The main disadvantage of NaOCl is its ability to produce cavitation on its concentration, temperature, irrigant has been shown to depend on its concentration, temperature, pH solution and storage conditions.10,11 Heated solutions (45–60°C) and higher concentrations (5–6%) have greater tissue-dissolving properties.2 However, the greater the concentration, the more severe the potential reaction if some of the irrigant is inadvertently forced into the periapical tissues. 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 ability to produce cavitation when used, owing to its antibacterial properties and its mechanical and solvent activity. NaOCl is used during the instrumentation phase to increase its time of action within the canal as much as possible without it being chemically altered by the presence of other substances that enhance its effectiveness. This irrigant has been shown to depend on its concentration, temperature, pH solution and storage conditions.10,11 Heated solutions (45–60°C) and higher concentrations (5–6%) have greater tissue-dissolving properties.2 However, the greater the concentration, the more severe the potential reaction if some of the irrigant is inadvertently forced into the periapical tissues. In order to reduce this risk, the use of specially designed endodontic needles and an injection technique without pressure is recommended.1

**Chlorhexidine**

A final flush with 2% chlorhexidine (CHX) solution after NaOCl is performed. This interaction can be prevented by using a solution containing CHX, which tends to be an excellent method to improve the intracanal cleaning.14 For this reason, CHX should not be used in conjunction with or immediately after NaOCl. Chlorhexidine has been shown to be effective in removing the smear layer from the canal walls and thus, it can be recommended during irrigation with EDTA to improve their efficacy at the end of the preparation.

**Activation systems**

Mechanical instrumentation alone can reduce the number of micro-organisms present within the root canal system, even without the use of irrigants and intracanal dressing,15 but it is not able to eliminate the smear layer.16 The introduction of instruments that can be rotated in handpieces at low speed inside the canal filled with irrigant is crucial. They are rotary brushes too large to be brought close to the working length, thus, they can be used effectively only in the coronal and middle thirds of the root canals, whereas ultrasonic tyres, which are smaller in size, can be used to eliminate the smear layer and to promote the penetration of the irrigant.17 The use of endodontic brushes for endodontic irrigation with CHX is recommended, and it is suggested that the irrigant is more effective when used at the root canal level.4

**Sonic activation**

Sonic activation has been 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 whole canal effectively, to remove the smear layer and to promote the filling of a greater number of lateral canals.18 Another recently introduced technique uses a sonic vibration that allows the delivery of a continuous activation of the irrigant in the root canal simultaneously. Sonic activation differs from ultrasonic activation in that it operates at a lower frequency (5–6 kHz), and for this reason it is generally found to be less effective in removing debris than are ultrasound systems.19,20

**Apical negative pressure systems**

The irrigant must be in direct contact with the micro-organisms and canal walls to be effective; the accessibility of the irrigant to the whole canal and its penetration in the apical third, 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.

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 into the majority of cases similar to those of ultrasonic activation techniques.21–24 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 use of laser-activated irrigation (LAI) and photon-initiated photocavitational (PIPP) technology.25

The mechanism of this interaction has been attributed to the effective absorption of the laser light by NaOCl. This leads to the vaporization of the irrigant and to the formation of vapor bubbles, which expand and condense with secondary cavitation effects.26

When is activated in a limited volume of liquid, the high absorption...
of the laser in NaOCl combined with the use of a handpiece. The short pulse duration employed (50 µs) determines a photoc hemical phenomenon. A study showed that there was no difference in bact erial reduction achieved by NaOCl (5%) and the laser with 568 nm. Another study investigated the capability of NaOCl to remove a bac terial biofilm created in vitro on the canal walls. This study found that it did not remove the bacterial biofilm from the apical third of the root canal and infected dental tubules. However, based on the combination phenomenon that could further refine disinfection and assist in the destruction of biofilms and the elimination of microorganisms. For this purpose, different substances and technologies have been investigated over time with different results.

Photodynamic disinfection

A new method recently introduced in endodontics in photodisinfec tion. This technique is based on the homogeneous concentration of photosensitive molecules (photosensitizer, PS) that the ability to target the bacteria according to the characteristics of the wavelength and energy, and in many cases due to the use of photomodulation the effect induced by the laser produces an alteration of the bacterial cell wall that leads to changes in osmotic gradient and a subsequent increase in its permeability associated with the loss of its functions. Nanoparticles synthesized from nanoparticles on a bacterial cell membrane and a subsequent increase in its permeability associated with the loss of its functions.

Bioactive glass

Recently, bioactive glass or bioactive glass ceramics have been a subject of research with a potential for endodontic disinfection. In any case, the possible success of the application of nanoparticles on the bacterial cell wall also depends essentially on the manner in which they can be delivered in the complex root canal system, various antimicrobial agents have been employed. Furthermore, some clinical measures, such as an increase in apical preparation and a more effective system of irritant delivery and activation of irrigation, can generate active oxygen species that can be bacteriostatic and bactericidal. They cause a rapid alteration of the bacterial cell wall, resulting in accumulation of a large number of nanoparticles on a bacterial cell membrane and a subsequent increase in its permeability associated with the loss of its functions.

Alternative antibacterial systems

Natural plant extracts

These compounds have been found to have promising antimicrobial properties, but conflicting results have been found for several reasons. These compounds have been found to have promising antimicrobial properties, but conflicting results have been found for several reasons. These compounds have been found to have promising antimicrobial properties, but conflicting results have been found for several reasons.

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Dr Nicola M. Gandolfo is Assistant Professor of Endodontics at Università Cattolica del Sacro Cuore in Rome. He completed his PhD at the same university in 2009, with a thesis on an innovative technique he developed for the reattachment of endodontically treated teeth. He has contributed to the development of various innovative endodontic systems and new techniques, and he holds international patents in the fields of endodontics and oral surgery. Dr. Giacomo has published extensively in international peer-reviewed journals, and he has contributed to several books of endodontic interest.

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