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Sincerely yours,

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Scientific Chairman of ROOTS SUMMIT 2018
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A future path for entrepreneurial dentists

Author: Dr Mitesh Badiani, UK

It is easy to generalise, but I think that most people would agree that we live in changing—and challenging—times. While technology is moving on apace, pushing all aspects of work and life forward and changing the way that we do even the most ordinary of things, uncertainty lingers over the future of our government, economy and commerce, not to mention the foot-dragging negotiations of Brexit or the numerous and frightening affairs overseas. It is difficult to predict which way things will go, whether you look at them a micro or a macro level.

Things are no different in dentistry. Disruption is afoot with the old, closed-door approach being slowly replaced by transparency and patient choice. New clinical indicators will increase the pressure to achieve higher quality and outcomes framework scores, and new regulations will ensure that the ‘rogue traders’ who occasionally blighted the name of the service—as they have so many others—can no longer gain a toehold, let alone a foot. All this change creates fertile ground for the entrepreneur, and yet they still face a perennial problem with financing their ambitions.

It is an unfortunate fact, but at the heart of any business is money. Whatever ethos drives a company, whether in the charitable sector, healthcare, public services, retail, or a brand within the FTSE 100, it can get nowhere without sustainable funding. This is a problem increasingly faced by dental practitioners, especially those looking to expand their business.

Ask around, and few dentists will say that they originally embarked upon their chosen career because they wished to go into business. There are far quicker and easier ways to do that. However, for those with a passion for the science, skills and service of dentistry, private practice offers the opportunity to take control and provides that invaluable commodity time. It might also mean specialising in one niche area, diversifying practice offerings or expansion through the creation of a portfolio of practices. Each of these options requires funding, but while traditional business loans can be accessible to the single practice owner, the entrepreneurial dentist with an eye on expansion will soon discover the necessity of looking elsewhere in order to finance their plans.

The pitfalls of independent dental practice portfolio growth

Developing a small portfolio of dental practices brings particular challenges when it comes to securing sufficient funding. Despite the fact that they are free from the restraints that often bind practices that are part of corporate chains, independent practices with multiple outlets face their own issues. Not only do they tend to be too big to sell when retirement beckons—because who can secure that kind of funding?—but it can be next to impossible to raise the finance for further growth or investment. If you cannot find the funds to run a practice well, there is no point in running one at all.
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Finance as an isolated issue needs methodical research, backed up by a comprehensive action plan and supported by a wide-ranging business plan. However, while practice owners and managers may wish to spend significant time looking for and securing funding, the practices bring other demands, including profit and loss (P&L), existing financial management, compliance, and of course, the small matter of delivering outstanding patient care, which will always be first and foremost for any reputable dental practitioner.

That commitment to patient care will also require time spent on hiring a team who share your philosophy, and delivering a training package that ensures that every member of the team shares the same ethos when it comes to the delivery of clinical excellence.

All of this takes time, even before you have moved on to compliance, an area not to be neglected but which is incredibly time-consuming. Compliance is often cited as the number one concern for dentists. Time must be spent ensuring your practice meets the regulations and interpreting the guidelines to ensure your practice is fully compliant.

It should also go without saying that staying on top of both P&L and financial management is imperative to the continued success of any business, dental practice or otherwise. Without a firm grasp on your existing finances, you cannot consider an expansion, no matter how entrepreneurial your spirit. Not only would your search for funding become exponentially more difficult, but in the unlikely event that you did gain financial backing you would simply be throwing good money after bad.

With so many demands on their time and their finances, how can today’s generation of entrepreneurial dentists keep moving forward and find the cash that they need to meet existing demands and fund future expansion, without compromising on outstanding patient care? There has not been a sustainable funding model, and it has been stifling those dentists with the vision to take their practices forward.

The difficult balancing act between clinical excellence and corporate expansion

While it might not be the path that they originally expected to follow, for some dentists—including myself—the non-clinical aspects of dentistry can hold as much interest and satisfaction as one-to-one patient care. There is a certain pleasure in seeing a practice flourish and grow, and for those with an entrepreneurial bent it can lead to ideas of expansion not just for the business opportunity, but for the challenges it brings. But once again, there comes the issue of funding.

After much time following the traditional financing routes, I came across Dentex, a UK partnership group for the dental profession, which allowed me to follow my interests without losing my autonomy. At my practices, we have always taken pride in the fact that we are one of the few dental practitioners outside of the large cities able to deal with the majority of our patient’s requirements in-house, with no need for external referrals. My wish was to maintain, and if possible expand, my existing practices into a small portfolio.

Aside from access to real-time financials and the investment I required to facilitate my plans, Dentex’s partnership model has enabled me to gain insights from a cross-practice comparison of financials, highlighting where I could make savings, or further investments, without hampering the services we have become known for.

The centralisation of all other elements of running the practices, such as cash flow, advertising, P&L, training, compliance, maintenance, has also liberated funds that would otherwise have been wasted through duplication of administration. And on a personal note, I have been freed to spend time pursuing my charitable interests and mentoring.

Some of my colleagues who are less focused on growing their own portfolio of dental practices have used the partnership model to unshackle themselves from aspects of practice admin in order to return to the clinical focus that originally fuelled their passion for dentistry, while others have taken the opportunity to slip into semi-retirement.

Work–life balance has always been a difficulty for practice owners. As any small business owner will attest, ‘switching off’ at the end of the day does not come easily when there is always something to be done. Having the safety net of being part of a wider group of dentists and being able to offload the aspects of the business that bring you less satisfaction without hampering the services we have become known for.

This new way of collaborating has meant that I have the freedom to pursue my own path while gaining support in areas such as financial responsibility and compliance. Dentists do not want to be tied up in red tape, but they do want the autonomy to decide what is best for their patients and their practice. The partnership group model is the ideal compromise.
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Photodamage of dental pulpa stem cells during 700 fs laser exposure

Authors: Prof. Dr Karsten König & Dr Anton Kasenbacher, Germany

Material and methods

Cells

Human stem cells from the dental pulp of adults (given by S. Gronthos, NIH, Bethesda, USA) were cultivated in α-modified Eagle’s Medium (MEM) by Gibco BRL Life Technologies (Paisley, Scotland) while adding 20% FCS, 2 mM L-glutamine, 100 µM L-ascorbate-2-phosphate, 100 µ Penicillin and 100 µg/ml Streptomycin at 5% CO₂ and 37 °C in 25 ml and 75 ml cell culture flasks (Greiner, Frickenhausen, Germany). The cells were treated for experiments and cultivation with 0.25% trypsin, 5 mM glucose, 0.05% EDTA in PBS for 5 minutes at 37 °C. After having been thus detached from the base of the culture flasks, the cells were incubated in cell chambers (MiniCeM, JenLab GmbH, Jena, Germany) for laser microscopy.

Comparative studies were conducted on Chinese hamster ovary (CHO) cells, which are available in many international laboratories as reference cells. The CHO cells were incubated in Dulbeccos HAM-F12 Medium (Gibco BRL) with 10% FCS, L-glutamine and an antibiotic mix of Penicillin, Streptomycin and Amphotericin B at 5% CO₂, and 37 °C. Trypsinisation corresponded to that of the stem cells.

Fig. 1: Femtosecond laser system with pulse-stretching unit.
Individual cells were marked by special diamond engravings in the exterior glass window. In case of the detection of cellular damage, these engravings were easily located by applying the phase-contrast technique.

Laser microscopy
An 80 MHz Ti:Sa Laser, Mai Tai (Spectra-Physics, Mountain View, USA) was applied for femtosecond-laser microscopy in the near infrared (NIR) spectrum. The laser power at microscope entrance and objective plane (power at the sample) were determined by the measuring instrument Fieldmaster (Coherent, Santa Clara, USA) and the measuring head LM2 and varied by grey filters when necessary. The measured values were specified as corrected in the presented protocol. This correction results from a limited measurement area and altered radiation conditions in the medium when compared to air.

Laser microscopy was realised via a modified LSM 410 (ZEISS, Jena, Germany) with a 40 x/1.3 oil immersion objective. The microscope scan modus 512 x 512 with a laser scan time t = 16 s was applied for cell irradiation. The cells were scanned ten times at the same focus plane. These experiments were realised at a central wavelength of 800 nm. After irradiation, the cells were transferred to an incubator in order to guarantee optimal conditions for further growth, cell division and repairing processes.

Pulse-stretching unit, generation and measurement of 700 fs pulses
In order to increase the pulse duration at the sample to 700 fs, a pulse-stretching unit was implemented in the light path in front of the microscope. This unit consists of coated mirrors and two parallel arranged gold-sputtered gratings with a grating constant of 600 lines/mm. The second grating was mounted on a motorised stage with micrometre precision. The pulse width was varied in dependence on the grating distance. The laser beam received a spatial dispersion by the first grating, which was compensated at the second grating (Fig. 1).

The pulse duration was initially determined at the laser exit with the autocorrelator MINI (APE, Berlin, Germany) with 88 fs at a central emission wavelength of 750 nm, 80 fs at 800 nm and 91 fs at 850 nm, hypothesising a Gaussian function. In general, measurements at the focal plane of the objective proved difficult, as divergent beams existed. A flat, non-linear measurement diode was employed, thus facilitating the measurement at the focal plane of high-aperture objectives. The autocorrelation function (ACF), which can be fitted with either Gauss-, Lorentz- or Secanthyperbolic-based analysis programmes in order to calculate the pulse duration.

