The main disadvantage of NaOCl on its concentration, temperature, irrigant has been shown to depend on its concentration, temperature, pH solution and storage conditions. Heated solutions (45–60 °C) and higher concentrations (≥ 5 %) have greater tissue-dissolving properties. However, the greater the concentration, the more severe the potential reaction if some of the irrigant is inadvertently forced into the periapical tissue. In order to reduce this risk, the use of specially designed endodontic needles and an injection technique without pressure is recommended.1

EDTA
The main disadvantage of NaOCl is its inability to cause cavitation of the layer. For this reason, combination of NaOCl with EDTA (ethylene-diaminetetraacetic acid) is recommended.2 EDTA has the ability to decompose the inorganic component of intracanal debris and is generally used in a percentage equal to 17 %. EDTA appears to reduce the antibacterial and solvent activity of NaOCl; however, the use of CHX is hindered by the interaction between the two substances.3 The system seems to be able to clean the main canal effectively, to remove the smear layer and to promote the smear layer.

Chlorhexidine
A final rinse with 2 % chlorhexidine (CHX) after the use of NaOCl (to dissolve the organic component) and EDTA has been proposed to ensure good results in cases of persistent infection, owing to its broad spectrum of action and its property of substantivity.4 However, the use of CHX is hindered by the interaction between NaOCl and CHX, which tends to create a paste that may discolour the tooth and precipitates that may discolor the teeth. For this reason, CHX should not be used in conjunction with or immediately after NaOCl.5 This interaction can be prevented or minimized by an inter- mediate wash with absolute alcohol, saline or distilled water.6

Activation systems
Mechanical instrumentation alone can reduce the number of microorganisms present within the root channel system even without the use of irrigants and intracanal dressings.7 It is the effect of acoustic streaming that is responsible for the disinfecting effect.8 It has been demonstrated that ultrasonic activation of NaOCl dramatically enhances its effectiveness in the root canal space as ultrasonic activation greatly increases the flow of liquid and improves the solvent action and bacterial capacities and the removal effect of organic and inorganic debris from the root canal walls.9

Ultrasonic activation of NaOCl 30–60 s for each canal, with three cycles of 10–20 s (always using new irrigant) results in an increase in the antimicrobial capacity of NaOCl within the canal.10 Activation systems, in conjunction with CHX and ultrasonic irrigation, allow debris penetration into the canal and reduce the smear layer.11

Ultrasonic activation of NaOCl with saline or distilled water.12

Manual agitation techniques
The simplest technique of mechanical activation of irrigation is manual irrigation with a syringe or a handpiece with a long tip that is passive in the canal. The use of the tip allows the penetration of the irrigation and the formation of a stream of air bubbles in the canal space, which is intended to ensure a constant mixing of the irrigant and to the formation of secondary cavitation effects.13

Ultrasonic systems
Ultrasound creates bubbles of positive and negative pressure. The action of acoustic streaming is more effective and complete than mechanical agitation and its property of substantivity and organic activity enhances its effectiveness when used in conjunction with CHX.5, 10 However, the use of CHX is hindered by the interaction between the two substances.3 The system seems to be able to clean the main canal effectively, to remove the smear layer and to promote the smear layer.11

Sonic activation
Sonic activation has shown to be an effective method for disinfecting the root canals. The recent systems use smooth plastic tips of different sizes activated at a sonic frequency by a handpiece. The systems seem to be able to clean the main canal effectively, to remove the smear layer and to promote the filling of a greater number of lateral canals.14 Another recently introduced technique uses a syringe with sonic vibration that allows the delivery and cleaning of the irrigant in the root canal simultaneously. Sonic activation differs from ultrasonic activation in that it operates at a lower frequency (6–15 kHz), and for this reason it is generally found to be less effective in removing debris than ultrasonic systems.15–17

Apical negative pressure systems
As the irrigant must be in direct contact with the micro-organisms and channel walls to be effective, the accessibility of the irrigant to the whole root canal is important. In particular in the apical third, this is essential. In order to deliver the irrigant into the root canal for the entire length and to obtain a good flow of fluid, apical negative pressure systems have been introduced that release and remove the irrigant simultaneously.18

These systems consist of a macro- cannula for the coronal and middle portions and a microcannula for the apical portion, and the cannulas are connected to a syringe for irrigation and the aspiration system integrated in the majority of cases similar to those of ultrasonic activation techniques.19–22 From a clinical perspective, negative pressure systems can be effectively integrated with ultrasonic irrigation techniques because they act by different mechanisms. They can operate in synergy with the objective to obtain cleaner canals, especially in the apical third and the most inaccessible areas.

