FROM NEEDLE TO NOVELTY: ENDODONTIC IRRIGATING DEVICES

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ABSTRACT: -

Effective cleaning and disinfection of the root canal system are essential for the success of endodontic treatment. Mechanical instrumentation alone cannot completely eliminate microorganisms, tissue remnants, and dentinal debris from the complex anatomy of the root canal system. Therefore, various irrigants and irrigation delivery and activation techniques have been developed to improve irrigant penetration, debris removal, smear layer disruption, and microbial elimination. This review aims to provide an overview of various irrigating devices and irrigant activation techniques used for root canal disinfection, with emphasis on their mechanisms of action, advantages, and limitations.

In root canal treatment conventional syringe irrigation remains widely used; however, its effectiveness may be limited by inadequate penetration into complex canal anatomy and the risk of apical extrusion. Activation techniques such as sonic and ultrasonic irrigation enhance irrigant movement through acoustic streaming and cavitation, thereby improving debris removal and microbial reduction. Laser-assisted techniques, including PIPS and SWEEPS, promote photoacoustic streaming and enhanced irrigant penetration. Nanoparticles demonstrate promising antimicrobial and antibiofilm properties, while the GentleWave system facilitates irrigant distribution through fluid dynamics and negative-pressure irrigation. Photodynamic therapy and ozone-based systems provide additional antimicrobial approaches, whereas the Self-Adjusting File combines canal preparation with continuous irrigant delivery and activation.

No single irrigation device can completely address all the anatomical and microbiological challenges of the root canal system. Conventional irrigation remains fundamental, while activation and emerging technologies may enhance cleaning and disinfection. Further clinical research is required to establish standardized protocols and determine the long-term clinical effectiveness of these advanced irrigation technologies.

Keywords: Root canal treatment; Irrigation; Irrigant activation; Sonic irrigation; Ultrasonic irrigation; Laser-activated irrigation; Nanoparticles; Photodynamic therapy; Ozone; Self-adjusting file.

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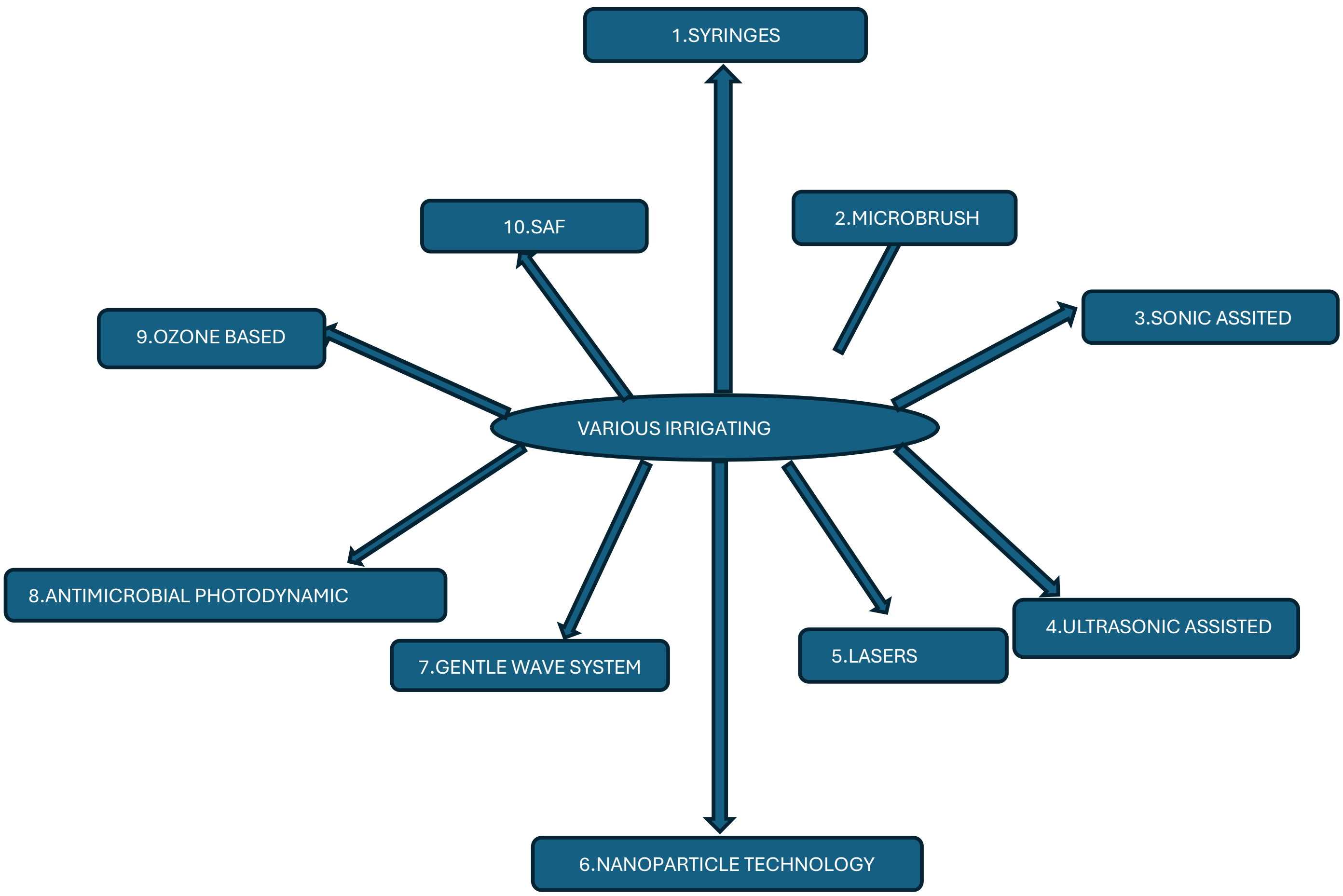
INTRODUCTION

