

# What's new for the clinician?

## Summaries of and excerpts from recently published papers

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### 1. Capacity of dental equipment to interfere with cardiac implantable electrical devices

Lahor-Soler E, Miranda-Rius J, Brunet-Llobet L, Sabaté de la Cruz X. *Eur J Oral Sci* 2015; 123: 194–201

Cardiac implantable electrical devices (CIEDs), which include pacemakers (PMs) and implantable cardioverter defibrillators (ICDs), are electronic appliances that are capable of analyzing the heart's rhythm and regulating cardiac arrhythmia through an electrical stimulus.<sup>1</sup> Cardiac implantable electrical devices are typically placed subcutaneously, through a surgical procedure, in the left infraclavicular region and are connected by flexible electrode leads via the subclavian vein.<sup>1</sup> In spite of the fact that present-day CIEDs possess protective mechanisms that recognize and filter most interference, some electromagnetic currents could temporarily affect their function.

Dental practice frequently involves the use of sophisticated electronic and electromagnetic equipment within the oral cavity. The proximity of the lower third of the face to the infra-clavicular region, where CIEDs are usually implanted, could augment the risk of interference in their function.<sup>1</sup>

The increased number of patients with CIEDs has made it necessary to establish a consensus concerning their compatibility with certain electronic instruments employed in the field of clinical dentistry. Lahor-Soler<sup>1</sup> and colleagues (2015) reported on an *in vitro* study that sought to examine the behaviour of CIEDs under the influence of electronic and electromagnetic equipment employed in the field of dentistry.

#### MATERIALS AND METHODS

For inclusion, all electronic dental instruments tested in the study were required to possess the capacity to generate electrical or electromagnetic fields derived from their mechanisms of action. In addition, manufacturers had contraindicated their use in patients with cardiac implantable electrical devices.

The following equipment was included in this study: an electrosurge (XO Odontosurge); an electric pulp tester (Denlux B 1000 Pulppen); an ultrasonic piezoelectric dental scaler (Satelec Suprasson P5 Booster); an electronic

#### ACRONYMS

**CIEDs:** Cardiac implantable electrical devices  
**PMs:** Pacemakers  
**ICDs:** Implantable cardioverter defibrillators

apex locator (Morita Root ZX); and the osseointegration monitoring tools, Periotest M and Osstell ISQ.

Three different types and manufacturers of pacemakers (PMs) and implantable cardioverter defibrillators (ICDs) were included in this study. The study was performed with a simulated model made of Forex, a plastic derived from expanded polyvinyl chloride (PVC). The model reproduced a number of life-size anatomic structures of reference, such as the thorax, neck, and lower jaw. It was filled with a solution of 0.4% saline in order to obtain an electrical impedance similar to that of the human body. The CIEDs were placed with their electrode leads in positions corresponding to where these leads would be placed *in vivo*.

The following variables were taken into consideration: **application distance** (*dA*) and **application time** (*tA*) of the instruments; dental equipment type; the type and manufacturer of the CIEDs; and the state of the insulation of the electrode leads of the CIEDs: normal (*nI*) vs. deteriorated (*dI*).

The dental equipment was set at pulse mode – on/off – in the tests with the variable **application distance** (*dA*) in order to test the most critical phases of the CIEDs that occur when these devices are switched on and off. In the tests with the variable **application time** (*tA*), the instruments were continuously set at the 'on' mode. In all testing the dental equipment was set at maximum potency and the CIEDs were programmed to maximum sensitivity mode.

A positive control – direct contact of an electrosurge with a CIED – which always induced electromagnetic interference, was established. The negative control corresponded to the normal functioning of the CIEDs, as reflected in their corresponding electrocardiography register.

The experiments with the variable *dA* were performed with electrode lead insulation in normal (*dAnI*) and deteriorated (*dAdI*) conditions. There was continuous application of the instrument for 10s at 20cm from the pacemaker and

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implantable cardioverter defibrillator. In the tests where electromagnetic interference was observed, the time period of application was increased to 60s.

