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Review Article

Root canal irrigant activation method: A review

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ABSTRACT:
The core of endodontic treatment is chemo-mechanical cleaning of the root canal system, as evidenced by current dental standards. The irrigation and activation of canals with specific solutions is an essential part of this process. In order to analyze different methods of irrigant activation for endodontic treatment, this review paper reviews and compares manual, heat, pressure, sonic, ultrasonic, and laser approaches.
Keywords: activation techniques; endodontics; irrigation; root canals; root canal treatment

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INTRODUCTION

Operative dental therapy is the focus of endodontic therapy. It is carried out when the dental pulp has an irreversible inflammatory process, necrosis, or fails to respond to prior root canal therapy. There are several things that can induce pulp inflammation, including deep cavities, trauma, and ongoing irritation.[1] The latter is among the most prevalent issues worldwide. The likelihood of it happening is increased by the existence of cariogenic oral bacterial species, fermentable carbohydrates, and tooth surfaces that are vulnerable to acidic attack.[2]It can be classified by depending on how deeply the caries lesion penetrates the tissue (e.g., pulp, dentin, or enamel)[3]. Endodontic therapy is required when dental caries progresses deeply into the tooth tissues and reaches the pulp, resulting in permanent inflammation. Patients' desire to keep their original teeth and growing awareness of the advantages of preserving normal dentition are driving the popularity of this kind of dental operation. This kind of care consists of opening the pulp chamber, preparing the teeth chemically and mechanically, and closing the root canals. When treating teeth using this method, functional restoration is necessary in order to meet clinical requirements. For the treatment to be successful, bacteria, necrotic tissues, and accumulated hard tissue debris must be removed.Regardless of the instrumentation technique employed, more than 35 percent of the root canal area is left untrimmed. It is crucial to prepare chemically by irrigating the root canal system with antiseptic treatments.[4] Different irrigation fluid were added to the clinical procedures for this reason. The sole irrigation solutions' qualities are insufficient to give the canal the appropriate level of disinfection. As a result, certain of these solutions might be activated to boost their impact throughout the endodontic treatment procedure.

Among methods of activation of irrigants utilized during an endodontic treatment we can outline:

- Manual activation;
- Thermal techniques (internal or external to the root);
- Pressure techniques (EndoVac, Kerr Endodontics, Gilbert, AZ, USA; Rinsendo, Dürr Dental, Bietigheim, Germany);
- Sonic/ultrasound techniques (EndoAcivator, Dentsply Maillefer, Ballaigues, Switzerland;
- Passive Ultrasonic Irrigation (PUI);
- Laser techniques.

Types of Irrigants and Irrigant Activation Methods

During the cleansing phase, 5.25% NaOCl, 17% EDTA, and 2% chlorhexidine (CHX) are available among the most commonly used irrigants.

1.1. Sodium Hypochlorite

NaOCl is the most widely used irrigant in endodontics thanks to its low cost and proven organoleptic and antiseptic power.

It was originally applied in 1920 as an irrigant for root canals. Sodium hypochlorite breaks down into sodium hydroxide and hypochlorous acid, often known as active chlorine, when it comes into contact with water. The active ingredient in irrigating solutions is hypochlorous acid, which may easily lyse bacteria because of its tiny molecular structure and ability to pass through bacterial cell membranes. The dentist should be pushed to purchase hypochlorite solutions made by pharmaceutical companies specifically for endodontic usage because the concentration of active chlorine in commercial solutions varies greatly. The amount of time needed for the solution to dissolve the injured tissues will increase with decreasing active chlorine concentration. Solutions of sodium hypochlorite need to be protected and kept at a temperature of about 4 °C.Sodium hypochlorite dissolves necrotic tissues more readily than it does viable tissues. 5.25 percent is the optimal concentration of NaOCl since it offers the finest balance between toxicity and proteolytic activity. Raising the concentration would result in an increase in toxicity in addition to the dissolutive capacity. Nonetheless, this irrigant's heating and agitation allow for the enhancement of its effects without raising concentrations.[5]