Endodontic preparations are fundamentally intended to clean and shape the root canal system. As a consequence of this procedure, a contaminant layer composed of organic and inorganic debris is produced, including pulp tissue remnants, bacterial elements and their by-products, and dentinal debris. This smear layer has a negative effect on endodontic treatment success, because it can interfere with the dentin penetration of sealers, resulting in lower retention in the root canal.[1] Failure to achieve proper cleaning and debridement can lead to persistent infection, postoperative pain, and unsuccessful treatment outcomes. [2]

To overcome this limitation, several irrigant and irrigant activation techniques have been developed to enhance disinfection and removal of smear layer. This article is going to discuss about irrigating devices used for the disinfection of root canal treatment. Among the most well documented are Syringe irrigation with needles, Microbrush, Manual Dynamic Activation (MDA), Sonic activation, Passive Ultrasonic Irrigation (PUI), Laser Activated Irrigation (LAI), Nanoparticle technology, Gentle Wave System, Antimicrobial Photodynamic Therapy, Ozone based system, and SAF .

This review article aims to compile comprehensive information on various irrigant activation methods used for root canal disinfection.



1.SYRINGE IRRIGATON WITH NEEDLES

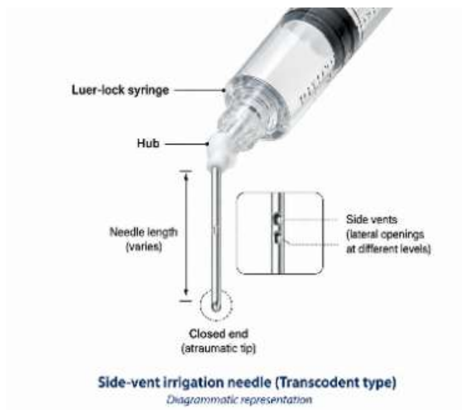
INTRODCUTION

Syringe and needle irrigant delivery during root canal treatment has been practiced for more than a century. In spite of advances in irrigation systems, syringe-and-needle irrigation remains a widely recommended technique.[3]

TYPES OF NEEDLES

Various needle types have been used over the years to deliver irrigants which differ, with respect to the presence of an open or closed tip and the number of outlets. Previously large-gauge needles (21–25G) are used, Such needles were scarcely able to penetrate beyond the coronal third of the root canal, even in wide canals. More recently, the use of needles with smaller diameters (28G, 30G, or 31G) has been advocated, primarily due to their ability to penetrate deeper into the canal.[3]

Syringes are commonly classified according to tip design. Luer tips, [which are not necessarily Luer-Lock], are conical in shape with a 6% taper. Luer-Lock tips share the same conical design while providing an additional locking mechanism to prevent accidental needle detachment. Depending on the procedure, needles vary greatly in length and thickness. Their diameter is measured in gauge numbers, which range from 8 to 30 and correspond to diameters of 4.57 mm and 0.31 mm, respectively. Higher gauge numbers correspond to thinner needles. It is not uncommon to encounter needles that share the same length but differ in diameter.[4]



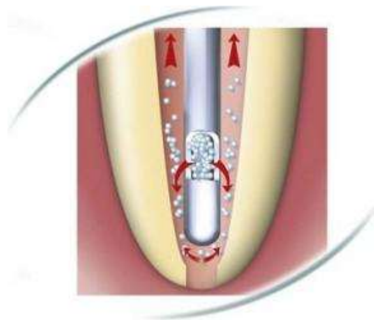
Irriflex needle [**Flexible Irrigation Needle Designed for Efficiency and Comfort**]

