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PROGRAMS & ABSTRACTS

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Abstract Title:

THE ENDODONTIC REVOLUTION

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There are certain basic requirements to maximize the outcome of endodontic treatment. Primarily this involves the disinfection of the root canal system. An appreciation of diagnosis and treatment planning followed by contemporary instrumentation techniques allows highly a predictable outcome for the endodontically managed tooth. New technology allows treatment to be streamlined and integrated into everyday clinical practice. The importance of visual enhancement and rotary instrumentation will be focused upon.

At the conclusion of this course, participants should be able:
• To be aware of the role of enhanced vision in the endodontic environment
• To be aware of integrating improved vision into clinical practice
• To be aware of mainstream technology which enhances outcome, in particular the appropriate use of rotary instrumentation
• Integrate the dental assistant into endodontic practice to maximize efficiency

Abstract Title:

THE EFFECTIVENESS OF IRRIGANTS ON REDUCING THE NUMBER OF MICROORGANISMS IN ROOT CANAL SYSTEM

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Infection of the root canals with bacteria causes pulpitis, microabceses formation, degradation of pulpal tissue, and then ultimately leads to the initiation and progression of периапical periodontitis. The obvious objective of endodontic treatment is to prevent or eliminate infection within the root canal. Over the years research and clinical practice have concentrated on instrumentation, irrigation, and medication of the root canal system, followed by obturation and the placement of a coronal seal. The effectiveness of sodium hypochlorite (NaOCl) are recommended as the main irrigants. This because of their broads antimicrobial spectrum as well their unique capacity to dissolve necrotic tissue remnants. Chemical and toxicological concern related to their use. Different approaches to enhance local efficacy without increasing the caustic potential. In addition chelating solutions are recommended as adjunct irrigants to prevent the formations of smear layer and or remove it before filling the root canal system. Based on the actions and interactions of currently available solution, a clinical irrigating regimen is proposed.

Key words: irrigants, chelator, chlorhexidine, sodium hypochlorite
The Effectiveness of Irrigants on Reducing the Number of Microorganisms in Root Canals System

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Abstract.

Infection of the root canals with bacteria causes pulpitis, microabscess formation, degradation of pulpal tissue, and then ultimately leads to the initiation and progression of periapical periodontitis. The obvious objective of endodontic treatment is to prevent or eliminate infection within the root canal. Over the years research and clinical practice have concentrated on instrumentation, irrigation, and medication of the root canal system, followed by obturation and the placement of a coronal seal. The effectiveness of sodium hypochlorite (NaOCl) are recommended as the main irrigants. This because of their broad antimicrobial spectrum as well their unique capacity to dissolve necrotic tissue remnants. Chemical and toxicological concern related to their use. Different approaches to enhance local efficacy without increasing the caustic potential. In addition chelating solutions are recommended as adjunct irritants to prevent the formations of smear layer and or remove it before filling the root canal system. Based on the actions and interactions of currently available solution, a clinical irrigating regimen is proposed.

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Introduction

A favorable outcome of root canal treatment is defined as the reduction of a radiographic lesion and absence of clinical symptoms of the affected tooth after a minimal observation period of 1 yr (Orstavik, 1996). Endodontic success is dependent on multiple factors (Orstavik, 2004), and a faulty treatment step can thus be compensated. For instance if cultivable microbiota remain after improper canal disinfection, they can theoretically be entombed in the canal system by a perfect root canal filling (Saleh, 2004), and clinical success may still be achieved (Peter, 2002).

There can be no doubt today that microorganisms, either remaining in the root canal space after treatment or re-colonizing the filled canal system, are the main cause of endodontic failure (Sjogren, 1997., Molander, 1998). The primary endodontic treatment goal must thus be to optimize root canal disinfection and to prevent re-infection. Infection of the root canal space occurs most frequently as a sequela to a profound carious lesion (Langeland, 1987). Cracks in the crown structure extending into the pulp chamber can also be identified as a cause of endodontic infection (Cameron, 1964). Regardless of the microbial entryways, it should be differentiated between vital and nonvital cases (Zehnder, 2002).