Data from each test were registered as binary, according to whether or not interference was produced, the class of electromagnetic interference, and its category (degree of severity). For the PMs/ICDs, the electromagnetic interference categories were: electrical noise, electrical reset, deprogramming, and short- and long-lasting stimulation inhibition. Inappropriate discharge was considered as electromagnetic interference exclusively for the ICDs and was a consequence of a false signal incorrectly interpreted as an arrhythmia. Classification of the severity of the observed interference was determined by an electrophysiologist with respect to possible clinical repercussions: *absence*, no interference; *light*, electrical noise or reset; *moderate*, deprogramming; *severe*, short-lasting stimulation inhibition ( $\leq 3$  pacings); and *very severe*, inappropriate discharge and long-lasting stimulation inhibition ( $> 3$  pacings).

## RESULTS

During analysis of the dental instruments, all, at some time, showed the capacity to induce electromagnetic interference in the CIEDs. With respect to the severity of the interference, significant differences were observed among the different instruments tested ( $P < 0.001$ ). In the *light* and *moderate* categories the greatest amount of electromagnetic interference was triggered by the electrosurge. In the *severe* category, however, it was the electric pulp tester that caused the most electromagnetic interference.

With respect to the **application distance** (*dA*), the quantity of interference induced in the CIEDs was statistically significant for all the dental equipment ( $P < 0.001$ ).

For the ICDs, the electric pulp tester and ultrasonic piezoelectric dental scaler displayed significant differences in the amount of electromagnetic interference induced according to the distance of application ( $P < 0.001$ ) and ( $P = 0.002$ ), respectively. The electronic apex locator, electrosurge, Osstell ISQ, and Periotest M did not, however, present significant differences for this variable ( $P > 0.05$ ).

The greatest amount of electromagnetic interference was produced 1cm from the area where the electrode lead insulation had deteriorated (1cm Fx) ( $P < 0.001$ ).

In the case of pacemakers (PMs), the electric pulp tester ( $P < 0.001$ ), Osstell ISQ ( $P=0.001$ ), Periotest M ( $P=0.003$ ), and ultrasonic piezoelectric dental scaler ( $P=0.005$ ) displayed significant differences in the amount of electromagnetic interference induced, according to the distance of application. A significantly greater quantity of electromagnetic interference was associated with a distance of 1cm from the electrode tip (1cm ET) ( $P < 0.001$ ). However, the electronic apex locator and electrosurge did not present significant differences for this variable ( $P>0.05$ ).

The distance between the CIED, located in the infraclavicular region, and the oral cavity is generally about 20cm. At this distance only two electric noises (electromagnetic interference *light* category), which were

induced by electrosurge, were reported in PMs. For the ICDs, 24 electric noises were observed (electromagnetic interference *light* category), which were induced by various dental instruments

In the analysis of **application time** (*tA*), it was observed that lengthening the time from 10 s to 60 s did not modify the amount of electromagnetic interference for any of the CIEDs ( $P = 1.000$ ), a result that was reported for both normal ( $P = 1.000$ ) and deteriorated ( $P = 1.000$ ) electrode lead insulation.

In the analysis of the type of CIED variable with respect to interference and its degree of severity, overall the ICDs experienced the greatest amount ( $P < 0.001$ ) and the largest number of electromagnetic interferences in the category *light* ( $P < 0.001$ ). The PMs, however, displayed the greatest amount of *moderate* and *severe* interference ( $P < 0.001$ ).

In the analysis of the variation in the integrity of the electrode lead insulation (normal vs. deteriorated), a statistical significance was globally observed in the number of interferences ( $P < 0.001$ ), with higher electromagnetic interference values when the insulation was deteriorated.

## CONCLUSIONS

The results show that at a clinical **application distance** (20cm), the electronic dental equipment tested provoked only *light* interference (electric noise) in the CIED examined, irrespective of manufacturer. Therefore, the researchers concluded that the dental instruments analyzed in the study may be used in clinical dentistry for patients with PMs and ICDs.