Handling of the needle during irrigation is essential, especially in thin roots, such as the mesio buccal root of maxillary molars. Application of extreme pressure during irrigation, or binding of the needle tip within the canal,may predispose the needle fracture. Furthermore, the hollow structure of irrigating needles increases their susceptibility to fracture. One of the reported drawbacks of needle irrigation is the periapical extrusion of the irrigating solution.[3]

Notched-end irrigation needles (Endoneedle type; Elsodent) offer the advantage of being blocked 3 mm from the apex, which prevents pressurized irrigant from irritating the periodontal ligament via a water-cannon effect.

Irrigation needle type (Transcodent) featuring two lateral openings at different levels and a foam tip. These needles enable effective cleaning of the entire root canal in an atraumatic manner. As with other types, these needles are available in various diameters, with 27- and 30-gauge being most appropriate for endodontic use, depending on the width of the canal.[5]

MECHANISM OF ACTION :Open-ended tips direct irrigant toward the apex, increasing apical canal pressure. Closed-ended, side-vented irrigant tips generate increased pressure against the root canal walls, thereby improving hydrodynamic activation.[6]The irrigants was administered at a rate of 0.26 ml/s, in accordance with the recommended optimal speed. Subsequently, neutrally buoyant tracer particles (density 1.1 g/cm³; MMSC, Maharashtra, India) were introduced to facilitate visualization of irrigant flow.[7] Side-delivery needle enables delivery of irrigating solutions to the root canal walls to enhance canal cleaning.



In a comparative SEM study to evaluating debris removal, the IrriFlex needle outperformed the conventional Endoneedle. This can be attributed to its flexible design, which allows easier penetration of the root canal system without breakage, as well as to the presence of multiple lateral openings at the same level, which help balance the pressure and flow of the expelled irrigant. The presence of these openings ensures enhanced exposure throughout the entire root canal.[4]

LIMITATIONS

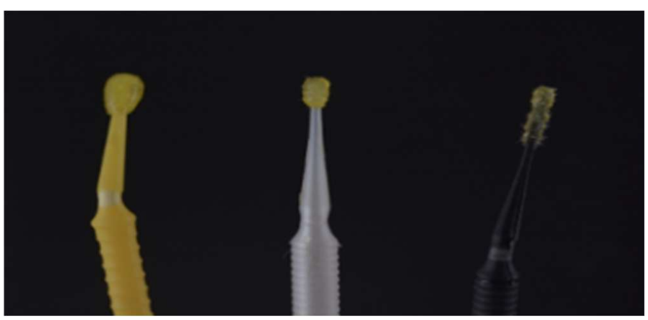
Nevertheless, conventional static syringe irrigation is associated with significant drawbacks, such as limited irrigant penetration into intricate root canal anatomies, suboptimal smear layer removal, and ineffective bacterial biofilm disruption. Excessive apical extrusion of irrigating solutions may result in inflammation, periapical tissue injury, and heightened postoperative discomfort.

Therefore various advanced irrigation techniques have been introduced to enhance irrigant activation, promoting deeper canal penetration and minimizing post-treatment discomfort.[8]

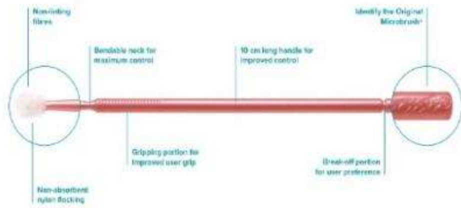
2.MICROBRUSH

INTRODUCTION

To enhance the removal of debris and smear layer from instrumented root canals, Ruddle employed a microbrush attached to a rotary handpiece. The Canal Brush are a newly developed endodontic microbrush that has recently become commercially available. Constructed entirely from polypropylene, this highly flexible microbrush may be operated manually using a rotary action.Weise.et.al demonstrated that the use of a small and flexible Canal Brush with an irrigant effectively removed debris from simulated canal extensions and irregularities [6].



MECHANISM OF ACTION :The microbrush comprises a shaft (shank) and a tapered brush section. During debridement, the microbrush rotates at around 300 revolutions per minute. These brushes are not intended for direct delivery of irrigant into the canal space. Rather, they are designed as adjuncts to agitate the irrigant within the root canal.[6]



ORIGINAL MICROBRUSH @ APPLICATOR

LIMITATIONS

The greater dentin roughness without alteration in dentin hardness, is observed in canal brush usage. This may be related to the frictional effects of bristle rotation on dentin previously treated with EDTA or CA.