Pulpitis is the host reaction to opportunistic pathogens from the oral environment
entering the endodontium (Hahn, 2000). Vital pulp tissue can defend against microorganisms and is thus largely noninfected until it gradually becomes necrotic (Langeland, 1987). In contrast, the pulp space of nonvital teeth with radiographic signs of periapical rarefaction always harbors cultivable microorganisms. Consequently, the treatment of vital cases should focus on asepsis, i.e. the prevention of infection entering a primarily sterile environment, which is the apical portion of the root canal. Antisepsis, which is the attempt to remove all microorganisms, is the key issue in nonvital cases. Vitality cannot always be predictably assessed with current sensitivity tests and radiologic methods before treatment (Seltzer, 1963).

Aseptic principles such as correct rubber dam placement and coronal disinfection of the tooth to be treated have long been accepted. Although asepsis is not the topic of the current communication, it is interesting to note that the majority of general practitioners disregard the most basic principles in that they do not place rubber dam for root canal treatment (Jenkins, 2001). Because of the complex anatomy of root canal systems, with their multiple fins and ramifications, antisepsis in necrotic teeth and teeth with failed root canal treatments is more challenging than in vital counterparts, both from a technical and a microbiologic point of view.

**Bacteria in Root Canal Infection**

As the host defense loses its access to the necrotic pulp space, opportunistic microorganisms selected by harsh ecological conditions and the low-oxygen environment aggregate in the root canal system (Nair, 2004). These microbial communities may survive on organic pulp tissue remnants and exudate from the periodontium (Sundqvist, 1994, Love, 2001). Consequently, clusters of microorganisms in necrotic teeth and teeth with failed root canal treatments are typically found in the apical root canal area, where they have access to tissue fluid (Nair, 2004). In long-standing infections, root canal bacteria can invade the adjacent dentin via open dentinal tubules (Armitage, 1983).

Primary root canal infections are polymicrobial, typically dominated by obligately anaerobic bacteria (Sundqvist, 1994). The most frequently isolated microorganisms before root canal treatment include Gram-negative anaerobic rods, Gram-positive anaerobic cocci, Gram positive anaerobic and facultative rods, Lactobacillus species and Gram-positive facultative Streptococcus species. The obligate anaerobes are rather easily eradicated during root canal treatment. On the other hand, facultative bacteria such as nonmutans Streptococci, Enterococci, and Lactobacilli, once established, are more likely to survive chemomechanical instrumentation and root canal medication (Chavez, 2003).

In particular Enterococcus faecalis has gained attention in the endodontic literature, as it can frequently be isolated from root canals in cases of failed root canal treatments (Haapasalo, 1983). E. faecalis is an extensively evaluated biological indicator (Jeansonne, 1994, Molander, 1998, Portenier, 2003, Sundqvist, 1998, 2003). Some factors can explain the concern with this pathogen in endodontic infections. Its high prevalence in cases with post-treatment disease associated with virulence factors (aggregation substance, enterococcal surface proteins (Esp), gelatinase, cytolysin toxin,
extracellular superoxide production, capsular polysaccharides, antibiotic resistance
determinant) can facilitate the adherence of host cells and extracellular matrix, tissue
invasions, immunomodulation effect and cause toxin mediated damage. In addition,
yeasts may also be found in root canals associated with therapy-resistant apical
periodontitis (Waltimo, 1997).

It is likely that all of the microorganisms able to colonize the necrotic root canal
system cause periapical inflammatory lesions. Enterococci can survive in monoculture,
but cause only minor lesions. Certain Gram-negative taxa appear to be more virulent
(Sundqvist, 1994). The outer membrane of Gram-negative bacteria contains endotoxin,
which is present in all necrotic teeth with periapical lesions (Dahlen, 1980), and is able to
trigger an inflammatory response even in the absence of viable bacteria (Dwyer, 1980).
The levels of endotoxin in necrotic root canals are positively correlated to clinical
symptoms such as spontaneous pain and tenderness to percussion. Virulent Gram-
negative anaerobic rods depend on the presence of other bacteria in their environment to
survive and establish their full pathogenic potential. Such aggregations of
microorganisms in an extracellular polysaccharide matrix associated with a surface (in
our case the inner root canal wall) are called biofilms.

In the root canal system, biofilms and infected dentinal tubules make disinfection
much more difficult (Haapasalo, 1987). Furthermore, it has been shown that organic and
inorganic dentin components, which are suspended in the irrigant during
chemomechanical instrumentation, inhibit most antimicrobial agents (Portenier, 2001.,
2002).