## IMPLICATIONS FOR PRACTICE

Dental instruments do cause interferences on cardiac implantable electrical devices (CIEDs). Cardiac patients should be informed about the small risk of interference when having dental treatment.

### Reference

1. Lahor-Soler E, Miranda-Rius J, Brunet-Llobet L, Sabaté de la Cruz X. Capacity of dental equipment to interfere with cardiac implantable electrical devices. *Eur J Oral Sci* 2015; 123: 194–201

## 2. Endodontic re-treatment: clinical comparison of reciprocating systems versus rotary system in disinfecting root canals

Martinho FC, Freitas LF, Nascimento GG, Fernandes AM, Leite FRM, Gomes APM, Camões ICG. *Clin Oral Invest* 2015; 19: 1411-7.

As occasionally happens with any dental procedure, a tooth that has undergone root canal treatment may not heal as anticipated after initial treatment for a variety of reasons, which results in infection not being cleared or a recurrence of infection, often presenting as an apical periodontitis. It is known that chemomechanical procedures are unable to promote an optimal disinfection of the root canal systems.<sup>1</sup> Thus other modified systems that are designed to shape the root canal completely from start to finish with one single file, e.g., the Reciproc (VDW) and WaveOne (Dentsply Maillefer) reciprocating systems have been introduced.<sup>1</sup> However, evidence on their cleaning and disinfecting abilities is only now emerging.

Rotary Shaping instruments are replacing the conventional hand file systems with the promise of enhancing the ability to shape the canal, and reducing clinical mishaps like blocks, ledges, transportations and perforations. When the clinician masters the “method-of-use” protocols of rotary shaping instruments, unpredictable file breakage, metal fatigue, loss of cutting efficiency, variation in length, diameter and curvature of the canal can be avoided and better shaping of the canals with a desired taper will be achieved. There are various rotary shaping instruments that are available on the markets. The concepts, strategies and techniques for successful use are not unique to any one system; they generally apply to all NiTi rotary systems regardless of their brand names or geometries. Most widely used rotary Niti instruments are: Profile system GT, Profile .04 .06 taper, Protaper, Quantec series, Light speed, Hero 645, k3 file series, etc.

No clinical study has compared the ability of single-file instruments to rotary systems in the disinfection of endodontically treated teeth. Martinho and colleagues (2015)<sup>1</sup> reported on a clinical study that sought to compare the effectiveness of single-file reciprocating systems and rotary systems in removing endotoxins and bacteria in endodontic retreatment.

### MATERIAL AND METHODS

Thirty teeth in thirty patients in need of endodontic retreatment were selected. All the teeth had previously been root-filled and showed radiographic evidence of apical periodontitis. The pulp chambers had no visual communication with oral fluid such as would be caused by extensive decay or a failure in restoration. A detailed medical and dental history was obtained from each patient. None of the patients evaluated presented periodontal disease. Teeth that could not be isolated with rubber dam were excluded. Patients who had received antibiotic treatment during the last three months or who had undergone root canal treatment in the last two years were excluded from the study. Samples were collected from the final 30 single-rooted teeth.

Files, instruments, and all materials used in this study were treated with Co<sup>60</sup> gamma radiation (20 kGy for 6h) for sterilization and elimination of pre-existing endotoxins. The crown and surrounding structures were disinfected with 30% H<sub>2</sub>O<sub>2</sub> (volume/volume for 30s), followed by 2.5% NaOCl for the same period of time and then inactivated with 5% sodium thiosulfate. The sterility of the external surfaces of the crown was checked by taking a swab sample from the crown surface and streaking it onto blood agar plates, which were then incubated both aerobically and anaerobically.

A two-stage access preparation was performed. The access cavity was made without the use of water spray but under manual irrigation with sterile/endotoxin-free saline and by using a sterile/endotoxin-free high-speed diamond bur. In the second stage, before the pulp chamber was entered, the access cavity was disinfected. Sterility was checked by taking swab samples of the cavity surface and streaking them onto blood agar plates, with subsequent incubation at 37°C under both aerobic and anaerobic conditions.