Therefore, the action of the Canal Brush appears to be limited to dispersing solutions within the root canal and producing microgrooves on the root dentin surface. In support of this hypothesis, Mendonça et al, reported that the bristles cause mechanical abrasion of dentin and restrict solution flow, thereby decreasing debris removal as a result of contact with the dentinal walls [1].

3.SONIC IRRIGATION

INTRODUCTION

Tronstad et al. in 1985 introduced sonic instrumentation, which operates at a lower frequency range (1–6 kHz), contains flexible polymer tips with a specific design used to preserve the original canal shape and minimize accidental removal of dentin.[9]

MECHANISM OF ACTION

Acoustic streaming–mediated activation of the disinfectant enhances and completes the irrigation process, contributing to improved outcomes in endodontic treatment. This method of agitation improves debridement and facilitates smear layer disruption. It has been shown to be more effective than syringe irrigation in eliminating debris from the apical two-thirds of the root canal [6].

The SONICflex air scaler handpiece has designation of its power modes “low,” “medium,” and “high” with the markings “1,” “2,” and “3,” respectively. According to the manufacturer, the respective amplitudes within the excitation unit of the handpiece were 120 ± 15 µm, 160 ± 15 µm, and 240 ± 15 µm. Sonic irrigant activation using EDDY at the highest power setting demonstrated superior than syringe needle irrigation in reducing intratubular bacteria throughout all regions of the root canal [10].

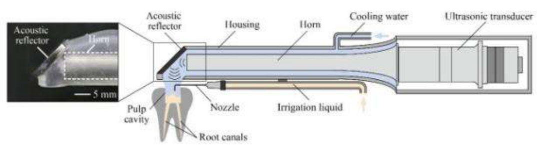
LIMITATIONS

The use of sonic activation techniques re linked to a higher risk of extrusion—especially with larger apical preparation sizes; however, this method demonstrate significantly greater efficiency in removing debris and the smear layer, as well as superior biofilm elimination capacity.[9]

4.ULTRASONIC IRRIGATION

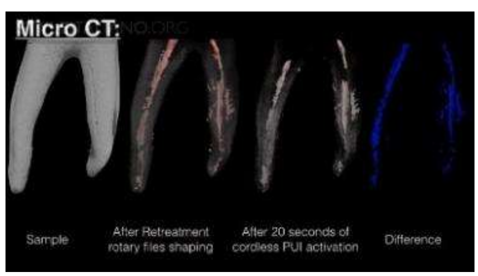
INTRODUCTION

Ultrasonic irrigation (UI) uses high-frequency ultrasonic waves in the range of 25–30 kHz to activate irrigants within the root canal system. Ultrasonics can be classified into two types: simultaneous ultrasonic instrumentation and irrigation (UI) and passive ultrasonic irrigation (PUI). In ultrasonic continuous irrigation, the irrigant is delivered through tubing that is connected to an irrigation syringe via a Luer-lock mechanism. PUI offers advantages such as improved penetration into complex canal anatomies, enhanced removal of debris and bacteria, and superior disinfection, particularly in difficult areas such as isthmuses and lateral canals.[11]



MECHANISM OF ACTION :Ultrasonic irrigation shown to be highly effective in eliminating smear layers and bacterial colonies, especially in curved canals and areas with complex anatomy. It produces acousting streaming and micro cavitaton, contributing

to efficient disinfection, bacterial biofilm disruption and superior elimination of debris from irregular areas of the canal. Through mechanical streaming, UI facilitates improved irrigant contact with canal walls, contributing to more effective microbial control. However, concerns have been raised about the apical extrusion of irrigants and the potential irritation of periapical tissues, there by warranting evaluation of its effect on postoperative pain.[12]



5.LASERS TREATMENT IN THE FIELD OF ENDODONTICS

INTRODUCTION

The incorporation of dental lasers into clinical dentistry has markedly improved procedural precision and efficiency, thereby contributing to superior treatment outcomes and enhanced effectiveness. Although numerous tools have been developed for cleaning and shaping the root canal system, recent research has emphasized the significant antibacterial potential of laser irradiation. . Laser systems eradicate intracanal microorganisms via three different mechanisms.