1.2.CHX

In endodontics, CHX solutions typically range from 0.2% to 2.0%. High quantities, as those employed in endodontic procedures, have a bactericidal effect because they break down bacterial cytoplasm by creating protein cross-links. Chlorhexidine was first used as an alternative to sodium hypochlorite because of its efficacy against a variety of bacterial species, including E. Faecalis, its decreased cytotoxicity for periapical tissues, and the negligible effects associated with the irrigant's potential extrusion beyond the apex.While chlorhexidine is an effective endodontic irrigant, it is not recommended as a reference irrigant for routine endodontic treatments due to its inability to dissolve damaged tissues, lack of activity against the inorganic components of the smear layer, and greater activity against Gram+ than Gram−. The antibacterial activity of CHX is sustained by its strong adherence to dentinal surfaces, and this effect seems to be directly correlated with the concentration and timing of the drug's application.This attribute is referred as "substantivity."[6] Commercially available endodontic chlorhexidine solutions are mixed with cetrimide, a surfactant agent, to reduce the surface tension of the mixture and facilitate the active ingredient's entry into the tubular system. This allows the active ingredient to function as substantivity activity in addition to its direct antibacterial action.[7]

1.3. EDTA (Ethylene-Diamino-Tetra-Acetic Acid)

1.3.1. Smear Layer

The formation of the smear layer or smear layers is due to the mechanical cutting action of the dentin by manual and rotating endodontic instruments. The debris produced stratifies on the inner walls of the root canals. The smear layer can also penetrate several microns into the dentinal tubules. It is made up of two components: organic particles and inorganic particles. The organic component is represented by necrotic or vital pulp tissue, odontoblastic processes, bacteria, and blood cells, while the inorganic component consists of calcified tissue[8]. It is evident that its removal is of fundamental importance to allow the irrigants to enter and act in the lateral macro and micro anatomies and obtain a good adaptation of the filling material to the canal walls [9].

1.3.2 EDTA

For the purpose of eliminating the inorganic component of the smear layer, the 17% EDTA is crucial. EDTA can be applied after shaping as well as during it. Nygaard-Ostby introduced EDTA to endodontics in 1957. In order to increase flow, 17% of EDTA solutions are now combined with a detergent.[10]

1.3.3.Chemical Properties of EDTA's

As a chelating agent, EDTA can bind to calcium ions via a coordinative bond to create "chelate complexes," which are then converted into the calcium ethylenediaminetetraacetate salt. As a result, this material affects both the inorganic portion of the smear layer and the hard tissues of the tooth. A concentration of between 10% and 17% is the most effective. Since EDTA has a strong demineralizing effect that is strongly correlated with acidity, it is often administered in buffered solutions with a pH of 6.5–7. Buffered EDTA has an effect on dentin's non-collagen protein component in addition to calcium ions.[11]

1.4. Interaction

It is essential to avoid the combination of the various irrigants. For example, CHX mixed with NaOCl forms parachloroaniline, a potentially carcinogenic substance. EDTA together with CHX forms a non-carcinogenic substance but is capable of occluding the dentinal tubules. Finally, the union between NaOCl and EDTA should be avoided, as they deactivate each other [12]. Mixing chelators and NaOCl reduces the pH, affecting the amount of free chlorine in the solution and causing an increase in hypochlorous acid and chlorine gas with a consequent decrease in hypochlorite ion. This union leads to a loss of reactive free chlorine in the NaOCl solution. It is advisable to use a physiological solution or sterile water between one irrigating agent and another to solve these problems. Finally, during endodontic treatments, gaseous blocks called vapour locks can form inside the root canals, compromising the cleansing phase if not removed because they prevent contact of the irrigants with the tissues and bacteria [13].

Types of Irrigants and Irrigation Protocols

The goal of root canal irrigation during endodontic treatment is to get rid of any germs, smear layer, residual pulp, and other contaminants. The literature refers to irrigation using a concentration of 1-6 percent sodium hypochlorite (NaOCl) as the gold standard in endodontics due to its antibacterial activity, capacity to inactivate bacterial toxins inside the canal, and ability to dissolve the organic component of the smear layer. This irrigant has the advantage of having a rapid onset of action and lubricating the root canal. However, if the solution inadvertently enters the periapical region or reaches soft tissue, one must be mindful of the cytotoxicity of NaOCl[14]. A rubber dam must be used during the process in order to avoid the final difficulty.