Life-/Dead-Test
In order to examine the vitality of dental pulp stem cells (DPSC), a test by Molecular Probes (Eugene, Oregon, USA) was applied. A mixture of 2 µM calcein AM and 4 µM ethidium-homodimer-D1 was added to the cell chambers and incubated for 20 min at 37 °C.

Live cells were stained by calcein (emission in the green spectrum), dead cells by ethidium-homodimer-D1 with an emission in the red spectrum (nucleus). Calcein AM is a non-fluorescent dye which easily permeates the cell membrane of live cells and is transformed by an enzymatic reaction to the strongly green fluorescent calcein which cannot pass the intact membrane. Ethidium-homodimer-D1 is a red fluorescent so-called dead-cell staining agent which can only permeate damaged cell membranes and is significantly intensified by binding to DNA. The Life-/Dead-Kit was incubated 5.5 h after irradiation. Fluorescence was achieved by two-photon excitation.

Verification of laser-induced ROS-formation
The formation of ROS was verified in situ via two-photon excitation of the membrane-permeable fluorophore dihydrofluorescein (DHF) according to the method by Hockberger et al. First, the cells were incubated with the marker (10 µM, Fluka, Germany) and irradiated after 15 min incubation time. Only one ROI (region of interest) was subjected to irradiation. Surrounding cells were used as control. After irradiation, a full-frame scan was realised with the low power of 4 mW in order to visualise the effect.

![Fig. 2: Laser-induced damage rate (lethality).](image-url)
Results

The pulse-stretching unit was adjusted in a way that allowed for each laser wavelength a pulse duration of 700 fs ± 50 fs in the focus. Single DPSC cells were scanned 10x and the effect compared to the non-irradiated surrounding cells was determined. In addition, comparative experiments were accomplished using CHO cells. Cells or cell clusters were selected which were widely spaced in order to inhibit any intercellular communication as far as possible. During scanning, the transmission signal was detected and displayed as a picture on the monitor. A total of 325 cells was subjected to morphological examinations as well as a life-/dead-test, 50 cells underwent ROS examination. The results were compared to earlier findings with a pulse width of 170 fs.

Morphological changes

So-called black spots resulted from specific irradiation power parameters in locations with significant granulation in the cells. The laser power was gradually increased by 2 mW in order to measure the threshold value for the appearance of the first laser-induced morphological changes (Tab. 1). Under these conditions and with optimum focus, the minimal power for the appearance of black spots was 20 mW for the DPSC cells and 22 mW for the CHO cells (Tab. 2). At a power of 26 mW, 30% of the DPSC cells and only 15% of the CHO cells presented these morphological changes. Cells with laser-induced black spots generally revealed morphological changes within the following five hours thus indicating a photodamage effect.

Life-/Dead-Test

First, the DPSC cells were irradiated with different power parameters (4 mW, 12 mW, 16 mW, 20 mW and 32 mW). The irradiated cells were marked, incubated after 5.5 hours with the Life-/Dead-Kit and after 1 hour of incubation tested concerning their fluorescence behaviour. At an irradiation of 20 mW, 64 of 69 DPSC cells revealed a green cytoplasm fluorescence, while a red fluorescence was observed in 5 DPSC cells (Tab. 3). This corresponds to a damage of 7%. When the power was raised to 26 mW, already 35% were subjected to a lethal effect. However all of the CHO cells tolerated a power of 20 mW, with 15% of them dying at 36 mW (Tab. 4 and Fig. 2). The comparison with experiments of shorter pulse widths, at which already
73% of the DPSC cells were damaged at a power of 20 mW, shows that the longer pulse width of 700 fs is better tolerated by the cells.

**Verification of the laser-induced formation of ROS (reactive oxygen species)**

The irradiation showed that no detectable DHF signals occurred at an average power lower than 35 mW. As can be seen from Figure 3 (upper part of a and b) ROS signals were detected at a higher power of 37 mW in both upper irradiated cells. Weak fluorescence signals occurred in the lower non-irradiated cell too. However, this cell was linked to the irradiated cells via membrane contacts. If the power is only insignificantly increased, its effects become more pronounced. In Figure 3c the irradiated cells show a significantly higher intensity. This effect is also confirmed by the considerable fluorescence of the irradiated cell (Fig. 3f). Thus, destructive oxygen radicals are formed during irradiation of a pulse duration of 700 fs. In comparison to the 170 fs experiments, a significantly higher average power is necessary to achieve detectable ROS formation.

**Conclusions**

DPSC are less sensitive to irradiation with femtosecond NIR laser at a pulse width of 700 fs under the described irradiation conditions than to shorter pulse width of 170 fs. At average power parameters of 20 mW, up to 10% of the cells were subjected to lethal effects within six hours after irradiation. At an average power of 26 mW, still two thirds of the cells survived. At the shorter pulse width all cells would be subjected to a lethal effect.

The observed lesser sensitivity at higher pulse widths and constant pulse energy corresponds to the results of earlier studies on Chinese hamster ovary cells (CHO) at an irradiation wavelength of 780 nm. In these earlier studies, it was concluded that the damage is subject to a two-photon effect, for which a damage effect E can be expected according to the formula

\[ E \sim \frac{P^2}{\tau} \]

with \( P \): average laser power and \( \tau \): pulse width.

As in comparison an increase of the pulse width by factor \( F = 700 \text{ fs} / 170 \text{ fs} = 4 \) exists, it follows that a power increase by factor \( S = 1.7 \) to 2 should be necessary in order to achieve the same destructive effect.

This relation cannot be confirmed exactly basing on the presented data, but a factor \( S > 1.25 \) can be assumed, as already 7% of the DPSC cells died at an average power of 16 mW and a pulse duration of 170 fs, but 20 mW at 700 fs were necessary to achieve the same effect.

DPSC cells react slightly more sensitive at a pulse width of 700 fs than CHO cells. At an exposure of 26 mW laser power only 15% of the CHO cells were damaged in comparison to 35% of the DPSC cells. The detected ROS formation indicates a photochemical damage process._

**Editorial note:** A list of references is available from the publisher.
Diode-laser assisted vital pulp therapy

Authors: Dr Maziar Mir, Prof. Dr Norbert Gutknecht, Dr Masoud Mojahedi, Dr Jan Tunér & Dr Masoud Shabani, Germany, Iran, Sweden

Introduction

The preservation of pulp vitality is one of the most challenging approaches in endodontics. In Vital Pulp Therapy (VPT), after pulp exposure due to extensive dental caries, tooth injuries and iatrogenic events, the intact portion and uninflamed dental pulp is preserved with a suitable dressing at the exposure area. The dressing materials are biocompatible or bioactive. At the moment, different methods for VPT are used, including: (1) direct pulp capping, (2) indirect pulp capping, (3) partial pulpotomy and (4) full pulpotomy. Pulp dressings in these methods are performed using mineral trioxide aggregate (MTA), calcium-enriched material (CEM), calcium hydroxide and biodentin. Bleeding control and pain reduction are the most common complications in partial or full pulpotomy. Lasers have several benefits in endodontic treatment, for example: (1) pulp diagnosis, (2) dental hypersensitivity reduction, (3) pulp capping, (4) pulpotomy, (5) disinfection of root canals, (6) root canal shaping, (7) root canal obturation, (8) apicectomy and (9) root canal photodynamic therapy. Dental lasers are either Class 3B (< 500 mW) or Class 4 (< 500 to 5,000 mW). The former lasers are used for biostimulation (Low Level Laser Therapy—LLLT), whereas the latter are used for evaporation, coagulation, cutting, etc. Most lasers in both groups are based on diode lasers. Although particularly used for such procedures, they can also be set at their lowest output and be used as biostimulators in a defocused mode. In the current case, a Class 4 laser in defocused mode was used for biostimulatory purposes in a case of VPT.

Case report

An 18-year-old female patient with complaints due to a right permanent molar tooth with deep caries was referred for treatment.

Medical history

The patient’s medical history showed neither systemic medical problems nor any allergic reaction, pharmaceuticals or history of past surgical procedures. Thus, the patient did not need to be referred for medical consultation.

Dental history

Oral and maxillofacial examination of the patient revealed no TMJ or myofascial disturbances, no functional or parafunctional habits, Class I occlusion, but a relatively poor oral hygiene.

Clinical findings

Intermittent pain during the last 24 hours, binding of explorer at the occlusal surface was obvious, thermal and cold vitality pulp tests were positive.
X-ray examination
X-ray examination showed a radiolucent lesion near the dental pulp.

Diagnosis
A reversible pulpitis was diagnosed.

Laser-assisted VPT procedure

Treatment delivery sequence
After fulfillment of the consent form, the operation area was anaesthetised by infiltration method and 2% lidocaine with Epi 1:80,000, 1.8 ml (Darou Pakhsh, Tehran, Iran). The controlled area and proper placing of the laser warning signs were defined to secure the operating room. The protective goggles for patient, operator and assistant were checked. Furthermore, the patient’s information (examination sheet and X-ray, consent form, etc.) was reviewed.

Mouth rinsing was done by 0.2% chlorhexidine oral rinse (Shahre Daru, Tehran, Iran) for one minute and then the surface of the tooth was cleaned by a swab wetted by the same chlorhexidine solution.

Cavity preparation was performed by fissure diamond burs and then round stainless-steel burs. After caries removal, the pulpal bleeding was obvious and a partial pulpotomy was indicated.

Partial pulpotomy was started with sterile round diamond bur on a high-speed handpiece to remove the inflamed pulp tissue gently via normal saline irrigation. Haemostasis was obtained by cotton pellet soaked in normal saline for five minutes and then followed by diode laser irradiation.