Irrigant Actions

Endodontic irrigant ideally should: have a broad antimicrobial spectrum and high
efficacy against anaerobic and facultative microorganisms organized in biofilms, dissolve
necrotic pulp tissue remnants, inactivate endotoxin, and prevent the formation of a smear
layer during instrumentation or dissolve the latter once it has formed. Furthermore, as
endodontic irragtants come in contact with vital tissues, they should be systemicall
nontoxic, noncaustic to periodontal tissues and have little potential to cause an
anaphylactic reaction.

Choosing the Main Irrigant

The currently used substances, sodium hypochlorite appears to be the most ideal and
the main solution, as it covers more of the requirements for endodontic irrigant. Hypochlorite has the unique capacity to dissolve necrotic tissue (Naenni, 2004) and the
organic components of the smear layer (Naenni, 2004., Baumgartner, 1987a., Haikel,
1994). It kills sessile endodontic pathogens organized in biofilms and in dentinal tubules
as efficiently as chlorhexidine or iodine at comparable concentration (Spratt, 2001). Inactivation of endotoxin by hypochlorite has been reported; the effect, however, is minor
compared to that of a calcium hydroxide dressing (Tanomaru, 2003). However, the use of chlorhexidine solutions may also be indicated under certain conditions.

Estrela et al. (2002) discussed the mechanism of action of sodium hypochlorite based on its antimicrobial and physico-chemical properties. The antimicrobial effectiveness of sodium hypochlorite based on its high pH (hydroxyl ions action) seems similar to the mechanism of action of calcium hydroxide (Estrela, 1995). The high pH of sodium hypochlorite interferes in cytoplasmic membrane integrity with irreversible enzymatic inhibition, biosynthetic alterations in cell metabolism and phospholipid destruction observed in lipidic peroxidation. The amino acid chloramination reaction forming chloramines interferes in cell metabolism.

Oxidation promotes irreversible enzymatic inhibition of bacteria replacing hydrogen with chlorine. Enzyme inactivation can be observed in the reaction of chlorine with amino groups (NH₂⁻) and an irreversible oxidation of sulphydryl groups (SH) of bacteria enzymes (cystein).

Thus, sodium hypochlorite presents antimicrobial activity with action on bacterial essential enzymatic sites promoting irreversible inactivation originated by hydroxyl ions and chloramination action. Dissolution of organic tissue can be verified in the saponification reaction when sodium hypochlorite destroys fatty acids and lipids resulting in soap and glycerol.

Chlorhexidine is a potent antiseptic, which is widely used for chemical plaque control in the oral cavity (Addy, 2000). Aqueous solutions of 0.1 to 0.2% are recommended for that purpose, while 2% is the concentration of root canal irrigating solutions usually found in the endodontic literature (Zamany, 2003). It is commonly held that chlorhexidine would be less caustic than sodium hypochlorite (Jeansonne, 1994). A 2% chlorhexidine solution is irritating to the skin. Chlorhexidine is a cationic agent (biguanide group; 4-chlorophenyl radical), which exhibits antibacterial activity. The cationic nature of the compound promotes connection with anionic compound at the bacterial surface (phosphate groups from teicoc acid at Gram-positive and lipopolysaccharide at Gram-negative bacteria) capable of altering its integrity. The potassium ion, being a small entity, is the first substance to appear when the cytoplasmic membrane is damaged. The alteration of the cytoplasmic membrane permeability promotes precipitation of cytoplasmic proteins, alters cellular osmotic balance, interferes with metabolism, growth, cell division, inhibits the membrane ATPase and inhibits the anaerobic process (Rolla, 1975., Jenkins, 1988., Jeansonne, 1994). Despite its usefulness as a final irrigant, chlorhexidine cannot be advocated as the main irrigant in standard endodontic cases, because: (a) chlorhexidine is unable to dissolve necrotic tissue remnants (Naenni, 2004), and (b) less effective on Gram-negative than on Gram-positive bacteria.
Concentration of Sodium Hypochlorite for Endodontic Usage

There has been much controversy over the concentration of hypochlorite solutions to be used in endodontics. The antibacterial effectiveness and tissue dissolution capacity of aqueous hypochlorite is a function of its concentration, but so is its toxicity. However, severe irritations have been reported when such concentrated solutions were inadvertently forced into the periapical tissues during irrigation or leaked through the rubber dam (Hulsmann, 2000).