* In the first approach, known as Laser-Assisted Disinfection (LAD), high-power lasers are employed to eliminate microorganisms within the root canal. Of the high-power laser systems, the Nd:YAG laser demonstrates enhanced ability to eliminate root canal bacteria, likely attributable to its deeper penetration into dentinal tubules. [13]

* In the second approach, referred to as **Laser-activated irrigation (LAI)**, Er,Cr:YSGG laser is employed to improve root canal disinfection through activation of irrigating solutions. The effectiveness of this method depends on the strong affinity of the laser wavelength for water and hydroxyapatite. In the presence of sodium hypochlorite (NaOCl), the laser energy is efficiently absorbed by the irrigant and rapidly transformed into thermal and kinetic energy, thereby enhancing fluid agitation, canal cleaning, and antimicrobial action.[13]

*The third laser-assisted method for root canal cleaning and disinfection is PDT. In this method, a light-absorbing substance called a photosensitizer is placed inside the root canal and activated using a low-intensity light source. In a clinical trial conducted by Emam et al. it was observed that when a diode laser was used to activate the photosensitizer inside the canal in combination with the placement of calcium hydroxide during regenerative treatment of immature single-rooted teeth, the increase in canal length and overall canal cleaning were significantly greater compared to photodynamic therapy alone or the placement of calcium hydroxide alone, in a follow-up phase of 9 months to 1 year.[13]

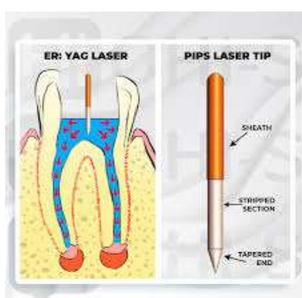
MECHANISM OF ACTION :Laser technology is based on the utilization of light energy, which is a form of electromagnetic radiation traveling at a constant velocity of approximately 300,000 km/s. Light is emitted in the form of waves, and its fundamental unit is the photon. The wavelength of the photons produced, which plays a key role in determining the laser’s type and clinical use, is directly influenced by the energy state of the electron at the moment of emission. Laser wavelengths vary in their clinical suitability, with specific wavelengths showing enhanced efficacy in selected dental procedures, particularly within endodontics. [13]

Photobiomodulation (PBM), formerly termed low-level laser therapy (LLLT), is a non-thermal modality that employs low-intensity laser irradiation (typically less than 0.5 W) in the red to near-infrared spectral range to achieve therapeutic effects. [13]

In contrast, the large range of lasers employed in endodontics requires a clear understanding of their specific features, including wavelength, energy levels, and applications, to ensure optimal clinical performance. In fact, in many clinical cases, treatment failures are not due to the inherent inefficiency of the laser, but rather to improper

laser selection or incorrect energy application.[13] Additionally, the Nd:YAG laser has been shown to damage bacterial cell walls and break down biofilm structures, making it a promising option for endodontic disinfection, especially in resistant cases where conventional treatment methods are inadequate.[14]

PIPS and SWEEPS



As advanced forms of laser-activated irrigation, PIPS and SWEEPS enhance photoacoustic dynamics within the canal system, thereby significantly improving root canal disinfection outcomes. In PIPS, low-energy, short-pulsed Er:YAG—are used to produce photoacoustic shockwaves within the irrigant. The resulting shockwaves induce intense irrigant streaming and cavitation while eliminating the need for intracanal placement of the fiber tip, thus minimizing the risk of apical extrusion. In contrast to PIPS, SWEEPS utilizes paired ultra-short laser pulses to create synchronized shockwaves within the irrigant, thereby enhancing photoacoustic effects. Consequently, this mechanism promotes vigorous fluid agitation and enables greater irrigant penetration into lateral canals and isthmus region within the canal[12].

While PIPS utilizes single-pulse energy with a 50 µs super-short pulse, SWEEPS employs a double-pulse approach using shorter 25 µs ultra-short pulses. Due to the shorter pulse duration, each pulse achieves a higher peak power at the same energy output, leading to the formation of a more forceful cavitation bubble. Additionally, the second pulse is timed to coincide with the terminal phase of collapse of the first bubble, optimizing shockwaveinteraction within the irrigant. These consecutive pairs of laser pulses generate shockwaves that enhance fluid movement and photoacoustic streaming, ultimately contributing to optimal root canal cleaning and disinfection[15].

LIMITATIONS

The use of Nd:YAG lasers in root canal disinfection is constrained by several key limitations. Foremost among the limitations is the reliance on in vitro research, which limits clinical applicability because experimental laboratory environments cannot faithfully mimic the intricate anatomical structures and dynamic microbial ecology of the human oral environment. Furthermore, significant heterogeneity in study designs—such as variations in laser settings, irradiation times, fiber configurations, and microbial strains complicates direct comparison of results[14,12].

6.NANOPARTICLE TECHNOLOGY

INTRODUCTION

Nanomaterials refer to natural, incidental, or engineered materials that contain particles in unbound, aggregate, or agglomerate states, wherein 50% or more of the constituent particles have one or more external dimensions within the size range of 1–100 nm[16].

