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Editorial

Emerging Trends in Root Canal Disinfection

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One of the most overlooked steps in endodontic therapy is the removal of necrotic debris from the root canal. Disinfection of the complex root canal system is the axiomatic principle for the success of endodontic therapy. Before placement of intracanal medicaments or obturating materials, it is essential to eliminate the biofilm from the root canal system completely [1]. Various limiting factors encountered by dentists during root canal disinfection: biofilm in the isthmus, apical delta and non-instrumented areas in the root canal system. A Review on Micro-CT evaluation of untouched areas after mechanical preparation with Xp-Endo shaper has shown that 38.6% of root canal wall remains untouched [2]. Various root canal irrigating solutions and devices were suggested to surmount these factors. Commonly used root canal irrigants are NaOCl (3%, 5.25%) and EDTA (17%).

NaOCl

Walker, in 1936, suggested using NaOCl at 3% and 5.25% for irrigation of root canals. The efficacy of the gold standard irrigant, NaOCl, was enhanced by using higher concentrations of 5.25% and 6% NaOCl and raising the temperature of NaOCl (45-60°C). Recent systematic review and meta-analysis concluded that Irrigant activation techniques such as Passive ultrasonic irrigation followed by Apical negative pressure irrigation, sonic irrigation and manual dynamic activation techniques would enhance the efficacy of NaOCl by penetration into the lateral canals [3].

EDTA

The inability of NaOCl to dissolve the smear layer is overwhelmed by the usage of EDTA at 17% for 1min, which will liquefy the inorganic constituent of debris. Using EDTA at 17% as the final irrigant will expose the collagen after smear layer removal, which acts as a substrate for the adhesion of E.Faecalis bacteria. Using 1%NaOCl as the final irrigant is suggested to remove the exposed collagen fibers and prevent the release of MMP2 from the dentin [4].

Syringe irrigation with a needle does not reach the non-instrumented areas in the isthmus, apical delta and C-shaped canals. Activation of irrigants with mechanical devices such as Ultrasonic, Sonic, Apical negative pressure irrigation, Laser activation, Photo-activated disinfection, Ozone and Gentle wave system is imperative to solve this problem.

Sonic activation

EndoActivator® (EA, Dentsply Tulsa Dental Specialties, Tulsa, OK, USA) consists of flexible polymer tips available in small (#15/.02), medium (#25/.04), large (#35/.04). The hydrodynamic activation with acoustic streaming and cavitation will agitate the irrigants and enhance their penetration into dentinal tubules. A meta-analysis conducted by Paixao S., *et al.* Concluded that sonic activation is efficient in smear layer removal compared to ultrasonic activation [5].

Eddy Innovative Sonic Powered Irrigation (EDW)

It consists of polyamide tips that work at a frequency of 6000Hz. Three-dimensional oscillating motion activates the irrigant by acoustic streaming and cavitation, resulting in better cleaning efficacy.

Smart Lite Pro Endo Activator (SLP EA, Dentsply Tulsa Dental Specialties, Tulsa, OK, USA)

It consists of Ultra quiet ergonomic, cordless, contra-angled design with a sonic motor that works at 18,000cpm. Flexible medical grade polymer tips with parallelogram cross-section, available in two sizes: Small (Yellow 15/02, 22mm length) and Red (Medium 25/04, 22- and 28-mm lengths). The elliptical motion of tips agitates the irrigant and creates acoustic streaming and cavitation [6].

VPro Stream Clean System (VSS) (Vista Dental Products)

The ultrasonic handpiece is attached to a novel irrigation needle made of NiTi (gauge #30) with a flow rate 0f 5-10ml/minute. In-vitro study concluded that the VSS system showed better removal of root canal debris compared to conventional needle irrigation at 1mm and 3mm from the apical constriction [7].

iVac™ System (Pac-Dent)

The Novel irrigation system consists of a polymer cannula of 0.35mm-0.50mm in diameter, connected to an ultrasonic handpiece to create vibrations for continuous activation of irrigant and negative pressure for evacuation of irrigant [8].