A new sterile pyrogen-free bur was used under irrigation with sterile/endotoxin-free saline to access the canal. In order to achieve the full length of the canal for the first microbiological and endotoxins samplings (s1), a K-file (Dentsply) pathway was used through root-filling materials into the full length of the canal—determined by the pre-operative radiograph. The first endotoxin sampling was taken by introducing sterile/apyrogenic paper points (Dentsply Maillefer) into the full length of the canal, which was determined radiographically, and retained in position for 60s for sampling. This sampling procedure was repeated with three paper points that were pooled in a sterile tube containing 1-mL Viability Medium Göteborg Agar III (VMGA III) transport medium for microbial cultivation.

After the pulp chamber had been accessed and the first endotoxin sample had been secured, the patients were randomly divided into three groups: WaveOne (Dentsply Maillefer) (n=10); Reciproc instrument (VDW) (n=10), and ProTaper Universal Retreatment system (Dentsply Maillefer) (n=10). After the first endotoxin sampling, the root canal length was determined from the pre-operative radiograph and confirmed using an apex locator (Novapex). The root canals were then prepared with a standardized procedure within each group according to the allocated instrumentation.

All instruments were set into permanent rotation with a 6:1 contra-angle handpiece (Sirona, Bensheim, Germany) powered by a torque-limited electric motor. Irrigation was performed with disposable syringes and 30-G NaviTip needles (Ultradent) by using 5mL 2.5% NaOCl solution between the pecking sequences (WaveOne and Reciproc groups) and between files (ProTaper).

After instrumentation, the NaOCl was inactivated with 5-mL sterile 0.5% sodium thiosulfate during a 1-min

period, the mixture then being removed with 5-mL sterile/apyrogenic water. Next, a new sampling procedure (s2) was performed as described previously at s1.

The kinetic chromogenic LAL assay (Lonza) was used for quantification of endotoxins. For the determination of cultivable bacterial counts (culturing procedure), 50 microliters of serial dilutions were plated onto 5% defibrinated sheep blood fastidious anaerobe agar by using sterile plastic spreaders to culture non-selectively obligate anaerobes and facultative anaerobes. The plates were incubated at 37°C in anaerobic atmosphere for up to 14 days. After this period, colony-forming units (CFUs) were visually quantified for each plate.

Comparison of the results between the root canal treatment groups (WaveOne, Reciproc, and ProTaper Universal Retreatment systems) was performed by using the Kruskal–Wallis test. Significance level was always set at 5% ( $P < 0.05$ ).

## RESULTS

Sterility samples taken from the external and internal surfaces of the crown and its surrounding structures, tested before and after entering the pulp chamber, showed no microbial growth.

The standard curve for detection of endotoxins fulfilled the criteria of linearity ( $r = 1$ ). At the baseline (s1), the LAL assay indicated that endotoxins were detected in 100 % of the root canals with a median value of 5.84 EU/mL (range, 0.093–9.15 EU/mL) (30/30). At s2, regardless of the instrumentation systems tested, endotoxins were still

detected in all root canal samples (30/30). No differences were found in the median percentage values of endotoxin reduction achieved with reciprocating systems—WaveOne [94.11 %] and Reciproc [93.29 %] and with rotary systems—ProTaper Universal Retreatment [94.98 %] ( $P > 0.05$ ).

Bacteria were found in all initial samples of the 30 root canals investigated. In the baseline samples, cultivable bacteria were recovered from 100 % of the root canals tested with a median value of  $4.98 \times 10^3$  CFU/mL (range,  $2.6 \times 10^2$  to  $1.6 \times 10^5$  CFU/mL) (30/30). Regarding bacterial reduction, no differences were found comparing WaveOne [98.27 %], Reciproc [99.54 %], and ProTaper Universal Retreatment [98.73 %]. All systems were effective in reducing the bacteria ( $P > 0.05$ ).