CEM cement dressing was applied with a base of 2 mm CEM cement paste according to the manufacturer’s instruction (Biunique Dent, Tehran, Iran) using a sterile plastic instrument and then the dry sterile cotton pellet was used for more adaptation of CEM cement to the cavity wall (Fig. 2).

Interim restorative treatment (IRT) was applied with Glass Ionomer GC Fuji IX according to the manufacturer’s instruction without finger pressure (Fig. 3). Permanent filing was postponed for one month.
Laser parameters

The laser parameters were as follows:

- For bleeding control: 980 nm (diode laser, Wuhan Gigaa, Wuhan, China), power 0.8 W, 8 Joule, fibre 400 µm, non-initiated fibre, CW, non-contact mode, 10 seconds in scanning mode (Fig. 1)
- For pain reduction: 980 nm, output power 0.3 W, irradiation time 10 s, 3 Joule, spot size 3 mm, power density 4, 246 W/cm² at the end of low-level handpiece. The cavity diameter was 4 mm, irradiation area 0.1256 cm², power density at the target surface 2.388 W/cm², dose 23, 88 J/cm², non-contact (5 mm away from the exposure area), scanning mode, single dose

Final result

Excellent VPT was observed with no bleeding, no carbonisation and no char. The patient did not experience any discomfort and was satisfied. Radiographic examination was taken in order to follow the result of laser-assisted pulpotomy based on radiographic changes (Figs. 4a & b).

Follow-up

The first visit after VPT was one day after the procedure. There was no pain, therefore, a second LLLT was not deemed necessary. The next visit was determined two days after the procedure via telephone conversation in order to check on the pain degree based on VAS scaling (Visual Analogue Scale). Since there were no symptoms, the final visit was determined to be one month after the procedure. Finally, after one month follow-up, a successful treatment was observed clinically (positive thermal pulp vitality test) and with radiographic examination (Figs. 5a & b).

Discussion

Diode laser is extensively used in many dental practices. Laser-tissue interaction with high power diode lasers is based on photothermal effects contrary to LLLT, where there is no photothermal effect, but based on photochemical mechanisms. Since LLLT is dose-dependent, the laser parameters have to be respected carefully. The precise molecular mechanisms for LLLT are not too clear, but the clinical effects on pain control, inflammation reduction and wound healing are well investigated. Gupta et al. reported that laser pulpotomy showed clinical and radiographical results superior to those of electro-surgery and ferric sulfate pulpotomy in human primary molars, using high power diode laser in order to achieve good coagulation. Uloopi et al. applied LLLT in pulpotomy and noted that this treatment modality can be considered for primary teeth pulpotomy and its success was comparable to MTA pulpotomy technique. It is obvious that the use of diode laser application in pulpotomy can be twofold. In this case, higher power was first used for good coagulation and LLLT was then used in for pain reduction and anti-inflammatory purposes.

Conclusion

Diode laser based on the protocol applied in this study can successfully be used in Vital Pulp Therapy...
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The essence of conservative dentistry is conservative, that is, economical tissue management—for both hard tissues and the protection of the endodontium’s vitality. Deep cavities accompanied by pulp exposure are, indeed, a huge challenge for the pulp to preserve its vitality, but also for the dentist and treatment performed to increase, not decrease, the chance to save vital pulp for many years.

In case of very deep cavities, it is oftentimes indicated to perform an endodontic treatment. However, one should remember that the possibilities of contemporary endodontics do not limit to complete cleaning of the root canals system and its tight 3-D filling, but offers other, less radical methods of treatment. Endodontic treatment does not have to be equal with “killing” the tooth. If the image of the pulp seen in the microscope is correct, direct pulp capping performed in aseptic conditions allows to preserve the tooth’s vitality.

If small serous effusion, small bleeding accompanying possible mechanical injury during cleaning stop by itself thanks to cleaning the chamber with a piece of cotton wool soaked with NaCl, chlorhexidine, or laser-assisted pulp protection, there are good prognosis for biological treatment. If no pulpitis occurs (the application of a rubberdam and Class II to Class I cavities conversion are necessary), when the pulp capping with MTA or Biodentine is performed, the size of pulp exposure (in a reasonable scope resulting from mechanical aspects) seems to have a secondary meaning. Dried pulp, being a confirmation of its aseptic death, pus leak (at least part of the pulp inflamed), heavy bleeding difficult to stop (strong hyperaemia of the pulp, usually due to the inflammation) are the situations when different treatment protocols need to be used.

Case report

A 35-year-old patient was referred to our clinic because of a deep cavity Class II (MO) in tooth 16. Because of the cavity complexity and a desire to avoid its complication—the pulp exposure, partially cleaned cavity bottom was covered by non-hardening (UltraCal XS) and self-hardening (Ultra-Blend) calcium hydroxide. Then, the cavity was filled with a temporary filling. The patient did not report any pain, and the sensitivity to stimuli was similar to other molars in the maxilla.

Clinical findings

In order to assess the extent of the tooth core damage and its chances for biological treatment, a RTG photo of tooth 16 has been taken (Fig. 1). On the photo we can see the radiological shadow indicating the presence of fillings on the occlusal surface. The radiological shadow in the medial part of the chamber projection, not having its counterpart in this tooth’s fillings, requires intraprocedural differentiation by pumping calcium hydroxide or dental dressing into the chamber.

In the chamber projection we can additionally observe thickened tooth structure, which suggests the presence of denticles. Brightness in the area of roots requires the differentiation between irreversible pul-

Fig. 1: RTG image before the treatment.
pits and congestion of the pulp as a response to the calcium hydroxide use.

Treatment plan
The reasonable treatment plan included: restoration of the medial wall of the cavity in order to provide better isolation with the use of the rubberdam before the next stage of the procedure, cleaning the remaining part of the cavity, the conservative restoration with indirect or direct pulp capping if its condition allows for such a procedure, or entering “classical” endodontic treatment, if the tooth will not prognose pulp viability preserving.

Cleaning with laser
In an articaine with epinephrine infiltration anaesthesia, by means of ultrasonic scaler, the temporary filling was partially removed in order to obtain the space required for the conversion the cavity into Class I. Cleaning was continued with the use of Er:YAG laser (LightWalker, Fotona), using the contact contra-angle handpiece H14 with cylindrical optical fibre with a diameter of 1.3 mm. The laser parameters used during the procedure are presented in Figure 2 (cavity preparation) and Figure 5 (surface preparation for reconstruction).

The fibre tip of the contact contra-angle handpiece was carried out at some distance from the surface of the tooth (circa 1 mm). The wall of the cavity was restored with the composite and the self-etching system. After the conversion into Class I cavity and performing the occlusal adjustment, the rubberdam was applied and, from the tooth prepared in such a way, all temporary filling was removed (using the scaler again) revealing the pulp exposure of 1 to 1.5 mm² area in the buccal part of the cavity bottom (Fig. 6). Delicate effusion of the colourless and odourless fluid stopped after two to three minutes, confirming the theory about hyperaemia as response to the calcium hydroxide application.

Treatment of hyperaemia
In the first stage of the treatment, the exposure area was skipped, focusing on the remaining fragments of the cavity, continuing to clean it with laser on the previously mentioned parameters (Fig. 2). In order to minimize the laser’s impact on the pulp, the deepest parts of the cavity were prepared using the parameters modified to the values presented in Figure 3. Once the dentine surface was cleaned, the inner surface of the filling (unevenness between dental dressing and metal matrix after condensation) was smoothed with the diamond turbine drill.

Laser parameters used during the procedure.
- Fig. 2: Cavity preparation.
- Fig. 3: Deeper parts with the risk of pulp exposure.
- Fig. 4: Laser application to exposed pulp.
- Fig. 5: Preparation to the composite restoration.
After preparation of the whole cavity, a piece of the temporary filling previously pressed into the chamber was removed by means of endodontic hand tools (Figs. 6 & 7). The pulp behaviour during the entire visit (correct pink colour of the visible fragment of the pulp, small serous effusion without anaerobic infection after the temporary filling removal, small pulp bleeding after removal of the foreign body from the chamber, and spontaneous termination of effusion and bleeding) resulted in, after the patient gave his consent to the treatment plan, an attempt to biological treatment. Er:YAG laser was applied on the exposed pulp (parameters shown in Figure 4) with the tip hold in 5 mm distance from the pulp in order to “defocus” the beam (to reduce the intensity of radiation). Then, the pulp was covered with Biodentine (Figs. 8–10). After the time necessary for Biodentine to harden, composite reconstruction of the occlusal surface was prepared with the materials formerly used for the reconstruction of the tooth wall (Fig. 11).

Posttreatment

The posttreatment radiographs of the tooth are shown in Figure 12. The behaviour of the pulp during the procedure gave a main reason to qualify it for the conservative treatment and the observation (for about three months). In comparison with analogical cavities treated with the use of Biodentine, but without the use of laser, in the two years’ period of observation (with a particular focus on the lack of ailments and discomfort after the anaesthesia stops), this case allows to expect tooth viability maintenance and the standardisation of the periapical tissues image during the X-ray control.

Conclusion

The use of laser increased control over the cleaning of the most damaged portions of the dentine in order to prevent further exposure, or in case they occur, reduce the associated risk for the pulp. The application of laser in the preparation of the exposed pulp makes reaching the state of homeostasis easier, additionally disinfecting the surface layer of the pulp.

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A 28-year-old male patient presented to our practice with an asymptomatic clinical picture of chromatic alteration of tooth #11 (Fig. 1). He had a history of dental trauma during childhood. Clinical and radiographic examination found traces of pulp necrosis (Fig. 2), for which he was referred for endodontic treatment.