Ultrasonic activation

Ultrasonic activation transfers the acoustic energy with an endodontic file or stainless steel wire, resulting in cavitation and microstreaming. The energy released from cavitation bubbles is transmitted to the canal walls and pull-out the debris coronally. Both acoustic microstreaming and cavitation could be aforethought-demanding elements in ultrasonic activation. Ultrasonic activation reduces the bacterial load significantly compared to conventional needle irrigation [9].

Gentle wave system (GW) (Sonendo, Laguna Hills, CA, USA)

GW consists of a handpiece, a console and a container. Irrigant from the handpiece will undergo degassing procedure to remove the gases from the solution, thereby preventing the vapor lock effect. Cavitation clouds created by shear forces combined with hydrodynamic cavitation result in microbubbles that collapse inward and cause sound waves of different frequencies. These cavitation clouds will rebound within the root canal system for efficient cleaning. A review of the gentle wave system concluded that it has better smear layer removal capability than Needle irrigation, Passive ultrasonic irrigation, Continuous ultrasonic irrigation and Endovac. GW has greater penetration of NaOCl into dentinal tubules than Passive ultrasonic irrigation and Continuous ultrasonic irrigation. Overall, the GW system showed a clinical success rate of 93.7% [10].

Laser Activated Irrigation-PIPS (Photon-Initiated Photoacoustic Streaming)

Absorption of laser light (Erbium: YAG laser-short pulse duration-50us) by NaOCl will generate photo-acoustic shock waves and evaporate irrigant with the formation of vapor bubbles which enlarge and implode, creating collateral cavitations. Studies reported that root canals irradiated with PIPS had reduced the bacterial load at the apical third of the root canals, and negative bacterial cultures were reported in many samples [11].

Photo-Activated Disinfection (PAD)/Light-Activated Disinfection (LAD)

It uses a photosensitizer (toluidine blue) attached to the bacterial surface and absorbs the light with wavelength (visible light-635 to 675 nm) or near-infrared(810nm). In the presence of a specific light source and adequate oxygen in the tissue, releasing oxygen free radicals and singlet oxygen produces a bactericidal effect. Ex-vivo results concluded that E. faecalis bacterial count was reduced to 99.5% and 98.89% at 4min and 2min, respectively [12]. In endodontic failure cases, E. Faecalis can penetrate to a depth of 150um into dentinal tubules [13]. Studies stated that PAD could destroy the bacteria and biofilm to a depth of up to 1mm [13]. A systematic review concluded that PAD could be used as an adjunct to ultrasonic activation to eradicate persistent endodontic infections [14].

Ozone:(O_3)

Ozone is a gas that disassociates into the water and releases a reactive form of oxygen, destroying the bacterial cell wall. A recent systematic review reported that ozone therapy could not be an alternative to NaOCl irrigant in reducing bacterial biofilm, and Ozone cannot increase the antimicrobial efficacy of NaOCl [15].

Silver Nanoparticles

Silver nanoparticles have been studied extensively for their action on biofilm. Sulfur proteins on the bacterial cell membrane attract the silver nanoparticles and destroy the cell wall. They penetrate the bacterial cell, disturb the respiratory enzymes and impede ATP production. They can directly denature the cell wall, DNA and ribosomes resulting in cell apoptosis. A systematic review of their antimicrobial efficacy concluded that they could be used as an effective root canal irrigant for 2 minutes [16].

Chitosan nanoparticles

Chitosan is a natural, biopolymer chitin obtained from the shells of crabs and shrimps. Chitosan is a cationic compound that acts on negatively charged bacterial cell membranes and results in cell lysis. Chitosan nanoparticles impede the growth of biofilm and seize the development of E. faecalis. With its chelating property, it enhances root canals' disinfection and inhibits bacterial attachment to dentine. With its antimicrobial action, chitosan nanoparticles emerge as promising root canal irrigants for the eradication of biofilm [17].

Conclusion

Although, It is impossible to completely eradicate the microorganisms from the complex root canal anatomy. Conventional needle irrigation techniques do not reach the isthmus, non-instrumented areas in C-shaped canals, apical deltas and lateral canals. Newer irrigation solutions and activation devices will enhance the penetration of irrigants into the complex root canal configurations and reduce the microbial load to a critical point that favors healing. Depending on the clinical condition, the selection of the irrigant, the concentration of the irrigant and the contact time will vary and be appropriately selected for a better endodontic outcome.

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