Machine Assisted Irrigation Agitation Techniques - A Review

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Date of Receiving : 23/Sep/2012
Date of Acceptance : 25/Oct/2012

ABSTRACT: Effective irrigant delivery and its agitation is a prerequisite for successful endodontic treatment. Although this can be achieved through chemomechanical debridement but it is not possible to clean and shape root canal completely because of its complex anatomy. Even with the use of various nickel titanium rotary instruments only the body of the root canal can be reached , leaving canal fins, isthmuses and cul-de-sac untouched. These areas act as reservoirs for tissue debris , microbes and their by-products , resulting in persistent periradicular inflammation. Thus, requiring irrigation to be essential part of endodontic treatment. The technological advancements in the last decade have brought to the fore new agitation devices which provide soft tissue debridement, smear layer removal through various mechanisms of irrigant transfer, to provide better cleaning and shaping of the root canals. The objective of this review is to present an overview of machine assisted agitation techniques and critique of their debridement efficacy.

KEY WORDS: Agitation, Debris, Irrigation, Machine-assisted, Root canal.

INTRODUCTION

In the hierarchy of cleaning and shaping of root canal systems, root canal irrigants are indispensable aids in dissolving and activating organic debris and destroying microorganisms. It is well established that even with the use of rotary nickel-titanium instruments currently available, central body of the canal, canal fins, isthmus and cul-de-sacs remain untouched that harbors tissue debris ,microbes and their by-products which might prevent close adaptation of the obturation material and result in persistent periradicular inflammation. Thus irrigation is the benchmark as it can reach where instruments cannot.

Protocol of effective irrigation comprises of 2 aspects, type of the irrigant and agitation technique. The former includes sodium hypochlorite, EDTA, CHX and normal saline. The latter includes manual agitation techniques and machine assisted agitation techniques.

Machine assisted agitation systems includes : Rotary brushes, Continuous irrigation during rotary instrumentation (Quantec –E irrigation system), Sonic irrigation, Ultrasonics, Pressure alternation devices, non instrumentation technique (NIT), Rinse endo, Endovac system and Other techniques

ROTARY BRUSHES

A rotary handpiece–attached microbrush has been used by Ruddle to facilitate debris and smear layer removal from instrumented root canals. The brush includes a shaft and a tapered brush section. The latter has multiple bristles extending radially from a central wire core. During the debridement phase, the microbrush rotates at about 300 rpm, causing the bristles to deform into the irregularities of the preparation. This helps to displace residual debris out of the canal in a coronal direction.

Canal brush is an endodontic microbrush that has recently been made commercially available. This highly flexible microbrush is molded from polypropylene and might be used manually with a rotary action. However, it is more efficacious when attached to a contra-angle handpiece running at 600 rpm. A recent report by Weise et al showed, use of rotary brushes removed debris effectively from simulated canal extensions and irregularities.

CONTINUOUS IRRIGATION DURING ROTARY INSTRUMENTATION

The Quantec –E irrigation system is self –contained fluid delivery unit that is attached to the Quantec –E Endo system.

It uses a pump console, 2 irrigation reservoirs, and tubing to provide continuous irrigation during rotary instrumentation. According to Setlock et al, compared with needle irrigation, Irrigation with this results in cleaner canal walls and more complete debris and smear layer removal in the coronal third of the canal walls. However, these advantages were not observed in the middle and apical thirds of the root canal.

SONIC IRRIGATION

It is performed by using a Risposonic file which is attached to a MM 1500 sonic handpiece after canal shaping. These files have a non uniform taper that increases with file size. They are barbed, so might inadvertently engage the canal wall and damage the finished canal preparation during agitation.

The EndoActivator System is a more recently
It consists of a portable handpiece and 3 types of disposable polymer tips of different sizes. Polymer tips are color coded small (yellow, 15/02), medium (red, 25/04), large (blue, 35/04). These tips are claimed to be strong and flexible and do not break easily. Because they are smooth, they do not cut dentin. It can effectively clean debris from lateral canals, remove the smear layer, and dislodge clumps of simulated biofilm within the curved canals of molar teeth. During use, the activation produces a cloud of debris that can be observed within a fluid-filled pulp chamber. Vibrating the tip, in combination with moving the tip up and down in short vertical strokes, synergistically produces a powerful hydrodynamic phenomenon. A possible disadvantage of the polymer tips used are radiolucent; therefore, it is 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.

ULTRASONICS

In 1980, an ultrasonic unit designed by Martin et al. became commercially available for endodontic use. Compared with sonic energy, ultrasonic energy produces high frequencies but low amplitudes. Two types of ultrasonic irrigation are present, first type is combination of simultaneous ultrasonic instrumentation and irrigation (UI). The second type, often referred to as passive ultrasonic irrigation (PUI), operates without simultaneous instrumentation.