After the initial consultation with the patient, anaesthesia was given, followed by establishment of absolute isolation. Subsequently, coronary access was achieved and the presence of pulp necrosis confirmed. A crown-down disinfecting instrumentation was performed using 2.5% sodium hypochlorite as irrigation agent and odontometry by radiographic method (Fig. 3), owing to not being able to use a foramen locator under these anatomical conditions, as its accuracy may have been influenced.

A manual preparation technique (step-back) was performed, using third-generation K-Files (Dentsply Maillefer) and 2.5% sodium hypochlorite as irrigation agent.
agent for the purpose of widening the entire root canal system. At each instrument encounter, passive ultrasonic irrigation was performed with flat inserts (Fig. 4) in order to enhance the cleaning effect. Complementing the intra-channel decontamination process, two biweekly exchanges of UltraCal calcium hydroxide (Ultradent) were performed (Fig. 5), also with the purpose of analysing quality of cleaning through the radiopacity of the filling observed radiographically (Fig. 6).

After the removal of the intra-canal medication and drying, the apical plug was prepared with MTA REPAIR HP (Angelus; Fig. 7) and inserted through the direct technique using previously measured endodontic condensers (Fig. 8). The aim was to fill and subsequently seal the apical 4 mm (Fig. 9). After 24 h, a root canal filling was performed with Tagger’s hybrid thermomechanical technique using an MTA-based sealer (MTA-FILLAPEX, Angelus). Radiographically, ideal sealing of the entire root canal area was observed (Fig. 10). The patient showed no postoperative complications. A follow-up examination was conducted after six months, which revealed new bone formation in the apical region (Fig. 11).

**contact**

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Dentinal defects after root canal preparation

with HyFlex EDM, WaveOne Gold and ProTaper Gold: Light-emitting Diode Assessment

**Author:** Drs. Taha Özyürek, Mustafa Gündoğar, Gülşah Uslu & Koray Yılmaz, Turkey

**Introduction**

Vertical root fractures are one of the most frequent complications seen on teeth having endodontic treatment, and generally result in the extraction of tooth (Haueisen et al. 2013). The root canal treatment procedures may cause dentinal stress and consequently dentinal cracks. The emerging dentinal fractures may transform into vertical root fractures under functional loads (Barreto et al. 2012). The physical and mechanical properties of nickel titanium (NiTi) rotary file systems may affect the incidence of cracks on dentinal surface (Adorno et al. 2011). Moreover, the type of movement used in shaping the root canals may also influence the incidence of dentinal defects. Liu et al. (2013) have reported that a continuous rotational movement causes more dentinal defects than reciprocation movement, while Bürklein et al. (2013) have reported that reciprocation movement causes more dentinal defects.

WaveOne (WO; Dentsply Maillefer) NiTi single-file system was recently modified to WaveOne Gold (WOG; Dentsply Maillefer). While maintaining the reciprocation movement of the file, its cross-section, dimensions and geometry were changed. The cross-section of the file was altered to a parallelogram, having two cutting edges. Moreover, the off-centre design that ProTaper Next (Dentsply Maillefer) files have is used in WOG files too. The most significant change in files is the Gold heat treatment method. Gold heat treatment is based on reversing the M-Wire technology employing the pre-production heat treatment, and by heating the file after production and then slowly cooling it. The manufacturer company claims that this new heat treatment increases the flexibility of files (WaveOne Gold Brochure).

Another NiTi rotary file system made using the Gold heat treatment procedure is the recently introduced ProTaper GOLD (PTG; Dentsply Maillefer) system. Similar to ProTaper Universal (PTU; Dentsply Maillefer) system, this model consists of three shaping (SX, S1 and S2) and five finishing (F1, F2, F3, F4 and F5) files. PTG uses the continuous rotation movement at the same torque and speed settings with PTU, but the manufacturer claims that PTG files are two times more resistant to the cyclic fatigue under favour of flexibility offered by the Gold alloy (ProTaper Gold Brochure). From the aspect of metallurgical character, PTG NiTi files have not only the 2-stage specific transformation feature but also high Af temperature similar to controlled memory (Shen et al. 2011).

Recently, the patented treatments have been involved in the innovative production of new HyFlex EDM files (HEDM; Coltène/Whaledent, Altstätten, ...
Switzerland). The main feature of these files is that they are manufactured via an electro-discharge machining (EDM) process. The EDM is a non-contact machining procedure used in engineering for manufacturing the parts that would be difficult to machine with conventional techniques. The removal of material is performed by pulsating electric current discharges that flow between an electrode and the work piece are immersed in a dielectric medium. The electric current partially melts and evaporates small portions of the material in a well-controlled and repeatable manner. The material is therefore superficially removed, leaving an isotropic surface, characterised by regularly distributed craters (Pirani et al. 2015).

In our comprehensive literature review, no study examining the dentinal defects caused by HEDM NiTi files during root canal shaping procedure was found. For this purpose, the aim of this in vitro study was to compare the incidences of dentinal defects that HEDM, WOG and PTG NiTi files create during shaping the mesial canals of mandibular molar teeth. The null hypothesis of present study was that there would be no difference between the dentinal defect formation incidences of HEDM, WOG and PTG NiTi files.

Material and methods

Specimen selection

After obtaining the ethical committee approval, 80 mandibular molar teeth that were extracted due to periodontal reasons and had < 20° of canal curvature (Schneider 1971) and two separate mesial canals were involved in this study. The soft and hard tissues around the teeth were mechanically removed using a periodontal curette. Moreover, the distal roots of teeth were removed under water-cooling. The crowns of teeth were removed from the enamel-cement junction under water-cooling, allowing 16 mm of root length. The radiographic images of teeth were taken in mesio-distal and bucco-lingual directions. Teeth that were found to have calcification, history of previous root canal treatment, involving internal and/or external resorption, or were fractured and/or had immature roots were excluded. The selected teeth were kept in distilled water at 4 °C for the experimental procedures.

The roots of teeth were wrapped with aluminum foil and then embedded into acrylic resin (Lmicryl, Konya, Turkey) (Capar et al. 2014). After the acrylic set, the teeth were taken out from the resin, and the foils were removed. To simulate the periodontal ligament, the resin blocks were filled with viscous silicon impression material (Express XT Light Body Quick; 3M ESPE, Neuss, Germany) and the specimens were then placed into the resin blocks again.

Root canal preparation

The canals of teeth were penetrated using a #10 K-file (Dentsply Maillefer) until the tip of file was seen from the apex. The working length was set to 1 mm shorter than this length. For all of the specimens, the glide path was created ensuring the apical diameter of 0.20 mm. For every specimen, 20 ml 1% sodium hypochlorite (NaOCl) was used during the preparation. The entire procedure was executed by the same endodontist, having 5 years of experience. The teeth were randomly divided into 4 groups, 20 teeth in each. And then, the following procedures were performed.

Group 1: HyFlex EDM

Using the torque-controlled endodontic motor (X-Smart; Dentsply Maillefer), the root preparation of the specimens in this group was performed by using a HEDM 25/.06 NiTi single-file system according to the manufacturer’s instructions at 500 rpm and 2.5 Ncm torque.

Group 2: WaveOne GOLD

Using the torque-controlled endodontic motor (VDW Reciproc GOLD; VDW, Munich, Germany), the root preparation of the specimens in this group was performed by using a WOG Primary (25/.07) NiTi single-file system according to the manufacturer’s instructions in “WaveOne ALL” programme.

Group 3: ProTaper GOLD

Using the torque-controlled endodontic motor (X-Smart; Dentsply Maillefer), the root preparation of the specimens in this group was performed by using a PTG NiTi rotary file system’s S1 (18/.02), S2 (20/.04), F1 (20/.07) and F2 (25/.08) files according to the manufacturer’s instructions at 300 rpm and 3 Ncm torque.

Group 4: Negative control

No intervention was made to this group and they were assigned to the negative control group.

“Under water-cooling the roots of 80 specimens were cut perpendicular to the tooth axis at 3, 6, and 9 mm distant from the apex, and 3 slices were obtained from each specimen.”
Assessment of dentinal defects

Under water-cooling (Isomet; Buehler Ltd, Lake Bluff, IL, USA), the roots of 80 specimens were cut perpendicular to the tooth axis at 3, 6, and 9 mm distant from the apex, and 3 slices were obtained from each specimen. Trans-illumination was applied to the slices from 1 mm distance in mesial, distal, buccal, and lingual directions using a LED (LED Light; Denshine Technology, China) device. The digital images (4 images from each slice) were taken under x25 magnification using a digital camera connected to stereomicroscope (Olympus BX43, Olympus Co, Tokyo, Japan). In order to eliminate the bias of observers, the canals on digital images were masked using a circular drawing. A total of 960 digital images—240 from each group—were examined to determine if any cracks were present. The images obtained were then randomly assigned to two experienced endodontists, who were not involved in the preparation of the specimens, in order to determine the presence or absence of dentinal defects. To define crack formation, two different categories were made (i.e. ‘no crack’ and ‘crack’) to avoid the confusing description of root cracks. ‘No crack’ was defined as the root dentine without cracks or craze lines either at the internal surface of the root canal wall or the external surface of the root. ‘Crack’ was defined as all lines observed on the slice that either extended from the root canal lumen to the dentine or from the outer root surface into the dentine (Shemesh et al. 2009) (Fig. 1).

Statistical analyses

In examining the intergroup incidence of dentinal defects, a Chi-Square test was used. The level of statistical significance was set to 5%. The statistical analyses were performed using SPSS 21 (IBM-SPSS Inc., Chicago, IL, USA) software.