The reduction of intracanal microbiota, on the other hand, is not any greater when 5% sodium hypochlorite is used as an irrigant as compared to 0.5% (Bysrom, 1985). From in vitro observations, it would appear that a 1% NaOCl solution should suffice to dissolve the entire pulp tissue in the course of an endodontic treatment session (Sirtes, 2005). It must be realized that during irrigation, fresh hypochlorite consistently reaches the canal system, and concentration of the solution may thus not play a decisive role (Moorer, 1982). Unclean areas may be a result of the inability of solutions to physically reach these areas rather than their concentration.

Chelator Solutions

Although sodium hypochlorite appears to be the most desirable single endodontic irrigant, it cannot dissolve inorganic dentin particles and thus prevent the formation of a smear layer during instrumentation. In addition, calcifications hindering mechanical preparation are frequently encountered in the canal system. Demineralizing agents such as ethylenediamine tetraacetic acid (EDTA) and citric acid have therefore been recommended as adjuvants in root canal therapy.

Antiseptics such as quaternary ammonium compounds (EDTAC) or tetracycline antibiotics (MTAD (Torabinejad, 2003) have been added to EDTA and citric acid irrigants, respectively, to increase their antimicrobial capacity. Chelating agents can be applied in liquid or paste-type form (Hulsmann, 2003). Later, based on the results of that first preliminary study and the successful introduction of EDTA to endodontic practice, urea peroxide and EDTA were combined in a water-soluble carbowax (polyethylene glycol) vehicle. This product has since been commercially available. One important aspect related to currently available irrigating solutions, i.e. EDTA and citric acid, is that they strongly interact with sodium hypochlorite (Baumgartner, 1987). Both citric acid and EDTA immediately reduce the available chlorine in solution, rendering the sodium hypochlorite irrigant ineffective on bacteria and necrotic tissue. Hence, citric acid or EDTA should never be mixed with sodium hypochlorite. The same goes for paste-type EDTA preparations: at a 1:10 ratio, they immediately rid a 1% sodium hypochlorite solution of all hypochlorite (Girard, 2005).
Technical Aspects of Irrigating Root Canals

Penetration of an irrigant into the instrumented root canal system is a function of irrigating needle diameter in relation to preparation size. Hence, while direct evidence is still lacking, the introduction of a slim irrigating needle with a safety tip to working length or 1 mm short of it is a promising approach to improve irrigant efficacy in the infected apical area of nonvital teeth with apical radiolucencies. It should be kept in mind that the solution does not reach further than 1 mm apically from the needle tip during irrigation. Hence, apical preparation size becomes an issue (McGurkin, 2005). When a 30-gauge needle is used, the apical preparation should be to an ISO-size 35 to 40 to secure proper rinsing of the apical area.

Discussion

The irrigant solutions are very important during root canal preparation because they aid in the cleaning of the root canal, lubricate the files, flush out debris, and have an antimicrobial effect and tissue dissolution, without damage to periapical tissues. The selection of an ideal irrigant depends on its action on microorganisms and periapical tissues. It is known that the smear layer may harbour bacteria, preventing the canal from being disinfected (Berutti et al. 1997). In addition, it has been demonstrated that the removal of this layer promotes dentine permeability (Pashley et al. 1981), enhancing diffusion and the action of intracanal medication (Ørstavik & Haapasalo 1990), allowing and producing greater penetration of filling material into lateral canals and dentinal tubules (Gutierrez et al. 1990, Lloyd et al. 1995).

Unfortunately, no irrigating solution is capable of acting simultaneously on the organic and inorganic elements of the smear layer. In an effort to remove this layer completely, many authors suggest the use of several solutions (Baumgartner & Mader 1987, Abbott et al. 1991). Neutral ethylenediaminetetraacetic acid (EDTA) solutions, in a 15–17% concentration, are effective in demineralizing the dentine (O’Connell et al. 2000, Calt & Serper 2002), and can be used to remove the smear layer (McComb & Smith 1975, Goldman et al. 1981, Baumgartner & Mader 1987, O’Connell et al. 2000, Calt & Serper 2002). However, as it does not dissolve organic matter (Baumgartner & Mader 1987), EDTA has been used with sodium hypochlorite (NaOCl) solution which, in addition to acting on pulp tissue remnants (Baumgartner & Mader 1987, Abbott et al. 1991), has antimicrobial properties (Baumgartner & Cuenin 1992).