Processing by machine should not be applied to a dried-out canal. Working in a dry atmosphere increases the risk of an instrument breakage or dentin debris obstructing the physiological apex. It is recommended to use pure distilled water, an aqueous solution of NaOCl, or specific lubricants with antibacterial qualities when using endodontic instruments. The literature suggests using aqueous solutions in place of pre-made lubricants. They are reducing the force produced during operation by nickel titanium (NiTi) devices as well as the torsional loading. It is recommended to irrigate the root canal with 2 mL of NaOCl in between using different tools[15].

Both organic and inorganic materials make up the smear layer, which is produced during instrumentation. Sodium hypochlorite, which dissolves only organic material, can be used in concentrations of 1% to 6% to remove the smear layer. Chelation agents, such as ethylenediaminetetraacetic acid (EDTA) in 10% to 19% and citric acid in 10% to 50%, can be used to remove the inorganic portion of the smear layer. Chelating compounds are typically recommended for use in the irrigation protocol's last phase. Chlorhexidine (CHX) is recognized by many clinicians as an antibacterial agent. Endodontic therapy requires a rubber dam to be employed during the process because of the range of substances that are used.

Chelation compound irrigation is not advised by several writers while root canal therapy is being performed. It could cause erosion of the root dentin.[16]While chelating chemicals are important, studies indicate that their damaging effects on dentin should be minimized by applying them in modest volumes (1 mL) and for brief periods of time (1 min). The smear layer and contaminants in the apical region of straight root canals can be eliminated in one minute with ultrasonic activation (UA) and EDTA irrigation (no difference compared to three minutes of activated irrigation). Excessive dentinal erosion occurred both intra- and peritubularly after a 10-minute EDTA irrigation.[17]

To create bactericidal activity, the exposed root canal wall is continuously washed with NaOCl or CHX after the smear layer has been removed using the aforementioned solutions. The ideal concentration of NaOCl solutions for irrigation is a topic on which researchers cannot agree. Compared to 2.5 and 0.5% concentrations (without activation), some studies indicate that a concentration of 5.25% is more effective in eliminating E. faecalis from infected root canals[18]. Conversely, additional study suggests that there are no appreciable variations among concentrations. Instead, it recommends regular delivery of fresh liquid and the operator using comparatively large amounts of the solution as antibacterial elements.

Certain medical professionals include CHX solution in the final irrigation protocol. Compared to NaOCl, chlorhexidine causes less tissue irritation and has antimicrobial qualities.[19]According to certain tests, a 2% CHX solution is more effective in getting rid of E. faecalis than a 5.25% NaOCl solution[20].Conversely, other findings demonstrate that sodium hypochlorite has better bactericidal qualities. Studies have also shown that, although having different modes of action, NaOCl and CHX have similar antibacterial effectiveness. Furthermore, research suggests that when CHX is used as a follow-up irrigant following EDTA, it does not cause dentin erosion in the same manner as NaOCl. While NaOCl at a concentration of 1-6 percent is still the gold standard in endodontics[21.]

Irrigants Activation Techniques

The most common technique for irrigation in clinical practice is the use of a traditional syringe. It suggests a number of issues, such as the vapor lock phenomenon and a disinfection level that is as low as one-third in the apical section of the root canal. The form of the needle that is used with a syringe for irrigation can also alter the way the irrigant flows through a canal, which can affect how effective the procedure is. Needles can be categorized as closed-ended or open-ended in general. Although the latter is said to be more successful, there is a greater chance of irrigant extrusion through the apical foramen. Depending on the kind of needle, the computational fluid dynamics could be different. Measurements of micro-particle image velocities could be used to verify it. According to the literature,During conventional irrigation with a needle, the exchange of fluids occurs only in very close proximity around the needle’s tip (approximately 1.00–1.15 mm according to the studies). This is a reason why syringe irrigation should only be used when it can be inserted within 1 mm of the working length. It is not always possible due to the complicated morphology of root canals and the danger of forcing the solution through the tissues. The velocity of liquid administration is a factor directly influencing flow outside of the needle. Between operators, a broad distribution of the aforementioned parameter was observed. It makes the syringe irrigation challenging to standardize and control [22].

