Endodontic irrigants and irrigant delivery systems

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Endodontic treatment is a predictable procedure with high success rates. Success depends on a number of factors, including appropriate instrumentation, successful irrigation and decontamination of the root-canal space to the apex and in areas so-called "no mans. These steps must be followed by complete obturation of the root canals, and placement of a coronal seal, prior to restorative treatment.

Several irrigants and irrigation delivery systems are available, all of which behave differently and have relative advantages and disadvantages. Common root-canal irrigants include sodium hypochlorite (NaOCl), chlorhexidine gluconate, alcohol, hydrogen peroxide and ethylenediaminetetraacetic acid (EDTA). In selecting an irrigant and technique, consideration must be given to their efficacy and safety.

With the introduction of modern techniques, success rates of up to 95 percent are being achieved.1 The ultimate goal of endodontic treatment per se is the prevention or treatment of apical periodontitis, such that there is complete healing and an absence of infection, while the overall long-term goal is the placement of a definitive, clinically successful restoration and preservation of the tooth. For these to be achieved, appropriate instrumentation, irrigation, decontamination and obturation of the root-canal obturation must occur, as well as attainment of a coronal seal.

There is evidence that apical periodontitis is a biofilm-induced disease.2 A biofilm is an aggregate of microorganisms in which cells adhere to each other and/or to a surface. These adherent cells are frequently embedded within a self-produced matrix of extracellular polymeric substance. The presence of microorganisms embedded in a biofilm and growing in the root-canal system is a key factor for the development of periapical lesions.3 Adults undergoing root-canal treatment, the root-canal system has a complex anatomy that consists of arborizations, idomains and canals that harbor organic tissue and bacterial contaminants (Figs. 1a, b).

The challenge for successful endodontic treatment is always to be the removal of vital and necrotic remnants of pulp tissue, debris and biofilm during instrumentation, the dentin smear layer, microorganisms, and micro-twins from the root-canal system.4 Even with the use of rotary instrumentation, the metallic ultrasonic instruments currently available only act on the central body of the root, leaving a residuum in the root space.5-10 Risks of tissue damage and facial nerve damage have been reported following use of hydrogen peroxide as a root-canal irrigant.10-12 Alcohol-based canal irrigants have antimicrobial activity too, but they do not dissolve necrotic tissue. The irrigant that satisfies most of the requirements for a root-canal irrigant is NaOCl.13 NaOCl has the unique ability to dissolve necrotic tissue, even in areas where hydrogen peroxide, a well-known effective anti-bacterial irrigant, cannot dissolve necrotic tissue.13-15 It also kills sessile endodontic pathogens found in a biofilm.16 There is no other root-canal irrigant that can meet all these requirements, even with the use of methods such as surfactants to increase the wettability of the irrigant.16,17 Increasing the temperature of irrigating solutions or adding surfactants might be used to increase the wettability of the irrigant.18,19 However, even with the use of methods that allow better penetration of the root-canal irrigant, it cannot dissolve inorganic dentine particles and thus cannot prevent the formation of a smear layer during instrumentation.20,21 Calculifications hindering mechanical preparation are frequently encountered in the root-canal system, further complicating treatment. Desinfecting agents such as NaOCl that have been recommended as adjuvants in root-canal therapy,22 may not be the gold standard in endodontic practice, dual irrigants such as NaOCl with EDTA are often used.23,24 The combination of NaOCl and EDTA has been used world-wide for antiseptics of root-canal systems.25 The combination of NaOCl and EDTA used for root-canal irrigation ranges from 2.5 to 6 percent,25 while NaOCl has been used for root-canal irrigation with a range of 2.5 to 5 percent.26 This is important to note that while NaOCl has unique properties that satisfy most requirements for a root-canal irrigant, it also exhibits tissues toxicity that can result in damage to the adjacent tissue, including nerve damage.27-30 Root-endodontic patients occur during canal irrigation. Furthermore, Salazger reported that “its irritative effect, chemical extrusion of an endodontic irrigant routinely occurred in vivo.”31 This highlights the importance of using devices and techniques that minimize or prevent NaOCl incidents.32-34

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Irrigation delivery systems

Root-canal irrigation systems can be divided into two categories: manual agitation techniques and machine-assisted agitation techniques.6,9 Manual irrigation techniques include positive-pressure irrigation, which is commonly performed with a syringe and a sidevented needle. Machine-assisted irrigation techniques include ultrasonics and ultrasonics, as well as newer systems such as the plastic rotary F File (Orange, CA), which delivers apical negative-pressure irrigation.17,18 The plastic rotary F File (Plastic Endo),47,48 the Vibringe (Vibiringe),49 the Rinsendo (Air
Apical vapor lock

Because the root canal is surrounded by the periodontium, and unless the root canal foramen is open, the root canal behaves like a closed-ended channel. This produces an apical vapor lock that resists displacement during ultrasonic instrumentation and final irrigation, thus preventing the flow of irrigant into the apical third of the canals and the embrittlement of the root-canal system.1

Apical vapor lock also results in gas entrapment at the apical third.3 During irrigation, NaOCl reacts with organic tissue to form hydrolysis liberating hydrogen and carbon dioxide.19 This gaseous mixture is trapped in the canal system and forms a column of gas into which further fluid penetration is impossible. Extension of instruments into this vapor lock does not reduce or remove the gas. This allows the canal to have an enable adequate flow of irrigant.

The phenomenon of apical vapor lock has been confirmed in studies in which roots were encased in clear acrylic to eliminate the impression material to restrict hydraulic pressure flow through the apical foramen. A closed-ended channel was then established. The result in these studies was incomplete delivery of irrigant into the canal with the use of a pressure-negative tip.54 Micro-CT scanning and histological tests conducted by Tay et al. have also confirmed the presence of apical vapor lock.11 In fact, studies conducted with root-end fillings found that an open canal channel cannot be regarded as conclusive as the efficacy of root-canal treatment and irrigation systems.13 The apical vapor lock may also explain why a number of studies of clinical irrigation were unable to demonstrate a clean apical third in sealed root canals.

In a paper published in 1985 based on research by Chow, the use of sodium hypochlorite as a disinfecting agent in root canals has been demonstrated to have a detrimental effect on the root canal lining.19 Fluid exchange and debris displacement from the canal walls is very important to his primary finding. Evolving in the canal is a column of gas that is impossible to remove. Extension of instruments into this vapor lock does not reduce or remove the gas. This allows the canal to have an enable adequate flow of irrigant.

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This does not imply that NaOCl can or should be excluded as an endodontic irrigant; in fact, its use is critical, as has been discussed previously.8–11 However, this does imply that it must be delivered safely.

Safety first
In order to compare the safety of six-canal-endodontic irrigation techniques and devices, an in vitro study of 69 teeth was conducted using the working length and removed irrigant.110 When the proper irrigating fluid is used, the belief that they were carrying irrigant to the apical terminus, thereby removing 100 percent of organic tissue and 100 percent of microbial contaminants, success in endodontic treatment may be taken to levels never seen before.

References

Editorial note: A complete list of references is available from the publisher.

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