Results

In the present study, 960 images taken from 240 tooth slices were examined. The distribution of dentinal defects caused by the tested NiTi file systems between apical, medial, and coronal regions is presented in Table 1. In the present study, no statistically significant difference was found among the NiTi files tested and between them and control group in terms of the total number of dentinal defects (P > 0.05).

Discussion

In this study, the dentinal defects created by HEDM, WOG and PTG NiTi file systems on mandibular molar teeth’s mesial canals were evaluated. According to the results of the present study, it was determined that all of the tested NiTi files created dentinal defects but no statistically significant difference was found when compared to the control group. For this reason, the null hypothesis of the present study was accepted.
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In many in vitro studies, the dentinal defects created by the NiTi file systems during root canal preparation were investigated using single- and straight-rooted teeth (Karataş et al. 2015b, Kfir et al. 2017). However, the increasing root canal curvature would increase the stress on the files, which were used in preparation, and consequently on the dentine. An increase in the stress on dentine would cause increasing irregularities (transportation, straightening, etc.) within the canal and lead to thinner dentinal structure in certain regions. Thinner dentine would weaken the root structure and prepare the ground for vertical root fracture formation (Kim et al. 2013). In previous studies, it has been reported that the highest level of stress occurred on the curved root canals during the root canal preparation by NiTi rotary files (Kim et al. 2013, Medha et al. 2014). For this reason, the mesial canals of mandibular molar teeth were used in present study.

NiTi file manufacturers generally recommend using the files on single. Based on four-canal maxillary first molar tooth in present study, the files were discarded after use in four canals (two specimens) in order to prevent the deformation from influencing the results (Hin et al. 2013).

It has been reported that use of larger files in shaping the root canals increase the incidence of dentinal defect formation (Capar et al. 2015). For this reason, in the present study, the apical diameter of files was determined to be 0.25 mm, and no larger file was used. Moreover, in order to protect the dentine microstructure, 1% NaOCl was used as an irrigation solution. Thus, it was ensured that most of the dentinal defects to be related with the mechanic preparation.

It has been reported that the forces applied while extracting the teeth, and the stress during storing the teeth and obtaining the slices might cause dentinal defects (De-Deus et al. 2014). This may explain the formation of dentinal defects in the negative control group, where no intervention was made. Studies using conventional methods of sectioning have failed in determining these defects in negative control groups (Capar et al. 2014, Karataş et al. 2015b, Li et al. 2015). When illumination was applied on the obtained dentine slices, the light moved along the dentine, but stopped at the point of any crack on dentine and thus the presence of crack and/or fracture could be determined (American Association of Endodontists, 2008). In Coelho and colleagues’ study (2016a, 2016b), dentinal defects could be determined in many specimens in negative control groups by employing light-emitting diode (LED) trans-illumination. Moreover, Arslan et al. (2014) have also used methylene blue in order to determine dentinal defects, and they reported non-significant differences between the experimental group and negative control group in terms of dentinal defects.

Arias et al. (2014) reported in their study that masking is important for eliminating observer bias because of observing which of the specimens had been shaped or not. For this reason, the canal-masking method was used in the present study in order to eliminate any bias. The movement kinematic of NiTi files may affect the amount of dentinal defects during canal root shaping by files. Under favour of the reciprocation movement in clockwise and counterclockwise directions, the file is protected from being stuck within the canal while shaping the root canals (Yared 2008). Some of the studies have reported WaveOne files to cause less dentinal defects than ProTaper Universal files (Kansal et al. 2014, Li et al. 2015), while some other studies have reported that reciprocation systems create more dentinal defects (Bürklein et al. 2013). Besides that, in some studies, no statistically significant difference between the reciprocation systems and rotary systems has been reported (Arias et al. 2014, Karataş et al. 2015a, Coelho et al. 2016b). Li et al. (2015) have examined the dentinal defect formation incidences of ProTaper Universal, ProTaper Next and WaveOne files in curved root canals of molar teeth. The researchers have reported that ProTaper Next file system created less dentinal defects than other files. El Nasr and El Kader (2014) have reported ProTaper Universal F2 files operating based on the same movement kinematic with WaveOne system.

### Table 1

<table>
<thead>
<tr>
<th>Group</th>
<th>3 mm n (%)</th>
<th>6 mm n (%)</th>
<th>9 mm n (%)</th>
<th>Total of specimens presenting defects n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>4 (20 %)</td>
<td>8 (40 %)</td>
<td>6 (30 %)</td>
<td>11 (55 %)</td>
</tr>
<tr>
<td>ProTaper GOLD</td>
<td>8 (40 %)</td>
<td>10 (50 %)</td>
<td>8 (40 %)</td>
<td>14 (70 %)</td>
</tr>
<tr>
<td>WaveOne GOLD</td>
<td>6 (30 %)</td>
<td>9 (45 %)</td>
<td>8 (40 %)</td>
<td>12 (60 %)</td>
</tr>
<tr>
<td>HyFlex EDM</td>
<td>5 (25 %)</td>
<td>10 (50 %)</td>
<td>7 (35 %)</td>
<td>11 (55 %)</td>
</tr>
</tbody>
</table>

* There were no statistically differences in each level at $P = .05$.  

![Table 1](image-url)
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to cause less dentinal defects. Similar to the results of other studies (Capar et al. 2014, Li et al. 2015), the researchers attributed these results to the heat treatment, to which WaveOne files are exposed. Karataş et al. (2015a) have examined the dentinal cracks created by ProTaper Universal, ProFile Vortex (Dentsply Maillefer), ProTaper GOLD, Reciproc (VDW, Munich, Germany), and F360 (Komet Brasserle, Lemgo, Germany) files systems in mandibular incisor teeth, and reported that there was no statistically significant difference between ProTaper Universal, ProFile Vortex, ProTaper GOLD and Reciproc groups in terms of dentinal defect formation. It is believed that the reason for the difference in the present study originates from the differences in methodologies used. Similar to the present study, Coelho et al. (2016b) have used LED in investigating the dentinal defects created by ProFile (Dentsply Maillefer), TRUShape (Dentsply Maillefer) and WaveOne GOLD systems on mandibular molar teeth’s mesial canals, and reported statistically non-significant differences between the negative control group and experimental groups in terms of dentinal defects.

Capar et al. (2014) have examined the dentinal defects created by HyFlex CM, ProTaper Universal and ProTaper Next NiTi file systems on mandibular premolar teeth during preparation procedure. The researchers have reported ProTaper Next and HyFlex CM files to cause less dentinal defects than the ProTaper Universal files. Ashraf et al. (2016) have examined the dentinal defects created by ProTaper Universal, ProTaper Next and HyFlex CM NiTi file systems in mandibular premolar teeth by using sectioning method. Researchers have reported that HyFlex CM files caused less cracks than ProTaper Universal and ProTaper Next files did. In our literature review, it was determined that HEDM files’ dentinal defect incidence had not been studied before. For this reason, it is not possible to directly compare the results of the present study to those of others. In a finite elements analysis, it has been shown that increasing the taper of files also increased the stress on root canals during shaping procedure (Kim et al. 2010). Bier et al. (2009) reported that the taper of files might influence dentinal defects on roots during the shaping procedure. Yoldaş et al. (2012) have alleged that the tip design, cross-section, constant or variable taper, and groove and pitch structure of NiTi files might be related with the formation of dentinal defects. However, it is not exactly known how the taper of files affected the results of present study, because the taper of files used were not same and the taper of HEDM file was not known. The similar results obtained are thought to originate from the fact that the files were made of alloys having no shape memory (Gold and CM).

Even though it was important to simulate the clinical conditions in a laboratory environment in the present study, especially in the studies on examining the mechanical properties of teeth, many external factors such as storing the teeth after extraction and until the sectioning procedure affected the results of study (Bürklein et al. 2013). For this reason, as stated by Coelho et al. (2016b) in their study, the use of teeth extracted using periodontal reasons, which require very low level of force during extraction, and the careful storage of these teeth until the sectioning procedures would allow for more successful outcomes. Another limitation of present study is the difficulty of standardisation of apical pressure applied by the operator during root canal shaping procedure and that this may influence the results.

Conclusion

Within the limitations of the present study, no statistically significant difference was found among the HEDM, WOG, PTG and the control group in terms of the total number of dentinal defects.

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Thoroughly irrigating the entire root canal system—including isthmi and lateral canals—is important for success of endodontic treatment. Research has shown that sonic activation of irrigants offers significant improvement in cleaning efficacy, since it removes considerably more debris and smear layer than needle irrigation. Besides cleaner root canals, it increases the effectiveness of disinfectant solutions to support long-term success. We spoke with leading Italian endodontist Dr Vittorio Franco about his daily irrigation protocol, passion for endodontics and experience with EDDY, a sonic-powered irrigation tip.

What do you like most about endodontics?

Nothing is clearly visible in endodontics, so one has to constantly adapt one’s strategy. In the end, one must discover the anatomy, understand the difference between one’s imagination and reality, and find a good treatment solution. Many recent dental studies have confirmed the importance of retaining the natural dentition and thus of endodontics as opposed to implantology. Now is the right time to be an endodontist. We now have more possibilities for preserving natural teeth and that is a wonderful thing.

Why is proper rinsing so important, and how can one see when the canal has been cleaned properly?

I think that the cleaning of the canal is the most important aspect of an endodontic procedure. Of the three major steps, shaping and obturation are less important than eliminating bacteria from the root canal. The main purpose of endodontic treatment is to clean the canal. Otherwise, root canals can become a good environment for bacteria to grow in. If the dentist retains vital tissue that will then become necrotic, it will facilitate bacterial growth. The main reason for retreatment is the presence of an infection due to poor cleaning in the first place.