2.1. Manual Activation

In manual dynamic activation (MDA), a gutta percha cone is placed one millimeter prior to the working length. In the root canal that has been filled with irrigant, a little pumping action is used. It consists of short vertical strokes (100 strokes per minute, 2 mm amplitude). Increased intracanal pressure brought about by dynamic motions breaks the vapor lock effect and greatly improves irrigant replacement. This makes it possible to use new portions of the solution and benefit from them on a greater area of the root canal system. After root canal preparation, activation—either with EDTA solutions or NaOCl—is advised. When MDA is added, EDTA or citric acid solutions become more effective at eliminating debris and the smear layer. particularly in one-third of the comparative root canal apex

The study suggested that manual activation causes a risk of post-treatment pain, occurring 24 h after the procedure. MDA was compared to irrigation with a needle without any activation and passive ultrasonic irrigation. The pain was evaluated after endodontic treatment of teeth with irreversible pulp inflammation [23]. Additionally, the penetration depth of irrigants into root canal dentin is lower with MDA compared to sonic, ultrasonic, and laser-induced activation techniques.

2.2. Thermal Techniques

Sodium hypochlorite has a boiling point of 96 to 120 °C. A heated NaOCl solution has a higher potential than a room temperature solution to breakdown pulp and clean a root canal. Sodium hypochlorite is more effective against E. faecalis and has a greater capacity to disintegrate necrotic pulp tissue when heated further. On the other hand, heated solutions outperform their non-heated counterparts in eliminating the organic component of dentine shavings. Elevated temperature accelerates the NaOCl reaction, which in turn enhances its antimicrobial characteristics and its capacity to dissolve organic residues. Research indicates that the ideal temperature range is between 50 and 60 °C and that the irrigant in the root canal system needs to be changed frequently[24].

NaOCl's ability to dissolve tissue is enhanced by raising its temperature, but this also increases toxicity and tissue irritation. Elevated temperature raises the oxidation-reduction potential of NaOCl, making it a more potent agent from an electrochemical perspective. Moreover, better breakdown of bovine muscle was obtained by electrically activating NaOCl before administration as opposed to inactivating it[25].

There are two ways to increase the temperature of irrigating solution: extracanal (heating of the solution before injection to the root canal) and intracanal (heating directly inside the root canal with heat carriers). According to research, intracanal heating of NaOCl is more efficacious than extracanal heating. The former technique caused much better cleansing of the walls of the root canal from debris in comparison to the latter[26]. It occurs most probably due to the rapid heat exchange between the tissue and environment in in vivo conditions. It results in less effective extracanal heating of the solution than was demonstrated in experiments.

Heat carriers (System-B—Endodontic Heat Source, Kerr Endodontics, Gilbert, AZ, USA, or similar) are utilized for intracanal heating. The maximum temperature of the device is between 150 and 180 degrees Celsius, and the measurement of the tip is 30/04. Before introducing the heat carrier, processing of the root canal is necessary. The root canal is filled with sodium hypochlorite with an endodontic needle. The heat carrier is inserted at room temperature up to 3 mm from the end of the working length and subsequently activated. Each activation cycle of the heat carrier lasts 5 s with another 5 s of pause. During the process, carriers make short upward and downward movements with a few mm of amplitude in order to mix the NaOCl solution. After each of the aforementioned cycles, the irrigation solution is replaced with a fresh one. Clinicians recommend intracanal UA of heated NaOCl because it results in superior penetration into dentin tubules and canal purity compared to syringe activation or UA alone[27]. While combining thermal activation and UA, better pulp dissolution was obtained in the side dentin tubules that remained contaminated after using either UA or thermal activation alone.