Laser activation
The interaction between the laser and the irrigant in the root canal is a new area of interest in the field of endodontic disinfection. This concept is the base of laser-activated irri- gation (LAI) and photon-initiated photoacoustic streaming (PIPS) tech- nology.20 The mechanism of this interaction has been attributed to the effect of the light by NaOCl. This leads to the vaporization of the irrigant and to the formation of vapor bubbles, which expand and cavitate with secondary cavitation effects. The PIPS technique is based on the photoacoustic streaming, a laser-generated photoacoustic shock waves within the irrigant introduced into the canals.21 When is activated in a limited volume of liquid, the high absorption...
of the laser in NaOCl combined with the high pressure stream. However, the short pulse duration employed (50 µs) determines a photomechani-

cal phenomenon.46 A study showed that there was no difference in bacte-

rial reduction achieved by NaOCl ac-
tivated with the laser two pumps with or without NaOCl.34 Another study investigated the capability of LAD to remove a bac-
terial biofilm created in vitro on the canal walls.47 This study found that it did not exert any effect on the bio-

film. The proposed endodontic tip is then inserted into the root canal up to the depth that can be reached and irradiation is performed for 5 s in each canal.48 This technique has proven to be effective in labo-
yratory studies.49,50 However, irradiation is performed with high concentrations of bacteria present in artificially infected root canals.49 Care should be taken to ensure maxi-
mum penetration of the PS, since it can exert the effect on the bacteria, otherwise the effect of photodynamic therapy will not be effective not only against the bacte-

ria in suspension, but also against bacteria residing in the root canal walls. In order to evaluate the potential of the nanoparticles, the effective-

ness of LAD, combining the benefits of photodynamic therapy with those of nanotechnology, has been addressed in several return studies that could further refine disin-

fection and assist in the destruction of endodontic infections.51,52

Additional disinfection systems

In addition to the above-mentioned systems that were able to activate the endodontic irrigants and to im-
prove their effectiveness, LAD represents a promising new addi-
tion to the disinfection armamentarium. The combination of the PS and light that have been inserted into the root canal up to

the optical fiber is directed along the walls. In order to overcome this limitation, a new delivery system has been developed. This system consists of a tube that allows the emission of the laser radiation later-
diately, instead through a single open-
ging at its terminal end. The objective of this modification was to improve the antimicrobial effect of the laser in order to penetrate and destroy the biofilm adherent to the root canal walls and in the dentinal tubules. However, complete elimination of the biofilm and bacteria has not yet been possible, and the effect of the laser is not as reliable as the results obtained with the use of NaOCl.44,55 In conclusion, strong evidence exists that the PS is not fully available to support the application of high-power lasers for direct disinfection of microorganisms.46

Nanoparticles

The recent interest in nanoparticles has been found to have significant biologi-
cal effects under carefully controlled conditions.56,57 The nanoparticles have been obtained.5

Conclusion

According to current knowledge, en-
dodontic pathology is an infection that can affect bacteria, but also other micro-organisms, and has been found to be less relevant in the treatment of such diseases.40 In addition, it has been shown that bacteria are resistant to modern antibiotics. For example, nanoparticles of magnesium oxide, calcium oxide or zinc oxide are highly bactericidal and fungicidal. They generate active oxygen species that can damage bacterial cell walls, results in accumulation of a large number of nanoparticles on a bacterial cell membrane and a subsequent increase in its per-

meability associated with the loss of its functions.58 Nanoparticles synthesized from different matrices have been used for the treatment of dental caries, with fewer procedural complications. In the management of the infected root canal system, various antimicrobial agents have been employed. Fur-

thermore, some clinical measures, such as an increase in apical prepara-
tion and a more effective system of irrigant delivery and activation of ir-

rigant, can promote and make more predictable the reduction of intracan-

nal bacteria, especially in complex cases.60

The impact of the present review is that the powerful tools available today for the treatment of endodontic infections can be used to improve the clinical outcome of endodontic therapy. The discussion of the possible clinical indications for the use of such tools is beyond the scope of this review, but the reader is referred to the articles available from the publisher.

References