Nanoparticles may be further functionalized with compounds including photosensitizers, bioactive molecules, and therapeutic agents to enhance synergistic outcomes. Silver nanoparticles are the most extensively studied metallic nanoparticles in root canal disinfection strategies due to their antimicrobial, antibiofilm, and antifungal properties[17].

Silver nanoparticle–based irrigation solutions possess antibiofilm activity equivalent to conventional agents such as 2% chlorhexidine and 5.25% sodium hypochlorite. Nevertheless, its application is associated with concerns about possible dentin discoloration as well as cytotoxic and inflammatory responses in surrounding host tissues. Beyond silver nanoparticles, other metallic nanomaterials studied as potential root canal irrigants include zinc oxide, magnesium oxide, titanium dioxide, and iron oxide[17].

MECHANSIM OF ACTION

It is essential to use biomaterials that effectively reduce microbial load within the root canal while remaining non-cytotoxic and promoting tissue regeneration. By penetrating biofilm matrices and binding electrostatically to bacterial cell membranes, nanoparticles induce membrane damage and increase cellular permeability, the production of reactive oxygen species, interference with essential cellular processes, protein denaturation, DNA damage, and eventual microbial cell death[16].

Novel nano-scaffolds are being engineered to serve as regulated drug delivery vehicles tailored to specific therapeutic needs. Compared with propylene glycol, the most commonly used carrier for delivering antimicrobial pastes into the root canal, nanofibers offer the potential advantage of increased surface area, thereby enabling more controlled and sustained drug release. [18] Silver nanoparticles (AgNPs) have attracted considerable research interest in dental science[16].

With the progress of nanotechnology, silver nanoparticles (AgNPs) have attracted significant scientific interest. Incorporation of AgNPs has been proposed across a diverse array of dental materials, including composite restorative resins, dental implant coatings, calcium silicate cements, endodontic sealers, and intracanal disinfectants. However, concerns regarding the cytotoxicity of AgNPs persist, primarily due to the potential adverse effects associated with the release of free Ag^{+} ions. These issues remain controversial, and current evidence is still insufficient to draw definitive conclusions[18].

7.GENTLE WAVE SYSTEM

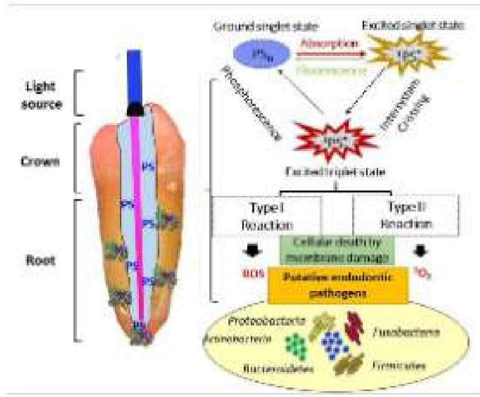
In 2014, the GentleWave system (GW) (Sonendo, Laguna Hills, CA, USA) was launched in the United States , and and represents an endodontic device designed for cleaning and disinfection of the root canal system.According to the manufacturer, the GW system is indicated for use with minimal canal instrumentation, potentially reducing the need for conventional mechanical preparation and thereby contributing to the preservation of tooth resistance.This is because excessive widening of the root canal has been associated with decreased fracture resistance of the root. Nevertheless, there remains no clear consensus regarding whether minimal instrumentation significantly affects fracture resistance.The GW system produces high-velocity shear forces that facilitate the distribution of irrigants within the root canal system, eliminating the need to introduce the handpiece tip into the canal orifice.More specifically, microbubble implosion produces a broadband acoustic field that travels through the irrigating solution, enabling comprehensive distribution throughout the root canal system and promoting effective soft tissue debridement and bacterial reduction.Furthermore, the GW system

incorporates negative-pressure irrigation, thereby reducing the risk of apical extrusion. It can be used in conjunction with standard endodontic irrigants, including NaOCl, EDTA, and distilled water[19].

8. ANTIMICROBIAL PHOTODYNAMIC THERAPY

INTRODUCTION

Antimicrobial photodynamic therapy (aPDT) has been extensively applied in root canal disinfection, showing significant antibacterial efficacy and being recommended as an adjunct to conventional treatment protocols [20].Photo-activated disinfection (PAD), also referred to as photodynamic therapy (PDT), is a novel treatment strategy that has gained growing acceptance in both medicine and dentistry for the destruction of microbial pathogens and tumor cells[19].Endodontic irrigation incorporating PAD is designed to achieve effective bacterial inactivation within the complex anatomy of the root canal system.In the PAD technique, a photosensitizer (PS), when activated by low-intensity visible light in the presence of oxygen, generates cytotoxic species that exert antimicrobial effects[21]· In photodynamic therapy, light at a defined wavelength is absorbed by a photosensitizer, resulting in the excitation of its electronic configuration to a higher-energy triplet state.In this triplet state, the photosensitizer reacts with molecular oxygen to produce reactive oxygen species (ROS), which mediate antibacterial activity through oxidative damage to microbial lipids, proteins, and nucleic acids.A variety of photosensitizers have been investigated for PAD applications, such as methylene blue, toluidine blue, Rose bengal–conjugated chitosan, and indocyanine green[17].