2.3. Ultrasound Techniques

Enhancing disinfection requires the use of ultrasonics both during and after root canal preparation. Dental ultrasonic equipment operates at frequencies between 25 and 40 kHz. The acoustic stream and cavitation processes are the foundation of ultrasonic disinfection.Pressure decreases and tiny air bubbles form at the instrument's tip when energy is supplied; when these bubbles burst, a powerful shock wave is produced. The biofilm may be disturbed when bubbles rupture because they produce microshocks and swift fluid movement. The antibacterial capabilities of UA of NaOCl significantly improve the root canal area's effectiveness of purification, offering the best lateral canal penetration.

encouraging the breakdown of necrotic tissues and the smear layer's organic component. For each root canal, UA of NaOCl in three cycles of 10 to 20 seconds (with irrigant renewal after each cycle) is thought to be adequate to produce cleaned canals. It appears that ultrasounds are far less effective at increasing EDTA activity. However, as previously noted, they may aid in a more thorough removal of the smear layer. The instrument tip must be inserted 1 mm short the working length when using UA [28]. When endodontic treatment is administered across several visits, ultrasound activation is advantageous as well because it can remove Ca(OH)2 from root canal walls more effectively than with manual methods.

2.4. Laser Activation Techniques

Diode lasers, neodymium-doped yttrium aluminum garnet (ND:YAG) lasers, erbium-doped yttrium aluminum garnet (Er:YAG) lasers, and erbium, chromium-doped yttrium, scandium, gallium, and garnet (Er,Cr:YSGG) lasers are among the lasers used to activate irrigants. Depending on where the point is placed, we can categorize laser activation techniques: Photon-Induced Photoacoustic Streaming (PIPS), in which the laser tip is positioned within the pulp chamber, and Laser-Activated Irrigation (LAI), in which the laser tip is positioned inside the root canal. Er:YAG laser is primarily employed for the latter approach. Furthermore, without the need for irrigants, lasers may be utilized to disinfect the root canal walls. Once more, combining two methods produces an even better outcome. The antibacterial impact of employing a laser in a canal filled with NaOCl is substantially stronger than that of using a laser alone.

The LAI cleansing mechanism relies on cavitation in the solution. The tip inserted in a root canal should be composed of glass fiber with a diameter between 200 and 400 m, regardless of the laser used. The root canal shall be processed until at least ISO 30 with a tool expansion of 02. The depth of tip insertion should be 1 mm less than the functional length of the canal. After positioning the tip at the desired depth, the laser must be activated and 1 mm/s of fiber must be removed from the root canal [29]. In the case of broad canals during the removal of the fiber, the operator needs to make sideway, sweeping movements. It is crucial to activate the laser only during the removal from the canal and not while inserting the fiber toward the canal. This allows us to avoid the danger of processing the canal with the laser. Keeping the glass fiber in constant motion in the root canal is equally important and prevents local temperature spikes.

PIPS is an activation approach wherein the instrument is positioned at the end of the canal to achieve the disinfecting effect, although it is not necessary to do so in order to create cavitation within the irrigant by placing a particular Er:YAG laser tip within the pulp chamber. When compared to UA, high-velocity irrigating streams are produced farther away from the activation source. With the laser tip positioned precisely inside the pulp chamber, the movement of newly formed follicles throughout the interior portion of the multi-root tooth is evident [30]. For efficient PIPS activation during canal processing, very little instrumentation is needed. It produces an apical preparation of ISO 20/25 without requiring a precise taper designation, while EndoVac demands an apical preparation of at least 35/0.04.

LAI is more efficient in cleansing the root canals, especially from intracanal bacteria than conventional or UA irrigation. Using this type of activation allows for achieving a smoother surface of the root canal than while using UA. It translates into the creation of stronger bonding between dentin and root canal filler. What is more, PIPS seems to be more effective than UA irrigation in the removal of apically located dentin residue [31]. Satisfactory removal of the smear layer by PIPS was also reported with a high quality of open tubules in the root canal dentin. PIPS appears to be more effective than conventional or sonic activation techniques in killing the bacteria deep in the dentinal tubules. No advantage in terms of disinfection was demonstrated for either LAI or PIPS.

2.5 Other Activation Systems

There exist gadgets on the market specifically designed to activate irrigants. We can use sound-wave-based systems (EndoAcivator, Dentsply) or pressure systems (EndoVac, Germany) among them.

Negative irrigation pressure is used with EndoVac. Compared to irrigation using a syringe and needle, it cancels out the vapor lock effect and offers superior cleaning at a depth of 1 mm from the working length. In adult permanent teeth, the best method for delivering the irrigant up to the working length was demonstrated to be the apical negative pressure irrigation technique. Compared to irrigation with a needle, patients complained of post-treatment pain less frequently after irrigation with the EndoVac device. It may be related to the fact that, in contrast to Manual Dynamic.