There are many published studies on the time required for proper irrigation. We have many variables to consider—contact time, refreshment of the solution, amount of tissue/bacteria, volume, temperature, shear stress and so on—so we cannot standardise this process and final result. There are studies that say one needs 30 minutes to achieve the complete elimination of bacteria, but they did not consider activation possibilities. If you ask me how I decide when irrigation has been sufficient, from my point of view, the only clinical way to determine whether the irrigating solution is working is from seeing bubbles in the solution. That means that the solution is reacting with something inside the root canal system—obviously if there is no communication like a large foramen or perforation.

“If bubbles stop being produced, the clinician can stop cleaning the canal because the sodium hypochlorite is probably no longer reacting.”

If bubbles stop being produced, the clinician can stop cleaning the canal because the sodium hypochlorite is probably no longer reacting. There may still be something inside the canal, but the solution has achieved its best result. That would be my only suggestion.

What is your irrigation protocol?

I start with 5 per cent sodium hypochlorite, which I use for the entire shaping procedure. At the end, I use 17 per cent EDTA, activate it and remove it quickly. Then I use sodium hypochlorite again and activate it up to four times depending on the case. For necrotic cases, I wait until I see the reaction of the irritant and the substrate. After removal of the sodium hypochlorite...
chlorite, I use 95 per cent ethanol to dry the canal. I do not use citric acid and chlorhexidine, but prefer EDTA to remove the smear layer.

**How did you activate the irrigant before you began using EDDY?**

I tried all activation tools before EDDY, as irrigation activation has been one of my favourite methods ever since I was introduced to it. Before EDDY, I used passive ultrasonic activation and still use it sometimes in my Italian practice. Now, I use EDDY for most of my cases.

**How important is it to have a flexible tip?**

EDDY is quite different from passive ultrasonic tips. With EDDY, one can combine two different things. First, one has an activation protocol that some studies have shown is at least as good as passive ultrasonic activation. Second, one has a gentle mechanical action on the canal walls. This is why I love EDDY. One can work on the wall and the shear stress seems to be impressive when using it. It is also very safe.

**What do you think about the polyamide material from which EDDY is made?**

It works very well. It is a very good material for working after shaping, as one cannot damage the canal wall. Also, the possibility of tip fracture is low if one works inside the canal.

**How did you learn about EDDY?**

I tried everything in terms of activation. The manufacturer asked me to test it before its impending launch in Italy and I was happy to do so. At first, I tried it with great care—and it instantly proved to be effective. I inspected the walls of the canal and was impressed by the level of the cleanliness of the walls.

With EDDY, one can work in all canals, and sometimes I like to work only with the tip in large and wide canals. I do not use a shaping instrument, but just one file for length determination and then continue with EDDY. One can also remove debris and the smear layer easily by activating the solution through the device. Every dentist will appreciate how EDDY works under the microscope.

**How does EDDY work, and how long does the activation need?**

I use EDDY in the same way as passive ultrasonic irrigation, applying three to four cycles of 30 seconds for each canal. I help the EDTA to contact the dental surface with EDDY for 15–20 seconds. After this, I activate every sodium hypochlorite rinse for 30 seconds. The number of cycles depends on the kind of canal. If I think that there is some necrotic tissue or a complicated anatomy, I use more than three cycles. If it is an easy case, I still use three cycles of activation.

**Would you recommend EDDY?**

Absolutely. It is a great solution, being inexpensive, easy to use and effective. One can effectively promote the contact of the irrigant with the dental tissue. This is one of the main ways in which the irrigating solution should work. One can achieve a very impressive shear stress so that is one of the best ways to activate the solution and clean the canal.

EDDY requires an air scaler. Should this be an obstacle to making the switch to this device?

Honestly, buying an air scaler is not a high-cost investment. As a general practitioner, one can use an air scaler for a number of applications, including prophylaxis, endodontics, periodontics and minimally invasive therapy. Personally, I use it for bone surgery. It is not as expensive as a piezoelectric surgery unit or a laser. I think that the cost benefits of EDDY and an air scaler are fantastic.

Thank you very much for the interview.
Irrigating the root canal: A case report

Author: Dr Vittorio Franco, UK and Italy

The patient reported on in this article is a student in dentistry and his parents are both dentists. They referred their son to a good endodontist, who then referred the case to me. As always, peers are more than welcome in either of my practices, in Rome and London, so when I treated this case, I had three dentists watching me, a future dentist on the chair, placing a great deal of pressure on me.

The 22-year-old male patient had a history of trauma to his maxillary incisors and arrived at my practice with symptoms related to tooth #21. The tooth, opened in an emergency by the patient’s mother, was tender when prodded, with a moderate level of sensitivity on the respective buccal gingiva. Sensitivity tests were negative for the other central incisor (tooth #12 was positive), and a periapical radiograph showed radiolucency in the periapical areas of both of the central incisors. The apices of these teeth were quite wide and the length of teeth appeared to exceed 25 mm.

My treatment plan was as follows: root canal therapy with two apical plugs with a calcium silicate-based bioactive cement. The patient provided his consent for the treatment of the affected tooth and asked to have the other treated in a subsequent visit.

After isolating with a rubber dam, I removed the temporary filling, and then the entire pulp chamber roof with a low-speed round drill. The working length was immediately evaluated using an electronic apex locator and a 31 mm K-type file. The working length was determined to be 28 mm.

As can be seen in the photographs, the canal was actually quite wide, so I decided to only use an irrigating solution and not a shaping instrument. Root canals are usually shaped so that there will be enough space for proper irrigation and a proper shape for obturation. This usually means giving these canals a tapered shape to ensure good control when obturating. With open apices, a conical shape is not needed, and often there is enough space for placing the irrigating solution deep and close to the apex.
I decided to use only some syringes containing 5 per cent sodium hypochlorite and EDDY, a sonic tip produced by VDW, for delivery of the cleaning solution and to promote turbulence in the endodontic space and shear stress on the canal walls in order to remove the necrotic tissue faster and more effectively. After a rinse with sodium hypochlorite, the sonic tip was moved to and from the working length of the canal for 30 seconds. This procedure was repeated until the sodium hypochlorite seemed to become ineffective, was clear and had no bubbles. I did not use EDTA, as no debris or smear layer was produced.

I suctioned the sodium hypochlorite, checked the working length with a paper point and then obturated the canal with a plug of bioactive cement. I then took a radiograph before obturating the rest of the canal with warm gutta-percha. I used a compomer as a temporary filling material.

The symptoms resolved, so I conducted the second treatment only after some months, when the tooth #11 became tender. Tooth #21 had healed. I performed the same procedure and obtained the same outcome (the four-month follow-up radiograph showed healing).

about

Dr Vittorio Franco is an endodontist who runs an endodontic referral practice in London and in Rome. An active member of the European Society of Endodontology, Franco is also the President-elect of the Italian Society of Endodontics.
Successful communication in your daily practice

Part I: Grumbling patients

Author: Dr Anna Maria Yiannikos, Germany & Cyprus

Imagine getting to your clinic every day and feeling confident that whatever happens to you, you will be able to resolve it. Resolve a problem easily—in a way that not only will you feel happy with yourself but also your patients and staff will stay loyal to you, because they will also be happy with the service and solutions you provide them!

You might be one of the best dentists in your area that has all the knowledge, the experience and the latest technology. But your clients do not see that, they might not understand it. Maybe they cannot see your expertise because of the way you are dealing and communicating with them; maybe your way of communication is not clear enough or not at the level that some of your clients desire!

This is my gift for you today: A whole new series of the most popular and challenging scenarios that might happen at your dental practice and how you will deal with them so that your patients will leave your practice with the feeling: “My dentist is THE BEST!”

How to deal with...grumbling patients?

Let’s start with the first script: How to deal with a patient that complains just for the sake of complaining? In the following, I will introduce to you 5 steps of how to deal with this problem successfully and peacefully.

How many times have we completed an excellent work or have we followed every step of the treatment protocol (for example whitening)? How many times have we informed our patient in detail regarding any discomfort that he or she might feel during a treatment?
But the patient still loves to grumble: “Doc, I feel…, the bleeding is excessive…, I have such sensitivity after the whitening…” and so on.

**5 steps for a successful communication**

Of course, in view of such a patient you might get upset, angry or frustrated; this is absolutely normal and an expected reaction. The important thing is to deal with your patients, to keep them and nothing else. Let’s investigate now the steps that we can apply to get a successful result.

**Step 1: Breath**

I know it’s hard to not get angry with grumbling patients, but let’s vision ourselves as the conductor of an orchestra: We are responsible to guide them all in the path that we desire.

**Step 2: Listen**

What is the real problem? Maybe the patient just wants to be listened at and pampered a little bit? Or she wants her ‘problem’ to be resolved by giving her something back (see Step 3). Of course, she has nothing to complain about, everything is normal and expected, but you will never say that to her!

**Step 3: Act accordingly**

Give your patient something so that she will feel that her problem is acknowledged and that it will be resolved immediately by you—her trusted doctor! This could be an advice like “Do not rinse for 6 hours”, or a prescription as “Use this cream, it will reduce the sensitivity”.

**Step 4: Follow-up**

Of course, it is a must to call her and check that she is all right some hours before she calls you (which might the same or the next day, it depends on the case).

**Step 5: Ask the right question!**

Do never ask her: “Is everything all right?” Why not? Just because of the fact that she will then start complaining again. Ask instead: “I just call to check that everything is ok!” By using this phrase you will not allow space or thought for more complains.