## CONCLUSIONS

This study found that the Reciproc and WaveOne reciprocating systems were as effective as the ProTaper Universal retreatment system for removal of endotoxins and bacteria in endodontic retreatment.

## IMPLICATIONS FOR PRACTICE

These systems were found to significantly reduce but not eliminate all endotoxins and bacteria in the root canal in re-treated teeth. The choice of which system to use is practitioner dependant.

## Reference

1. Martinho FC, Freitas LF, Nascimento GG, Fernandes AM, Leite FRM, Gomes APM, Camões ICG. Endodontic retreatment: clinical comparison of reciprocating systems versus rotary system in disinfecting root canals; Clin Oral Invest 2015; 19: 1411-1417.

## 3. Antibacterial activity of a mouthwash on oral biofilm: essential oils vs. 0.2 % chlorhexidine

Quintas V, Prada-López I, Prados-Frutos JC, Tomás I. *In situ* antimicrobial activity on oral biofilm: essential oils vs. 0.2 % chlorhexidine. Clin Oral Invest 2015; 19: 97-107.

Listerine® and Corsody® are popular mouthwashes on the South African market. Listerine® contains a fixed combination of four essential oils (EO) as the active ingredients (thymol 0.064%, eucalyptol 0.092%, methyl salicylate 0.060%, menthol 0.042%). EO kills microorganisms by disrupting their cell walls and inhibiting their enzymatic activity. They prevent bacterial aggregation, slow down bacterial multiplication, and extract endotoxins.<sup>1</sup>

In oral applications, chlorhexidine binds to the mouth tissue, oral mucosa and teeth. It is then released over time to kill bacteria and fungi. This helps to reduce the bacterial count and prevents dental plaque. It has become the gold standard in dentistry due to its ability to adhere to soft and hard tissue and maintain a potent sustained release.

Recognizing that biofilm bacteria may be ten to 1,000 times more resistant to antimicrobial agents than planktonic cells<sup>1</sup> a more predictive assessment of mouthwash efficacy

## ACRONYMS

CLSM: confocal laser scanning microscopy  
EO: essential oils

may be better achieved with biofilm tests.<sup>1</sup> Studies have been performed on the activity of essential oils on oral biofilm, both *in vitro* and *in situ*. The latter have greater value when establishing the antiseptic efficacy of several mouthwashes since their activity is tested under *in vivo* clinical conditions.<sup>1</sup>

There are few studies in the literature in which the effects of essential oils on *in situ* undisturbed plaque-like biofilm (PL-biofilm) have been measured by applying confocal laser scanning microscopy (CLSM) together with bacterial vitality techniques.<sup>1</sup> Quintas and colleagues (2015)<sup>1</sup> reported on a study that sought to evaluate the *in situ* antibacterial activity of an essential oil mouthwash on undisturbed *de novo* PL-biofilm up to 7 h after its application using CLSM and a dual-stain fluorescence solution.

## METHODS

This was a randomized, double-blind, crossover study of the antibacterial efficacy of essential oils on an *in situ* model of PL-biofilm growth. The study group was composed of 15 systemically healthy adult volunteers between 20 and 45 years old and who presented a good oral health status: a minimum of 24 permanent teeth with no evidence of gingivitis or periodontitis (community periodontal index score = 0) and an absence of untreated caries at the beginning of the study. The following exclusion criteria were applied: smoker or former smoker, presence of dental prostheses or orthodontic devices, antibiotic treatment or routine use of oral antiseptics in the previous three months, and presence of any systemic disease that could alter the production or composition of the saliva. Professional tooth cleaning was performed on all volunteers before starting the study.

An individualized splint of the lower arch was created for each volunteer, which was able to hold six glass disks (6mm in diameter, 1mm thickness) and polished at 4,000 grit.

The splints with the glass disks were worn by the volunteers for 48 h to favour growth of the PL-biofilm, withdrawing it from the oral cavity only during meals (it was stored in an opaque container in humid conditions) and to perform oral hygiene procedures, using only mechanical removal of bacterial plaque with water without the use of any toothpaste or mouthwash.