When it comes to the possibility of pushing irrigants through the apex and into apical tissues, EndoVac is far safer than UA, even if UA is more efficient in root canal processing. The minimal apical preparation needed for this system is 35/0.04 [32].

Pressure-sucking technology is used in the hydrodynamic irrigation system RinsEndo (Germany) When compared to utilizing a syringe and needle, it is distinguished by the irrigants penetrating deeper. It is more likely to force the irrigant via the apical foramen. Compared to use a syringe and needle, RinsEndo is more effective at cleaning root canals;Nevertheless, it is less effective than MDA. Studies have been conducted on the existence of damaged instruments within the root.

The endoActivator system (Dentsply Maillefer, Ballaigues, Switzerland) uses sound waves to activate the irrigant and has a synthetic non-cutting tip. The dentin is not shaved by the tip, preventing the canals from getting even wider. The size of the root canal determines the variety of tips that can be used. They need to be modified so that the working length is reached up to 2 mm earlier and the tip can move freely in the canal. To activate the EDTA solution, EndoActivator may be used[33].

EDDY (VDW, München, Germany) is an elastic polyamide fiber tip that operates in the 5000–6000 Hz frequency range and is actuated by air ultrasonic tip. Compared to UA sharp points, a flexible working tip is safe for root canal walls and does not harm dentin. In straight root canals, irrigation without syringe activation and PUI are preferable to sonic activation (with EDDY of EndoActivator) for debris removal. Furthermore, smear layer removal was achieved more effectively by EDDY and PUI than by manual activation. According to the study, EDDY can also be more successful.

than PUI at removing antibiotic pastes from the root canal. One must bear in mind, that patients subjected to irrigation with EDDY complained about post-treatment pain more frequently than a group of patients treated with MDA. It might be related to the much more frequent pushing of irrigants through the apical foramen caused by using EDDY [34].

Efficacy of Activation Systems in Curved Canals

The curvature of the canals may affect how effectively the activation system works. Studies on curved root canal models' shapes are uncommon. The majority uses models with straight canals. Increasing the apical size above 40 may enhance disinfection when treating severely curved canals; however, this is not always achievable. The adverse impacts of increased canal curvature were most obvious for the sonic techniques, but this was not noticeable for PUI. The latter may have an enhanced PUI influence due to ultrasonic file pre-bending.

According to multiple research, sonic agitation (Endo Activator and EDDY) performed significantly better than syringe irrigation but comparable to PUI [35]. The smear layer was much more susceptible to all activation methods than syringe irrigation. Nevertheless, several studies have found a substantial difference in cleaning abilities between sonic and ultrasonic activations. While activation with PUI produced the best results for clearing debris from uneven canal surfaces, EDDY outperformed PUI significantly in terms of antibacterial activity. EDDY and syringe irrigation eliminated the smear layer from the coronal region substantially more effectively than from the apical region. In contrast, PUI did not show any appreciable enhancement in terms of smear layer removal. The increased streaming velocity of ultrasonic devices, which is often unaffected by the curvature of the root canal, may help to explain this finding.

Effectiveness of Activation Methods in Conservative Shaping

Numerous research investigations have demonstrated that the combination of conservative canal shape with a potent irrigation approach, 3D cleaning, helps achieve good cleaning results. As part of the technique, ultrasonics are used to activate the heated NaOCl. This 3D cleaning technique is regarded as safe in terms of the possibility of overheating or irrigant extrusion. For example, the temperature increase at the exterior root surface during the internal heating stage was less than 42 °C, whereas the temperature at which periodontal tissue injury could occur was 47 °C. During the 3D cleaning process, there was no evidence of NaOCl extrusion, despite the irrigant's viscosity decreasing when heated.

The authors assert that proper root canal cleansing and disinfection were made possible by the use of 17% EDTA and 3D cleaning. Additionally, it has been shown that this approach outperforms passive ultrasonic irrigation in terms of cleansing and disinfection. Disinfectants' ability to penetrate dentinal tubules and exert antibacterial activity on dentin is reduced by the smear layer created during instrumentation. Following conservative root canal preparation, irrigation with 17% EDTA eliminates the smear layer in the dentinal tubules, leading to cleaner canals and improved warm NaOCl penetration into the dentinal tubules and lateral anatomies. According to a study by Amato et al., 3D cleaning was the sole irrigation method used in canals with a conservative design (size 30 at the tip and 4% taper)[36].