It is so simple!

Start using the described 5 steps each time that you have this ‘invisible problem’. At least, try it as an experiment and see if it works for you as well! Write me your comments or even add-ins. I will love to hear them!

In the next issue of laser magazine, I will present you the second part of this new series of communication concepts that will teach you with 5 simple steps how to shush the patients that have too many questions with courtesy and caring. Until then, remember that you are not only the dentist of your clinic, but also the manager and the leader. You can always send me your questions and request for more information and guidance at dba@yiannikosdental.com or via our website www.dbamastership.com. Looking forward to our next trip of business growth and educational development!

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When an idea turns into innovation

Author: Marc Chalupsky, DTI

Although the headquarters of COLTENE are in Switzerland, its endodontics plant is in southern Germany. At the factory, located in Langenau, a town between Stuttgart and Munich, 155 employees produce treatment auxiliaries and endodontic equipment in a fully automated and camera- and laser-controlled process. The German location houses an impressive logistics department thanks to the office’s central location. Dental Tribune was invited to learn more about the company’s endodontic products.

A now well-known expert in endodontics, Dr Barbara Müller has been responsible for the company’s endodontics business unit for over 20 years. She takes pride in the company’s achievements. Today, COLTENE is an international leader in the development and manufacture of dental consumables and solutions for a variety of applications. The company operates worldwide, with subsidiaries and distributors in over 120 countries. With the 1990 introduction of the ParaPost X System, COLTENE came to be known as a provider of endodontic solutions. This position has been further entrenched in recent years as the company’s portfolio of endodontic products has continued to grow.

An impressive endodontic range

The CanalPro line, for example, features a cordless endodontic motor, a fully automated electronic apex locator and a variety of rinsing...
solutions, which are colour-coded for procedural safety. ROEKO and HYGENIC paper points are sterile and highly absorbent, and being non-adhesive, allow for reliable and easy drying of the root canal. Fast and safe obturation can be conducted with GuttaFlow bioseal, a bioactive three-in-one obturation material that combines cold free-flow gutta-percha with a sealer and bioceramic in one outstanding filling system and with HYGENIC and ROEKO Guttapercha points. Recent studies have evaluated the in vitro toxicity of endodontic sealers such as GuttaFlow bioseal and GuttaFlow 2, as well as Angelus’s MTA–FILLAPEX and Dentsply Sirona’s AH Plus, on stem cells from the periodontal ligament. It was found that especially GuttaFlow bioseal and also GuttaFlow 2 showed lower toxicity levels and higher cell viabilities than the competing sealers did. In addition, GuttaFlow 2 demonstrated a better result in terms of microleakage and sealing ability than the competing sealers did.

COLTENE’s HyFlex instrument, probably its best-known product, has set a new benchmark for NiTi rotary files. HyFlex EDM, the latest generation, integrates the controlled memory effect of its predecessor, HyFlex CM. Furthermore, owing to an innovative manufacturing process using electrical discharge machining, HyFlex EDM has a specially hardened surface that makes the files stronger and more fracture-resistant. The controlled memory of both HyFlex CM and HyFlex EDM gives the instruments a number of important properties, including extreme flexibility, superior canal tracking, regeneration after repeat autoclaving and strong fatigue resistance.

To achieve these characteristics, HyFlex CM and HyFlex EDM are manufactured using a special thermomechanical process whereby the crystallographic phase transition from austenite to martensite at room temperature results in an advanced controlled memory of the material, making both files extremely flexible. “We successfully managed to give our NiTi material shape memory properties,” said Müller. “We did this by changing the DNA of the material through a switch from low to room temperature. Our idea became not only an innovation, but a product many of our competitors have tried unsuccessfully to copy.” Introduced at the International Dental Show in Germany two years ago, the new HyFlex EDM reduces the number of files needed to two to three, particularly in straight and larger canals.

Fig. 3: Participants from Malaysia, the Philippines, and Taiwan listened to the product presentation such as the CanalPro cordless handpieces. Fig. 4: Participants were able to work with the complete COLTENE Endodontics portfolio, such as the CanalPro motors, CanalPro irrigation solutions, and HyFlex instruments. Fig. 5: Dr Margaret Tiu, Faculty Member (Assistant Professor A1), University of the East, College of Dentistry, Philippines and Past President (2008–2010) of the Endodontic Society of the Philippines (ESP).

Fig. 6: Dr Margaret Tiu presented a mandibular first molar case with four canals. She used a combination of HyFlex CM and HyFlex EDM to properly shape the canals.
Proven clinical experience

According to Müller, a number of clinical studies have demonstrated the efficacy of both systems. For example, Goo et al. compared the bending stiffness, cyclic fatigue and torsional fracture resistance of NiTi rotary instruments, including V-Taper 2, V-Taper 2H (both SS White), HyFlex CM, HyFlex EDM and ProTaper Next X2 (Dentsply Sirona). HyFlex EDM showed the highest cyclic fatigue resistance of the group, with V-Taper 2H and HyFlex CM coming in next. Overall, they showed high torsional resistance. In comparison with HyFlex CM, the EDM version demonstrated a higher fracture resistance.

In another study, Kaval et al. aimed to evaluate these properties in novel NiTi rotary files, including HyFlex EDM OneFile from COLTENE, ProTaper Gold and ProTaper Universal (both Dentsply Sirona). The results showed that HyFlex EDM OneFile demonstrated significantly higher cyclic fatigue resistance and higher distortion angle to fracture, but a lower torsional resistance than both ProTaper options. In addition, Pedulla et al. sought to measure the torsional and cyclic fatigue resistance of HyFlex EDM OneFile in comparison with VDW’s RECIPROC R25 and Dentsply Sirona’s WaveOne Primary. HyFlex was found to have a significantly higher cyclic fatigue resistance and higher angular rotation to fracture.

Furthermore, Lacono et al. aimed to measure the wear of HyFlex EDM after clinical application. No fractures were registered, no wear or degradation was reported, and the increased fatigue resistance of HyFlex EDM (compared with HyFlex CM) allowed it to remain usable for longer when shaping severely curved canals.

A case from the Philippines

Dr Margaret Tiu, a clinician based in the Philippines, agrees that the increased fatigue resistance and strong flexibility of both HyFlex systems allowed her to manage an S-shaped case more easily. At a recent COLTENE Train the Trainer event (Fig. 6), she presented a mandibular first molar case with four canals that was referred to her by another dentist (Fig. 7) who could not negotiate the canal owing to its difficult anatomy (Fig. 8). After utilising the crown-down technique and the HyFlex CM files to flare the coronal third of the distobuccal and distolingual canals, Tiu then continued to use HyFlex EDM to negotiate the mesiobuccal and mesiolingual canals, as she had discovered a slight curvature in the middle third of the canals. As for the S-shaped distobuccal and distolingual canal, she continued with the HyFlex CM files. Post obturation radiograph showed properly shaped canals with proper healing (Fig. 9)._

Dental Tribune Asia Pacific will publish another background article on the Train the Trainer event, with cases from the Philippines and Taiwan, as well as other studies on GuttaFlow.

References

Fig. 7 Fig. 8 Fig. 9
New apex locator from FKG Dentaire

The apex locator S-Apex by FKG Dentaire SA combines design and precision in a compact format: Measuring 6 cm x 11 cm x 6 cm, the S-Apex takes up little place, fits every hand and can be stored on any instrument tray.

The S-Apex meets all the criteria of the latest generation apex locator, especially as it works according to the proven ratio technique. This involves measuring the impedances of two frequencies (400 Hz and 8 kHz) to provide an absolutely precise length measurement. Blood, electrolytes or other substances do not impair its reliability. It is not necessary to set the device on zero before each measurement; the automatic calibration eliminates the effect of such sources of disturbance as temperature changes inside the canal.

The practitioner is informed during the measurements of the exact file position at every point in the root canal. The deeper the file penetrates into the canal, the more bars appear on the large LCD display. In the apical region, the colour of the bars changes from blue to green—an indication to the practitioner that the critical region has been reached. In addition, an audible signal can also be activated.

For enhanced safety the practitioner can mark the important points of the root canal treatment on the display: The “flash” bar is set in the region of the apex; it acts as a reference point for measuring or enlarging the root canal. The “memory” bar marks such points as the start of a sharp bend or shows at which point a change in the file size becomes necessary.

www.fkg.ch

eq-v: Your choice for continuous wave obturation

Meta Biomed has now established its European headquarters in Mülheim/Ruhr in Germany and, with the move, the Korean medical technology company is aiming at increasing its presence throughout Europe. Meta Biomed has a deserved reputation of being one of the dental industry’s primary innovators, as the company’s focus on research and development has achieved continual breakthroughs in the quality and performance of its medical devices and biomaterials. The focus of improvement through innovation continues with the launch of Meta Biomed’s new EQ-V endodontic obturation system, which promises to deliver reliable, convenient and precise root canal obturation.

The decision to base Meta Biomed in Mülheim has been warmly welcomed by local economic development company Mülheim/Ruhr & Business and state-owned economic development agency NRW.INVEST, both of which have supported Meta Biomed throughout the expansion process. As a company with more than 1,000 employees worldwide, establishing itself in Germany is recognition of the “made in Germany” label as an international signifier of high quality. This emphasis on providing exceptional products reflects the company’s own corporate ethos.

