i probe The flexible probe offers unmatched effectiveness, patient comfort and safety in irrigating root canals. It has rounded end and side port and is available both in 28 gauge & 30 gauge version.

Pro Rinse endodontic irrigating probe is among the smallest –bore irrigating needles, with features of flexibility, side venting and a closed blunt end.

Proultra piezo ultrasonic needles- used in non-surgical root canal irrigation by application of ultrasonic vibration. The piezoflow irrigation needles are used in conjunction with a piezo–electric ultrasonic energy generating unit to provide the energy for tip oscillation. Syringe or other irrigation source is attached to the luer-lock connection on the ultrasonic needle. Removal of irrigant is through the conventional suction.

Vista– probe-These are bendable one inch needle tip designed to irrigate sub gingival surgical sites, and sulcus. It has universal luer- lock design with closed end and side port delivery. It is available in 23, 27 &30 gauges

Ni–Ti superflex–2.5 times more flexible tip.It has adjustable needle angle for longer life and produce less clogging. It is available in 30 Gauge with luer–lock system. Miscellaneous–Applie–vac needle, flex, Navitip & NaviTip FX & canal brush.**(Fig. 4)**

Fig. 4. Flex System and Canal Brush

Gutta-Percha Points The acknowledgment of the difficulty of apical canal irrigation has incited to different inventive procedures to encourage the penetration of solutions in the canal. One of these incorporates the usage of apically fitting gutta-percha cones in an up-and-down motion at the working length. Regardless of the fact that this energizes the exchange of the apical solution, the overall volume of fresh solution in the apical canal is probably going to stay little.

Endo Activator: Endo Activator (Advanced Endodontics, Santa Barbara, CA, USA) is a new type of irrigant facilitator. It is based on sonic vibration (up to 10,000 cpm) of a plastic tip in the root canal. The system has 3 different sizes of tips that are easily attached to the handpiece that creates the sonic vibrations.(6) Endo Activator does not deliver irrigant to the canal but it facilitates the penetration and renewal of the irrigant in the canal. Townsend C, Maki J.(7) have indicated that the use of Endo Activator facilitates irrigant penetration and mechanical cleansing compared with needle irrigation, with no increase in the risk of irrigant extrusion through the apex.**(Fig. 5)**

Fig. 5: Endoactivator Needle Designs

EndoVac: EndoVac (Discus Dental, Culver City, CA, USA) speaks to a novel approach of delivering the irrigant through the needle, the EndoVac system depends on a negative-pressure approach. The irrigant is put in the pulp chamber and it is sucked down the root canal and back up again through a thin needle with a special design.[8] EndoVac system brings down the risks related with irrigation near to the apical foramen considerably. Advantage of the reversed flow of irrigants might be great apical cleaning at the 1-mm level and a strong antibacterial impact when hypochlorite is utilized **(Fig. 6)**.

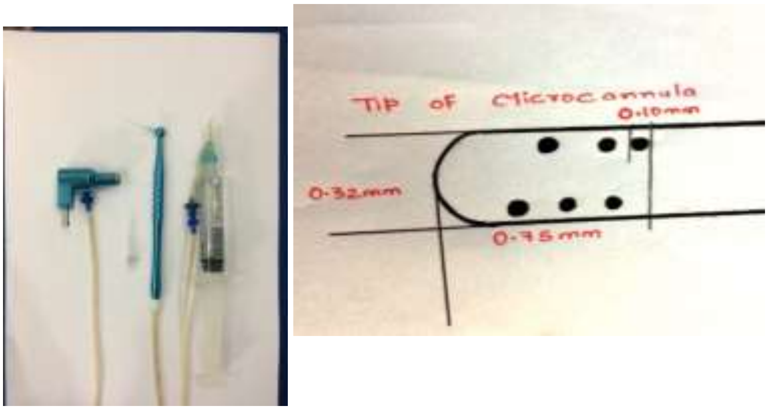


Fig. 6: EndoVac system uses negative pressure to make safe and effective irrigation of the most apical canal possible. The irrigant in the pulp chamber is sucked down the root canal and back up again via the needle, opposite to the classic method of irrigation.

Ultrasound: The use of ultrasonic energy for cleaning of the root canal and to facilitate disinfection has a long history in endodontics. The comparative effectiveness of ultrasonics a hand-instrumentation techniques has been evaluated and concluded that ultrasonics, together with an irrigant, contributed to a better cleaning of the root-canal system than irrigation and hand-instrumentation alone.[9] Cavitation and acoustic streaming of the irrigant add to the biologic – chemical activity for maximum effectiveness **(Fig. 7 & 8)**. Investigation of the physical systems of the hydrodynamic reaction of an oscillating ultrasonic file proposed that stable and transient cavitation of a file, steady streaming, and cavitation microstreaming in all add to the cleaning of the root canal.[10-12] Ultrasonic files must have free movement in the canal without making contact with the canal wall to work effectively. Goodman A et al evaluated the importance of ultrasonic preparation for optimal debridement of anastomoses between double canals, isthmuses, and fins.[13] The effectiveness of ultrasonics in the elimination of bacteria and dentin debris from the canals has been shown by Spoleti P et al.[14]