After 48h, the glass disks were withdrawn one by one from the splint from each volunteer (from right to left in a distal-mesial direction) at baseline, 30s, and 1, 3, 5, and 7h after performing the following mouthwashes under supervision:

1. A single, 30s mouthwash with 20mL of sterile water (negative control) (M-WATER) or
2. A single, 30s mouthwash with 10mL of 0.2% chlorhexidine (Oraldine Perio®, Johnson and Johnson, Madrid, Spain) (positive control) (M-0.2% CHX) or
3. A single, 30s mouthwash with 20mL of essential oils in a hydroalcoholic solution (Listerine Menthol, Listerine®, Johnson & Johnson, Madrid, Spain) (M-EO)

On the day of the experiment, the volunteers were not allowed to eat or drink during the course of the tests. Collection of the different PL-biofilm samples started at baseline and finished after 7h.

All volunteers performed the three mouthwashes, with a rest period of two weeks between each test.

The glass disks were withdrawn from the splint and were immediately submerged in 100µL of fluorescence solution and kept in a dark chamber at room temperature for 15min. Microscopic observation was performed by a single investigator, who was unaware of the study design, using a laser scanning spectral confocal microscope (Leica Microsystems) with an HCX APOL 63x/0.9 water immersion lens.

Four selected fields or XYZ series in the central part of each disk were evaluated. The optical sections were scanned in 1µm sections from the surface of the biofilm to its base, measuring the maximum thickness of the field and subsequently the mean thickness of the biofilm of the

corresponding sample. The maximum biofilm thickness of each field was divided into three zones or equivalent layers: outer layer (layer 1), middle layer (layer 2), and inner layer (layer 3).

Quantification of bacterial vitality in the series of XY images was determined using cytofluorographic analysis (Leica confocal software).

## RESULTS

The mean Plaque Like-biofilm thickness at baseline was 22.1 µm (range 12–28 µm). Significant differences were not found over time for M-EO (Listerine) with regard to basal thickness. However, for M-0.2 % CHX (Chlorhexidine), lower PL-biofilm thickness values were obtained in comparison to both the basal thickness and the M-EO thickness.

The basal vitality in PL-biofilm was 73.6 % (44–94 %). The M-WATER mouthwash did not have any significant effect on PL-biofilm vitality compared with the basal level. The results after M-0.2 % CHX and M-EO showed significant differences compared with their respective basal levels from 30 s after mouthwash use to 7 h later. In comparison with the values obtained, 30 s after M-0.2 % CHX and M-EO, a significant recovery of the bacterial population was observed in the later PL-biofilm samples (after 3 and 5h, respectively). Comparing M-0.2% CHX and M-EO, M-EO presented lower percentages of bacterial vitality up to 7h after application, obtaining significant differences from 1 to 5h post-mouthwash.

In comparison with M-WATER, the prevalence of live bacteria was significantly lower in the three biofilm layers in all the biofilm samples taken after M-EO ( $p < 0.05$  in all comparisons). In comparison with M-0.2% CHX, the prevalence of live bacteria was significantly lower in the middle and inner layers from 1 h after mouthwash use to 7h later.

## CONCLUSION

A single application of essential oil mouthwash presents high antibacterial immediate activity and penetration capacity *in situ* and substantivity which lasts for at least 7h after its application over *de novo* biofilm. These results are better than those observed with 0.2 % chlorhexidine under the same conditions.

## IMPLICATIONS FOR PRACTICE

This study provides evidence of the efficacy of both mouth washes using an *in situ* model. Clinicians should note that clinical trials are the gold standard in treatment decision making as regards which product is superior.

## Reference

1. Quintas V, Prada-López I, Prados-Frutos JC, Tomás I. *In situ* antimicrobial activity on oral biofilm: essential oils vs. 0.2 % chlorhexidine. *Clin Oral Invest* 2015; 19: 97-107.