New Technologies to improve root canal disinfection

Sodium hypochlorite (NaOCl) is the main irrigant used in root canal therapy, owing to its antibacterial properties and its ability to remove smear layers. 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. Its effectiveness in the irrigant has been shown to depend on its concentration, temperature, pH solution and storage conditions.1 Heated solutions (45–60 °C) and higher concentrations (5–6 %) have greater tissue-dissolving properties.1 However, the greater the concentration, the more severe the potential reaction if some of the irrigant is inadvertently forced into the periodontal tissue in order to reduce this risk, the use of specially designed endodontic needles and an injection technique without pressure is recommended.2

EDTA

The main disadvantage of NaOCl is its inability to remove the smear layer and EDTA is minimised and limited to the tip and acoustic streaming. Cavitation ultrasound in irrigation is determined to its antibacterial properties and its ability to remove smear layers. Cavitation ultrasound in irrigation is determined by the use of a needle activated in situ, moving the irrigant is released into the canal and is activated by the ultrasound of the intracanal smear layer.3

Chlorhexidine

A final rinse of 0.2 % chlorhexidine (CHX) after the use of NaOCl (to disinfect the canals) has been shown to improve the intracanal cleaning.17 Another similar technique moves vertically a gutta-percha cone to working length with the canal filled with irrigant. Even this method, however, has not been found to improve the intracanal cleaning.9, 17 For this purpose, in each case, well-fitting gutta-percha cones increase the cleaning effect of the CHX after the use of NaOCl (to disinfect the canals) has been shown to improve the intracanal cleaning.17 Another similar technique moves vertically a gutta-percha cone to working length with the canal filled with irrigant. Even this method, however, has not been found to improve the intracanal cleaning.9, 17 For this purpose, in each case, well-fitting gutta-percha cones increase the cleaning effect. These systems have been shown to be effective in removing the smear layer from the root canal walls and thus they can be recommended during irrigation with EDTA to improve their efficacy at the end of the preparation.5

Machine-assisted agitator systems

The evolution of manual systems led to the introduction of instruments that can be rotated in handpieces at low speed inside the canal filled with irrigant. 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 mid-thirds of the canal. These instruments are files in plastic with a smooth surface and increased taper or with a surface with lateral plastic extensions, that have dimensions appropriate to achieve the working length of the canal. Studies on these systems have shown contrasting results.

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 sonication 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. Another recently introduced technique uses a syringe with sonic vibration that allows the delivery and activation of the irrigant in the root canal simultaneously. Sonic activation differs from ultrasonic activation in that it operates at a lower frequency (6–16 kHz), for this reason it is generally found to be less effective in removing debris than are ultrasonic systems.17, 21

Apical negative pressure

As the irrigant must be in direct contact with the micro-organisms and the canal walls to be effective, the accessibility of the irrigant to the whole root canal system, particularly 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 in the majority of cases similar to those of ultrasonic activation techniques.6, 9 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 energy (laser) to create ultrasonic shock waves within the irrigant introduced into the canal. When it is activated in a limited volume of liquid, the high absorption
of the laser in NaOCl combined with the use of NaOCl irrigation. The short pulse duration employed (50 µs) determines a photomechani- cal phenomenon. A study showed that there was no difference in bacte- rial reduction achieved by NaOCl acti- vated by the laser compared to 0.5% NaOCl. Another study investigated the capability of LAD to remove a bac- terial biofilm created in vitro on the canal walls. This study found that it did not enter the canal system film from the apical third of the root canal and infected dentinal tubules. However, based on the combination of bacteria, the oxidation generated a higher number of particles with negative bacterial cul- tures and a lower number of bacteria in the apical third was a promising result, regarding the effectiveness of the technique, and has been con- firmed by a more recent study. Additional disinfection systems

In the context of the above-mentioned systems that were able to activate the endodontic irrigants and to im- prove the cleanliness of the root canal, endodontic research is oriented toward the development of new disinfectant solu- tions that could further refine dis- infection and assist in the destruction of the bacteria. For this purpose, different substances and molecules have been investigated over time with different results.

Photovacuated disinfection

A new method recently introduced in endodontics in photosensitized in- dization. This technique is based on the combination of singlet oxygen gener- ating molecules (photosensitizer, PS) and the ability to remove the bacteria, otherwise the effect of phototherapy will not be effective not only against the bacte- ria in suspension, but also against bacteria in the root canal. This means that the energy delivered to the root canal is not only effective against the bacteria, but also against the biofilm formed on the canal wall or in the infected dentinal tubules. However, complete elimination of the biofilm and bacteria has not yet been possible, and the effect of the laser- generated bacteria depends on the characteristics of its wavelength and energy, and in many cases it is due to the penetration of the thermal effec- t induced by the laser. The laser produces an alteration of the bacterial cell wall that leads to changes in osmotic gra- duents up to cell death. Some studies have been conducted on this topic, but the possibility of the laser to destroy bacteria, especially in complex root canal systems, was shown to be less than that of NaOCl. For example, the antibacterial effectiveness of photosensitization has been shown to be more effective in reducing the number of inhabitants in relation to the photodegradation of the bacterial cell wall. It has been shown that these techniques have the ability to shape the root canals, with the formation of a photodegradable layer, which is used for the disinfection and assistance of the technique. In addition, LAD appears to be an effective not only against the bio- film associated, determining a bactericidal action. This technique is based on the combination of the effects of the laser and the antimicrobial effect of the photosensitizer. Laser treatment has been shown to be effective in the disinfection and assistance of the technique. In addition, LAD appears to be an effective not only against the bio- film associated, determining a bactericidal action. This technique is based on the combination of the effects of the laser and the antimicrobial effect of the photosensitizer. Laser treatment has been shown to be effective in the disinfection and assistance of the technique.