Sodium hypochlorite (NaOCl) is the most popular irrigating solution. NaOCl ionizes in water into Na⁺ and the hypochlorite ion, OCl⁻, establishing an equilibrium with hypochlorous acid (HOCI). At acidic and neutral pH, chlorine exists predominantly as HOCI, whereas at high pH of 9 and above, OCl⁻ predominates. Mcdonnell (1999). Hypochlorous acid is responsible for the antibacterial activity; the OCl⁻ ion is less effective than the undissolved HOCI. Hypochloric acid disrupts several vital functions of the microbial cell, resulting in cell death (Barrette 1989., McKenna, 1988). NaOCl is commonly used in concentrations between 0.5% and 6%. It is a potent antimicrobial
agent, killing most bacteria instantly on direct contact. It also effectively dissolves pulpal remnants and collagen, the main organic components of dentin.

Hypochlorite is the only root-canal irrigant of those in general use that dissolves necrotic and vital organic tissue. It is difficult to imagine successful irrigation of the root canal without hypochlorite. Although hypochlorite alone does not remove the smear layer, it affects the organic part of the smear layer, making its complete removal possible by subsequent irrigation with EDTA or citric acid (CA). It is used as an unbuffered solution at pH 11 in the various concentrations mentioned earlier, or buffered with bicarbonate buffer (pH 9.0), usually as a 0.5% (Dakin solution) or 1% solution. However, buffering does not seem to have any major effect on the properties of NaOCl, contrary to earlier belief (Zehnder, 2002).

There is considerable variation in the literature regarding the antibacterial effect of NaOCl. In some articles hypochlorite is reported to kill the target microorganisms in seconds, even at low concentrations, although other reports have published considerably longer times for the killing of the same species (Gomes, 2001, Radcliffe, 2004, Waltimo, 1999). Such differences are a result of confounding factors in some of the studies. The presence of organic matter during the killing experiments has a great effect on the antibacterial activity of NaOCl. Haapasalo and colleagues (2000) showed that the presence of dentin caused marked delays in the killing of Enterococcus faecalis by 1% NaOCl. Many of the earlier studies were performed in the presence of an unknown amount of organic matter (eg, nutrient broth) or without controlling the pH of the culture, both of which affect the result. When the confounding factors are eliminated, it has been shown that NaOCl kills the target microorganisms rapidly even at low concentrations of less than 0.1%. (Portenier, 2005). However, in vivo the presence of organic matter (inflammatory exudate, tissue remnants, microbial biomass) consumes NaOCl and weakens its effect. Therefore, continuous irrigation and time are important factors for the effectiveness of hypochlorite.

Bystrom and Sundqvist (1983, 1985) studied the irrigation of root canals that were necrotic and contained a mixture of anaerobic bacteria. These investigators showed that using 0.5% or 5% NaOCl, with or without EDTA for irrigation, resulted in considerable reduction of bacterial counts in the canal when compared with irrigation with saline. However, it was difficult to render the canals completely free from bacteria, even after repeated sessions. Siqueira and colleagues (2002) reported similar results using root canals infected with E faecalis. Both studies failed to show a significant difference in the antibacterial efficacy between the low and high concentrations of NaOCl. Contrary to these results, Clegg and colleagues (2006) in an ex vivo biofilm study, demonstrated a strong difference in the effectiveness against biofilm bacteria by 6% and 3% NaOCl, the higher concentration being more effective.

The weaknesses of NaOCl include the unpleasant taste, toxicity, and its inability to remove the smear layer by itself, as it dissolves only organic material. The limited antimicrobial effectiveness of NaOCl in vivo is also disappointing. The poorer in vivo performance compared with in vitro is probably caused by problems in penetration to the

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most peripheral parts of the root-canal system such as fins, anastomoses, apical canal, lateral canals, and dentin canals. Also, the presence of inactivating substances such as exudate from the periapical area, pulp tissue, dentin collagen, and microbial biomass counteract the effectiveness of NaOCl (Haapasalo, 2000). Recently, it has been shown by in vitro studies that long-term exposure of dentin to a high concentration sodium hypochlorite can have a detrimental effect on dentin elasticity and flexural strength (Sim, 2001, Marending, 2007). Although there are no clinical data on this phenomenon, it raises the question of whether hypochlorite in some situations may increase the risk of vertical root fracture.