Meta Biomed’s EQ-V is a brand-new system that offers a revolutionary and convenient option for continuous wave obturation. With the user in mind, both the EQ-V Pack and Fill are lightweight and ergonomically designed to allow for comfortable handling. Each is protected with chemically proven housing material and offers outstanding heating performance, as the fill needs just 35 seconds to reach a temperature of 200 °C. A highly efficient and replaceable lithium battery ensures that the EQ-V has an extended battery time, making it ideal for longer and more complicated procedures. The device’s unique 360° rotating cartridge provides dental professionals with unparalleled access and precision, and comes with the added benefit of being easily replaceable and disposable. All in all, the EQ-V is a product that embodies Meta Biomed’s commitment to providing low-cost, high-quality solutions for everyday dental procedures.

Meta Biomed is inviting dental professionals to join the company at the 2017 International Dental Show, to be held in Cologne in Germany, from 21 to 25 March. There is a great level of excitement at Meta Biomed about showcasing its industry-leading endodontic products to such a large audience. “We will be located at Booth B060 in Hall 11.1 and are looking forward to meeting our customers and answering any questions they may have,” said Ian Yun, Managing Director at Meta Biomed.

http://www.meta-biomed.com/eng/
Proven: EDDY rinses every canal safely and effectively

More than two years’ experience in everyday practice and study results have proven that the EDDY sonic-activated irrigation tip by VDW cleans even severely curved root canals safely and effectively.

VDW presented the sonic-activated EDDY irrigation tip in 2015 as a solution to the limitations of ultrasonic activation and manual irrigation. The tip, which is made of a soft polyamide, oscillates at an optimum frequency of 5,000–6,000 Hz. This activates the disinfectant solution and produces acoustic streaming and cavitation effects, thereby achieving effective cleansing of the entire canal system. The polyamide tip, softer than dentine and particularly gentle, enables efficient chemical disinfection of side canals, apical ramifications and isthmi owing to oscillating 3-D movements. The flexible tip adapts itself to every canal anatomy without the risk of creating ledges or perforation. Another advantage is that, during the preparation, EDDY requires only a maximum of 30 seconds per rinse interval—a considerable saving of time and increased efficiency compared with manual irrigation with cannulas.

Study results prove long-term treatment success
Several studies (e.g. Neuhaus et al., Urban et al.) compared the irrigation performance of EDDY with other methods and found that EDDY produces outstanding results: EDDY removed bacterial biofilm in complex root canal anatominies just as effectively as passive ultrasonic irrigation did. In addition, the soft and flexible polyamide tip was gentler on the root canal wall. Both sonic-activated and ultrasonic-activated irrigation strengthened the tissue dissolution capacity of the irrigants used equally. Finally, EDDY removed calcium hydroxide deposits and debris more effectively and thus prove to be significantly superior to manual irrigation.

Being a single-use tip of universal size, EDDY can be integrated easily and efficiently into everyday practice. The tip is compatible with most standard air scalers, avoiding the need for further investment and thus facilitating changeover.

A list of references can be obtained from the company.
For more information, please visit https://www.vdw-dental.com/en/products/detail/eddy/

Rooter S—new cordless endodontic motor

FKG Dentaire SA presents its new Rooter S endodontic motor. The outstanding feature of this new instrument is its ability to be used both on its own and in combination with the new apex locator from FKG, the S-Apex. Rooter S also has completely functions which guarantee greater safety for the user. Convincing functions in practice With its modular capabilities, the new endodontic motor from FKG provides users with maximum possible flexibility during treatment. The elegant endodontic motor only weighs 103 grams and guarantees application without any signs of fatigue. In addition, the angle piece can be turned through 290° to ensure optimum visibility in all quadrants. This is assisted above all in the molar sector by the extremely small head, which has an integrated electrode file. With speeds from 50 to 1,000 rpm, users have the choice of eleven different speed settings to suit their individual needs. The user can adjust all functions by push-button and store the settings at six storage locations. The easy-to-read colour display shows all the relevant information and settings and can be turned through 180° for left-handed users. Acoustic signals further assist root canal preparation as the user does not have to keep looking at the instrument’s display.

The Rooter S and S-Apex combination
Rooter S combines with S-Apex offers an additional safety function: “Auto Apical Slow Down” reduces the rotational speed automatically as soon as the file tip approaches the reference point. This means that the instrument can guarantee the highest possible safety for both user and patient because it prevents the critical point in the apical area from being exceeded.

S-Apex carries out an exact length measurement during treatment so that the user can prepare the root canal safely. This is particularly important in order to prevent any later complications. The Rooter S can also be connected to the apex locator by data transfer cable in order to provide additional functions such as “Auto Start and Stop” or automatic stop as soon as the file has reached the reference point (“Auto Apical Stop”).

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Rooted in the heart of Europe:
Endodontic community gathers in Brussels

By DTI

The 18th Biennial Congress of the European Society of Endodontology (ESE) took place from 14 to 16 September at SQUARE—Brussels Meeting Centre. This year’s meeting was hosted by the Belgian Association for Endodontology and Traumatology and the Flemish Society for Endodontology. According to the organisers, over 2,000 endodontic specialists from all over the world participated in the event.

Held under the theme “Rooted in the heart of Europe”, the congress was aimed at the entire dental team. The scientific programme included four parallel sessions with lectures by world-leading speakers covering many different fields of dentistry, as well as poster presentations in various categories. Highlights were papers on endodontic biofilm; new treatment techniques, such as the preservation of the pulp tissue; root canal disinfection; and age- and general health-related topics. The event was preceded by pre-congress workshops hosted by the congress sponsors, in which a range of topics, such as shaping canals, ideal root...
canal therapy and laser-activated irrigation, were addressed.

According to head of the local organising committee Prof. Roeland de Moor, the committee tried to design a programme in which there were speakers addressing a wide range of fields and updating attendees on the pertinent topics regarding recent research, developments and new technologies. He particularly highlighted papers on endodontics in paediatric dentistry. "There are a number of speakers focusing on young patients and their problems, not just root canal therapy alone," he said during the event.

A trade exhibition, spanning a space of about 2,000 m², was held parallel to the scientific programme and displayed the latest equipment, instruments and materials for use in endodontics. Among the main sponsors were Dentsply Sirona (diamond), VDW (gold) and KaVo Kerr (silver).

Established in 1983, the European Society of Endodontology was formed to enhance the development of endodontology for the benefit of patients, endodontists and general dentists and to represent the specialty throughout Europe. Today, the society represents more than 6000 ordinary and over 230 certified members from 34 member societies and 31 European countries.

The ESE traditionally holds its congresses every other year in one of the countries represented by its full-member societies. The next ESE Biennial Congress will take place in Vienna in Austria from 12 to 14 September 2019.
ROOTS SUMMIT announces programme for 2018 event

By DTI

The programme for the next ROOTS SUMMIT, the premier global discussion forum dedicated to endodontic dentistry, has just been released and is available online. The event, featuring lectures by prominent industry professionals like Dr Stephen Buchanan, will be held at the European School of Management and Technology in Berlin from 28 June to 1 July 2018.

In addition to Buchanan’s presentation, ROOTS SUMMIT 2018 will feature speakers such as Dr Frederic Barnett, giving a lecture titled “Luxation injuries and root resorption: Management and long-term prognosis”. Furthermore, Drs Jenner Arqueta, Jorge Vera and Josette Camilleri and many more will be addressing current topics relevant to the world of endodontics. Twelve lectures have been scheduled in total and will stretch over the three days of the summit.

There will also be the opportunity to attend hands-on workshops, speak to industry professionals on-site and engage with new equipment, procedures and protocols in endodontic dentistry. A number of dental companies specialising in endodontics, including META BIOMED, FKG Dentaire and Dental Engineering Laboratories, have already confirmed their participation. Approximately 500 visitors are expected at next year’s ROOTS SUMMIT, which is again being organised in collaboration with Dental Tribune International.

More information about the 2018 ROOTS SUMMIT and a registration form are available at www.roots-summit.com. An early bird discount is on offer until 18 September 2017. Dental professionals are invited to like the ROOTS SUMMIT Facebook page.
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Article lengths can vary greatly—from 1,500 to 5,500 words—depending on the subject matter. Our approach is that if you need more or less words to do the topic justice, then please make the article as long or as short as necessary.

We can run an unusually long article in multiple parts, but this usually entails a topic for which each part can stand alone because it contains so much information.

In short, we do not want to limit you in terms of article length, so please use the word count above as a general guideline and if you have specific questions, please do not hesitate to contact us.

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Questions?

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The 11th International Federation of Endodontic Associations

IFEA World Endodontic Congress

2018 Seoul

October 4th - 7th, 2018 Coex, Seoul, Korea

Endodontics: The Utmost Values in Dentistry

Title | The IFEA 11th World Endodontic Congress / IFEA WEC 2018 Seoul
Date | Oct. 4th (Thu) – 7th (Sun), 2018
Venue | COEX, Seoul, Korea
Theme | Endodontics: The Utmost Values in Dentistry
Hosted by | IFEA (International Federation of Endodontic Associations)
Organized by | KAE (The Korean Academy of Endodontics)
Official Language | English
Website | www.ifea2018korea.com
facebook | www.facebook.com/ifea2018seoul

Confirmed Speakers (As of July, 2017)

Paul Abbott
Australia

Filippo Cardinali
Italy

Gustavo De-Deus
Brazil

Samuel Dorn
USA

Gianluca Gambarini
Italy

Nick Grande
Italy

Mo K. Kang
USA

Syngcuk Kim
USA

Sergio Kuttler
USA

Zvi Metzger
Israel

Ove Peters
USA

Gianluca Plotino
Italy

Clifford J. Ruddle
USA

Frank Setzer
USA

Hagay Shemesh
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Yoshi Terauchi
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Ghassan Yared
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*More speakers will be announced later
*Last names in alphabetical order
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