Furthermore, heating the irrigant to 150 °C may induce the decreased viscosity of NaOCl, which could lead to turbulent flow and the microfilm peeling from the canal walls. According to a recent study, conservative NiTi (20/04) rotational canal instrumentation paired with passive ultrasonic irrigation was found to be as clean as a significantly larger canal preparation (40/04) in oval-shaped canals[37]. With the added benefits of ultrasonic NaOCl agitation, intracanal heating, and 17% EDTA irrigation, 3D cleaning would improve root canal preparations' ability to be cleaned, even conservative ones.

Moreover, recent studies have shown that smaller conical instruments would come into contact with fewer root canal walls, which may make it more difficult to completely remove biofilm. But according to a study by Ghassan Yared, germs could be killed without coming into contact with the root canal walls [38].

DISCUSSION

Consequently, a sufficient degree of disinfection may have been achieved by the combination of 3D cleaning and 17% EDTA, which may have made up for the smaller percentage of undamaged, uninstrumented root canal walls.

Given the various intricacies of the endodontic environment, it makes sense to gravitate toward cleaning methods that enable an irrigant's three-dimensional activation. Removing damaged tissues, getting rid of germs that are present in the endodontic area, and avoiding recontamination after treatment are the main goals of endodontic therapy[39].

To ensure both short- and long-term success, it is crucial to locate and thoroughly clean every root canal after a proper diagnosis has been made. The current body of literature conclude that the bacteria and their byproducts present in the complex structure of the endodontic space cannot be entirely eliminated by the methods now in use for the shaping and cleansing phase. It is believed that a large portion of failures are caused by missing root canals, insufficient tissue removal, or bacteria left unchecked.

In several studies, the ultrasonic activation of NaOCl after intracanal rewarming with a system-B type heat carrier has proven more effective than intracanal rewarming alone. The results demonstrated that the ultrasonic activation of intracanal-heated NaOCl improved the penetration of the irrigant into the dentinal tubules much more than ultrasonic activation alone. Histological analysis also revealed that this technique produced much less debris than syringe-only irrigation. The heated NaOCl increases the available chlorine, resulting in a superior collagen dissolution. Ultrasonic activation alone also increases the temperature of the irrigant, but this occurs only near the tip of the instrument. When activating the NaOCl using ultrasound or heating, it is also important to consider its catalytic decomposition. This technique implies that the solution must always be renewed to have active chlorine available. Considering that this technique does not increase the external root surface temperature beyond 42.5 °C, it can be considered safe for the periodontal ligament[40].

Conservative root canal shaping combined with a powerful irrigation technique, 3D cleaning, aids in obtaining excellent results in terms of cleaning, as proven by numerous research studies. This approach is significantly important in difficult cases such as severe curvatures where minimally invasive shaping reduces the percentage risk of breaking a file. At the same time, an effective cleaning will be obtained.

Always bearing in mind that to ensure both short and long-term success, it is essential to reduce the bacterial load within the complex endodontic space as much as possible, it is natural to orient ourselves towards the use of performing irrigant activation protocols[41].

The limitations of this review are that detailed information on the real influence of irrigation time, irrigant volume, and irrigant activation time is not available. Future studies should also examine these parameters in detail, focus on clinically relevant comparisons, and have enough sample sizes to reach reliable conclusions. Moreover, the conclusions may only be properly supported with a systematic review method for the selected articles.

CONCLUSIONS

The outcome of root canal therapy depends upon the meticulous irrigation procedure,hence the present irrigation techniques play a pivotal role in the field of endodontics. In general, a variety of irrigants, such as distilled water, NaOCl, EDTA, and CHX, should be mixed with a variety of activation techniques. In addition, a few methods include subsonic, sonic, and ultrasonic processes; heating; negative apical pressure; and manual dynamic activation.It is highly dubious a suggesting the best irrigation activation for root canal treatment.however the treatment done using sonic,ultrasonic activation produce much better outcome than the tooth that have not been activated.

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