ADVANTAGES

Nanoparticle-based photosensitisers offer several advantages over conventional photosensitising molecules, including:

1. Enhancing production of reactive oxygen species ;
2. Decreasing the likelihood of mutltiple drug resistance
3. Facilitating selective treatment by localised delivery carriers
4. Possesing a non immunogenic nature of nanoparticl matrix[18].

COMPARISON BETWEEN PDT AND LLLT [PBM]

A clear and critical distinction should be drawn between photobiomodulation (PBM) and antimicrobial photodynamic therapy (PDT)In photodynamic therapy (PDT), a low-intensity laser—most frequently a diode laser—is utilized as a cold light source to excite a photosensitizing drug.The power parameters used in photodynamic therapy (PDT) are generally higher than those employed in low-level laser therapy (LLLT), typically ranging from approximately 100 mW to several watts. However, the irradiation is delivered for a brief duration to prevent undesirable thermal effects[13].Although both modalities utilize laser irradiation, photodynamic therapy (PDT) is principally employed as a disinfection strategy.This approach involves the application of an exogenous photosensitizing dye into the root canal system, which, upon light activation, produces cytotoxic reactive oxygen species that effectively eradicate microorganisms.In contrast, photobiomodulation (PBM) is performed without the use of any exogenous photosensitizing agent. Instead, it employs low-level light irradiation to stimulate intrinsic cellular processes, promoting tissue repair and modulating inflammation. Consequently, PBM serves as an adjunctive therapy aimed at regulating the host response rather than functioning as a primary antimicrobial protocol[13].

9.OZONE -BASED DELIVERY SYSTEM

INTRODUCTION

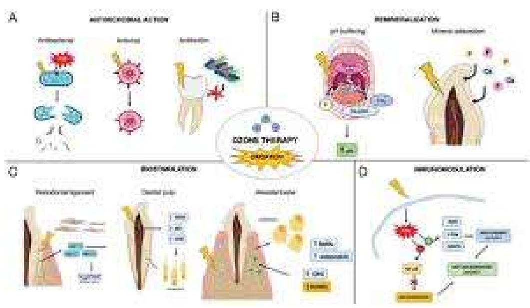
Ozone is a triatomic molecule composed of three oxygen atoms (O_3)It is administered topically in the form of an oxygen–ozone gas mixture or as ozonated water.Due to its inherent instability, ozone readily decomposes back into molecular oxygen (O_2) and singlet oxygen (O_1), a highly potent oxidizing species that exerts additional antimicrobial effects by damaging microbial cell components. Several systems are used to deliver ozone during root canal irrigation, including the Neo Ozone Water-S device, the HealOzone unit by Kavo, and the OzoTop apparatus. Research conducted by Nagayoshi and colleagues demonstrated that water containing ozone at a concentration of 0.5 mg/L exhibited strong antimicrobial activity against both Gram-positive as well as Gram-negative microorganisms[6].

Ozone offers a rapid, uncomplicated, and economical approach for disinfecting root canal systems. It is considered one of the strongest antibacterial agents and oxidizing substances used in endodontic therapy. In comparison with commonly used antiseptic solutions, ozonated water has shown superior biocompatibility. In 2004, Nagayoshi et al.

reported that ozonated water exhibited antibacterial efficacy comparable to that of 2.5% sodium hypochlorite, while demonstrating reduced cytotoxic effects[9].

MECHANISM OF ACTION

The antimicrobial action occurs through ozone interacting with organic molecules that possess unsaturated (double) bonds, leading to their oxidation and subsequent microbial destruction. Viral inactivation results from the denaturation of envelope proteins, which disrupts the virus's ability to attach to host cells. Additionally, ozone oxidizes the unsaturated fatty acids within the lipid envelope and damages single-stranded RNA, ultimately leading to viral destruction. Nevertheless, the virucidal efficacy of ozone depends on several parameters, such as its concentration, the duration of exposure, and the environmental conditions, including temperature and relative humidity[22].