In ultrasonic irrigation it is difficult to control the cutting of dentin and so the shape of root canal. It resulted in Strip perforations and highly irregular-shaped canals. Therefore, UI is not generally perceived as an alternative to conventional hand instrumentation. 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. 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. 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.

PRESSURE ALTERNATION DEVICES

As it is very difficult for the irrigant to reach the apical portions of the canals because of air entrapment, when the needle tips are placed too far away from the apical end of the canals. Conversely, if the needle tips are positioned too close to the apical foramen, there is an increased possibility of irrigant extrusion from the foramen that might result in severe iatrogenic damage to the periapical tissues. Concomitant irrigant delivery and aspiration via the use of pressure alternation devices provide a plausible solution to this problem.

NON INSTRUMENTATION TECHNIQUE

Lucci et al introduced minimally invasive approach for removing canal contents and accomplish disinfection that did not involve the use of a file. This system consists of a pump, a hose, a special valve and connector that needs to be cemented into the access cavity. Cleaning action is provided by oscillation of irrigant solution at reduced pressure. It has been reported that it results in good cleaning of root canal in vitro.

VAPOUR LOCK EFFECT

Air entrapment by an advancing liquid front in closed-end microchannels is a well-recognized physical phenomenon. The ability of a liquid to penetrate these closed-end channels is dependent on the contact angle of the liquid and the depth and size of the channel. Under all circumstances, these closed-end microchannels will eventually be flooded after sufficient time (hours to days). This phenomenon of air entrapment and the time frame in which complete flooding occurs has practical clinical implications when irrigants are delivered by using syringe needles from the coronal or middle third of a root canal. Because endodontic irrigation is performed within a time frame of minutes instead of hours or days, air entrapment in the apical portion of the canal might preclude this region from contact or disinfection by the irrigant.

RINSE ENDO SYSTEM

The RinseEndo system (Du¨rr Dental Co) root canal irrigation device based on pressure-suction technology. 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 extracted from the root canal and automatically merged with fresh rinsing solution. The pressure-suction cycles change approximately 100 times per minute.

The manufacturer of RinseEndo 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. This system has been shown to be superior to conventional static irrigation in dentin penetration of a dye marker; however, a higher risk of apical extrusion of the irrigant was also observed.

ENDOVAC SYSTEM

In the EndoVac system (Discus Dental, Culver City, CA), a macrocannula or microcannula is connected via tubing to a syringe of irrigant and 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 titanium handle 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 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 and siphons off the excess irrigant to prevent overflow. The cannula in the canal simultaneously exerts negative pressure that pulls irrigant from 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. A recent study showed that the volume of irrigant delivered by the EndoVac system was significantly higher than the volume delivered by conventional syringe needle irrigation during the same time period.36

OTHER TECHNIQUES OF ROOT CANAL DISINFECTION

Other than irrigants, irrigant activating systems and intra-canal medicaments, research is turning towards newer and more rapid methods of achieving cleaner root canals. The more prominent among them are:

1. Lasers: It has been documented in numerous studies that: CO2, Nd:YAG, Argon, and Er:YAG laser irradiation has the ability to remove debris and smear layer from the root canal walls following biomechanical instrumentation. A new endodontic side firing spiral tip (RCLas; Lumenis, Opus Dent, Israel) overcomes the disadvantage of the straight emission of the laser beam, and thus claims to enable cleaning of the root canal walls laterally.

2. Photoactivated disinfection: An alternative approach to microbial killing in the root canal system by laser light involves the use of low power lasers to drive a photochemical reaction that produces reactive oxygen species, a technique termed photo-activated disinfection (PAD). By using exogenous photosensitizers such as tolonium chloride, killing of all types of bacteria can be achieved. In vitro studies of PAD have demonstrated its ability to kill photosensitised oral bacteria (E. faecalis), and more recently microbial killing in vivo in the root canal system has been demonstrated. While PAD can be undertaken as part of the routine disinfection of the root canal system, it also has potential use for eradicating persistent endodontic infections for which conventional methods have been unsuccessful.

3. Ozone: It is a strong oxidant and is unstable at high concentrations. Heal Ozone by KaVo is a new system introduced for various applications including disinfection/remineralization of caries and endodontic disinfection. The unit looks like a standard handpiece with a protruding needle and a plastic/silicone cap that fits over and seals the access. The needle goes in the canal and provides the ozone.

CONCLUSION

Despite the plethora of studies on the effectiveness of various endodontic irrigant agitation regimens, it is noteworthy that none of the system is accurate that can increase clinical efficacy of the treatment outcome. There is a need to determine from a practice management perspective how these devices are perceived in terms of their practicality and ease of use. Understanding these fundamental issues is crucial for clinical scientists to improve the design and user-friendliness of future generations of irrigant agitation systems.

REFERENCES


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