Complete cleaning of the root-canal system requires the use of irrigants that dissolve organic and inorganic material. As hypochlorite is active only against the former, other substances must be used to complete the removal of the smear layer and dentin debris. EDTA and CA effectively dissolve inorganic material, including hydroxyapatite (Baumgartner, 1984, 1987). They have little or no effect on organic tissue and alone they do not have antibacterial activity, despite some conflicting reports on EDTA. EDTA is most commonly used as a 17% neutralized solution (disodium EDTA, pH 7), but a few reports have indicated that solutions with lower concentrations (eg, 10%, 5%, and even 1%) remove the smear layer equally well after NaOCl irrigation. EDTA and CA are used for 2 to 3 minutes at the end of instrumentation and after NaOCl irrigation. Removal of the smear layer by EDTA or CA improves the antibacterial effect of locally used disinfecting agents in deeper layers of dentin (Orstavik, 1990).

The effectiveness of irrigation relies on both the mechanical flushing action and the ability of irrigants to kill bacteria (Gulabivala et al. 2005) and dissolve tissue (Lee et al. 2004), and it has been suggested that the flushing action may be the most important factor (Baker et al. 1975). Irrigation dynamics should then be considered when evaluating the effects of an irrigant on root canal contents (Gulabivala et al. 2005). The penetration of the irrigant and the flushing action created by irrigation are dependent not only on the anatomy of the root canal system, but also on the system of delivery, the depth of placement, and the volume and fluid properties of the irrigant (Lee et al. 2004, Gulabivala et al. 2005). Irrigant flow rate is rarely mentioned as a factor contributing to irrigation effectiveness (Williams et al. 1995) and standardized in research papers (Chow 1983., Lee et al. 2004, Sedgley et al. 2005), although flow rate is considered a highly significant factor determining flow pattern in fluid dynamics and has been shown to influence the replacement of the irrigant in certain parts of the root canal.

Conventional irrigation with syringes still remains widely accepted (Peters 2004), and has also been advocated as an efficient method of irrigant delivery prior to passive ultrasonic activation (van der Sluis et al. 2006). Syringe delivery of the irrigant allows control of the depth of needle penetration in the canal and the volume of irrigant flushed through the canal (van der Sluis et al. 2006). Increased pressure applied during irrigation has been associated with irrigant extrusion through the apex (Gernhardt et al. 2004, Tinaz et al. 2005), whilst others suggest that flow rate of irrigant is the factor influencing extrusion.
This apparent disagreement reflects some confusion regarding the difference between pressure and flow rate. In addition, the dental syringe plunger is relatively small in surface area, and this coupled with the strength of a clinician's thumb can develop unanticipated high pressures in the syringe barrel (Whitworth et al. 2005).

Study (Hsieh, 2007), showed that flow of irrigation approached the apex in large root canals and when the irrigating needle tip was placed close to the root apex. Successful irrigation of a root canal prepared with a size 30 to size 40 master apical file required a 27 gauge irrigating needle to be placed 3 mm away from the apex. A root canal prepared with a size 45 master apical file was successfully irrigated with a 27 gauge needle tip placed 3 or 6 mm or with a 25 gauge needle placed 3 mm from the apex. When the root canal preparation was increased to size 50 master apical file or larger, it was necessary to use either a 27 gauge needle at 3 or 6 mm, a 25 gauge needle at 3 mm, or a 23 gauge at 3 mm from root apex for irrigation. Thus, for the narrower root canals, a finer needle inserted closer to the apex was necessary for efficient root canal irrigation. In conclusion that large master apical files are beneficial to successful irrigation in instrumented root canals, but very large tools (i.e. size 80 or above) cause turbulence and incomplete root canal irrigation. Root canal irrigation was affected by the diameter of the irrigating needle, the depth of the irrigating needle engaged in the root canal and the final size of the root canal preparation. Needles of larger diameter placed further from the root apex, used in conjunction with a narrow master apical file, were less efficient. This prevents the irrigation fluid from flushing into the root canal apex region.

Conclusion

Finally, it should be mentioned that the irrigating concepts presented here are aimed at obtaining a clean root canal system that is ideally prepared for the classic filling technique, using gutta-percha and a sealer. In the future, other ways to fill root canal systems may evolve and/or be established, such as the use of resin bonded systems (Shipper, 2004), bioactive materials (Zehnder, 2004), or even the attempt to regenerate pulp tissue in necrotic cases (Banchs, 2004). Although radical changes in the irrigating concept are not likely to occur, the specific needs for irrigants when such alternative attempts are followed are yet to be delineated.

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