ADVANTAGES AND DISADVANTAGES ;

A marked reduction in cytotoxic effects on oral cells has been reported for ozone gas when compared with commonly used endodontic irrigants such as 2.25% sodium hypochlorite and 2% chlorhexidine (Hyslop et al., 1988; Filippi, 2001). Moreover, aqueous ozone at concentrations up to 20 mg/mL demonstrated no toxic effects on oral cells (Filippi, 2001; Ebensberger et al., 2002; Nagayoshi et al., 2004; Huth et al., 2009). Hence, ozone is presently being considered as a potential alternative or adjunctive antimicrobial agent in root canal therapy[23].

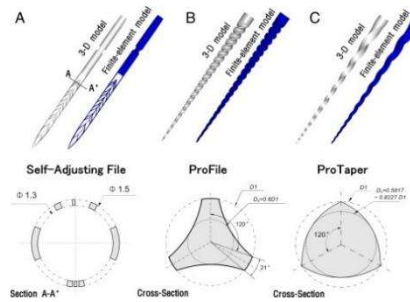
Although ozone significantly lowers bacterial counts, its use as a sole irrigant does not achieve results comparable to sodium hypochlorite (Nagayoshi et al., 2004; Case et al., 2012; Hubbezoglu et al., 2014; Kaya et al., 2014; Boch et al., 2016). Ozone has also been advocated as an adjunct during chemomechanical preparation, as it can enhance the antimicrobial efficacy of conventional root canal irrigating solutions. However, combining sodium hypochlorite with ozone has not demonstrated additional benefits, as the antimicrobial effect was comparable to that achieved with sodium hypochlorite used alone (Hubbezoglu et al., 2014; Boch et al., 2016). Therefore, the current evidence does not support the routine use of ozone as a secondary disinfecting agent in conventional root canal therapy performed with sodium hypochlorite[23]. Ozone therapy is contraindicated in conditions such as pregnancy, glucose-6-phosphate dehydrogenase deficiency, hyperthyroidism, severe anemia, acute alcohol intoxication, recent myocardial infarction, and known hypersensitivity to ozone[24].

10.SELF ADJUSTING FILE

INTRODUCTION

The Self-Adjusting File (SAF) system is a shaping and cleaning device developed for minimally invasive endodontic therapy. It functions with a dedicated RDT handpiece head (ReDent) and a VATEA irrigation pump, which delivers a continuous flow of irrigant through the hollow file.

The system is available in two diameters—1.5 mm and 2.0 mm—both of which exhibit high compressibility. The 1.5 mm file can be compressed to the size of a #20 K-file, while the 2.0 mm file can be reduced to the dimension of a #35 K-file. This marked compressibility allows the instrument to conform to the canal's cross-sectional configuration, even in oval canals that may not be clinically evident to the operator, thereby justifying the term "self-adjusting file"[25].



MECHANISM OF ACTION

The Self-Adjusting File (SAF) system operates in a manner entirely distinct from conventional rotary instruments. Instead of cutting dentin in chips, the SAF exerts a gentle abrasive action that gradually grinds the dentinal walls into a fine powder. This debris remains suspended in the irrigant and is continuously flushed coronally by the ongoing flow of the solution. Consequently, the system does not produce large dentin chips nor does it tend to compact debris into canal irregularities such as isthmuses.

The SAF is engineered to compress when it reaches a constricted portion of the canal and to re-expand to its original dimensions when the canal space enlarges. This property enables the instrument to conform closely to the canal's cross-sectional anatomy. In addition, the design allows irrigant to pass continuously through the hollow lattice file, where it is constantly agitated by the file's vibrating motion. This continuous activation minimizes the accumulation of smear layer and necrotic debris within the root canal system[26].

CONCLUSION :

Proper cleaning and disinfection of the root canal system are essential for the success of root canal treatment. Although conventional syringe-and-needle irrigation remains a simple, practical, and widely used method, its ability to reach complex areas of the root canal system is limited.

The development of different irrigant activation techniques has helped overcome some of these limitations. Sonic and ultrasonic activation improve irrigant movement and help in the removal of debris and microorganisms, while laser-assisted techniques provide enhanced fluid agitation and penetration. Newer approaches such as nanoparticle technology, photodynamic therapy, the GentleWave system, ozone, and the Self-Adjusting File have also shown promising potential in improving root canal disinfection.

However, each technique has its own advantages and limitations, and no single irrigation system can completely disinfect the root canal system. Therefore, these techniques should be used as adjuncts to conventional chemomechanical preparation rather than as complete replacements for it.

With continuing advances in technology, these newer irrigation systems may further improve the quality and predictability of endodontic treatment. Nevertheless, more well-designed clinical studies are needed to establish their long-term benefits and determine the most effective protocols for their routine clinical use.

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