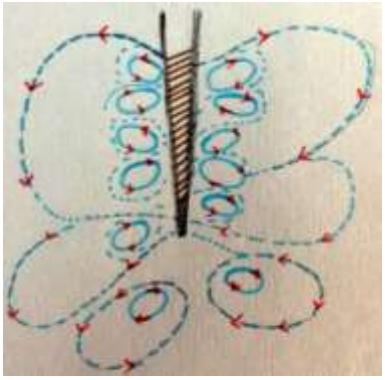


Fig. 7: Acoustic Streaming

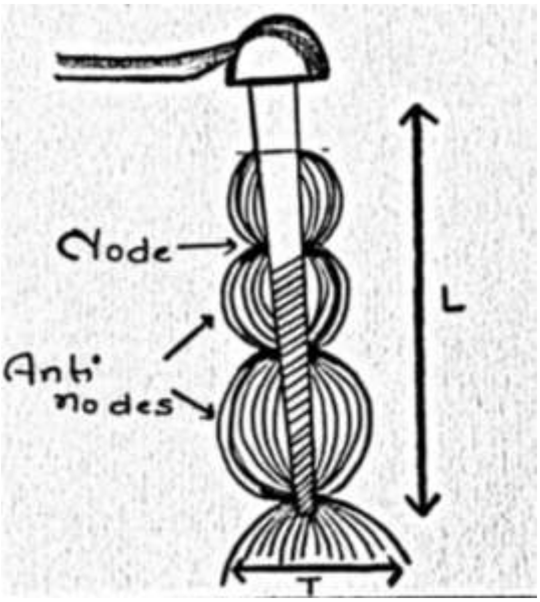
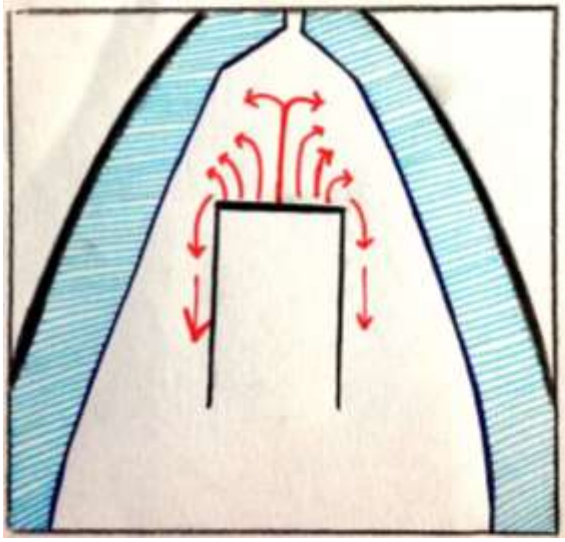


Fig. 8: Oscillation of Ultrasonic Instrument

Clinical and Technical Aspects of Irrigation

The most important technical aspect of root canal irrigation is the correlation between the diameter of the irrigating needle and the apical preparation size. Inside the root canal the effect of irrigation is restricted to 3- 4 mm apical from the needle tip. In an in vitro study, it was demonstrated that the introduction of an irrigation needle 1 mm short of working length resulted altogether less residual microbes in the root canal in contrast when using a needle 6mm short of the working length. The aim is to introduce the needle as close as possible to working length to enhance the irrigation effectiveness. Since the smallest needle recommended for root canal irrigation is a 30–gauge needle, the apical preparation should be size 35 to 40. Even in severely curved canals, an apical preparation of size 35 to 40 can be accomplished with current modern rotary nickel – titanium instruments without the danger of canal straightening. Flexible irrigation needles with a safety tip are suggested, so that the needle can be pre- bent according to the canal curvature to permit appropriate cleaning of the apical part of curved root canals. When attempting to insert the needle tip as close as possible to the working length, the needle may be stuck in the root canal and the pressure exerted can easily result in extrusion of Sodium Hypochlorite or Hydrogen per oxide into the periapical tissue. Hence when resistance to needle is felt, it should be pulled back approximately 2 mm to ensure space between the canal wall and needle to allow the irrigant to flow out of the canal. This will minimize the risk of injecting irrigation solutions beyond the apex and into the periapical tissue.



When introducing the irrigation needle there must be enough space between the canal wall and the needle to allow the irrigant to flow out of the root canal.

Irrigation Protocol[15]

- Apical preparation ought to be atleast size 35 and 30 gauge needle should be used.
- After access cavity preparation flush the cavity and the canals with Sodium Hypo chlorite. Canals must always be filled with Sodium Hypochlorite because this will increase working time available for the irrigant. At the same time, cutting efficiency of root canal instruments is enhanced due to the lubrication effect.
- During instrumentation: 2-5 ml of Sodium Hypochlorite per canal should always be utilized throughout mechanical root canal preparation.
- After shaping: 5-10 ml of Sodium Hypochlorite per canal. when the shaping procedure is finished, flush with a high volume of Sodium Hypochlorite.
- After shaping: irrigation with 5 ml of EDTA for each canal for 1 minute (or with citric acid). After a final rinse of Sodium Hypochlorite, the canals should be irrigated with either EDTA or Citric Acid to remove the smear layer.
- Final rinse with 2ml Sodium Hypochlorite for every canal to neutralise the acidic effect of EDTA and to permit Sodium Hypochlorite to penetrate into the opened tubules.
- Apical arrangement ought to be atleast estimate 35 and 30 gage needle ought to be until
- Optional: Final irrigation-especially in retreatment cases: Chlorhexidine. Rinse with water to remove Sodium Hypochlorite and then with a 2% Chlorhexidine solution.
- Before root canal filling: rinse with 3 ml of alcohol per canal to dry the root canal.

Summary

Traditionally, the most common way in which the irrigant has been introduced into the root canal was through a needle connected to a syringe. With time the needle designs have been modified due to the possible risk of irrigant extrusion beyond the root apex. An increasing number of novel needles – tip designs such as Endoactivator, Max–I Probe, Vibringe, RinsEndo and Endovac are emerging in an effort to better address the challenges of irrigation.

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