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roots

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Magda Wojtkiewicz

Managing Editor

While taking care of others, you should remember to take care of yourself

Self-care is one of those things that is essential, but we often do not take enough time for it, or feel that we do not have enough time or knowledge. However, taking care of yourself—your body, health and mental well-being—is most important not only in order to feel better but also in order to perform better in the long run and to be able to help others better.

Back pain is one of the most common problems among dental professionals. The results of a study conducted in 2015 showed a 70.0% incidence of back pain among dentists, lower back pain predominating in 47.6% of cases.[1] Such findings demonstrate a high prevalence of lower back pain among dental professionals.

Unfortunately, the importance of ergonomic working posture is usually not the focus of dental students and young practitioners. Dr Ali Nankali in his article "Back pain—a clinician's nightmare" (page 42) emphasises that many young clinicians are aware of their incorrect posture and positioning, yet they do not know how to correct it: "The lack of confidence does not allow them to challenge their habits on their own, and so they often seek help" and "Many dentists who do not know how to manage back pain try to work in a standing or a different sitting position, which, unfortunately, is reported to lead to more intense pain, especially in the upper and lower back areas".

Another study, conducted by Swedish researchers between 2012 and 2014, concluded that "understanding the relationship between working conditions and well-being is crucial to being able to design specific interventions for oral healthcare providers which will improve their working conditions and health".[2] The lead author of the study, Dr Charlotte Wåhlin from Linköping University, recommends that dental professionals use ergonomic exercises in the daily practice to prevent work-related disorders.

Undeniably, offering high-quality treatment to patients should be the focus of every dental professional, but it should never come at the expense of their health or well-being. Therefore, striking a balance between self-care, including correct working posture, atmosphere at work, and physical and mental health, and professional performance is crucial for obtaining the best results in the long term.

Magda Wojtkiewicz
Managing Editor

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CanalPro™ Jeni

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NEW

The revolutionary CanalPro Jeni in a nutshell! Watch now!
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Slow down everyone—dentistry does not need to be done at speed

Part 2: The cornerstones of Slow Dentistry are beneficial for every dentist

An interview with Prof. Katalin Nagy, honorary global Ambassador for Slow Dentistry, Hungary

By Monique Mehler, Dental Tribune International

These days, there is a growing emphasis on quality over quantity, that is, preferring an object or service that is worthwhile rather than a quick and easy fix. As Dr Miguel Stanley explained in Part 1 of this series (roots **magazine** *1/21*) this is what Slow Dentistry—a more patient-oriented and wholesome approach to dentistry—is built on. It also seeks to bring the focus in dental care back to clinical excellence rather than single-minded emphasis on profit. In this interview, Slow Dentistry Honorary Global Ambassador for Hungary Prof. Katalin Nagy speaks about why dental practice makes different demands in the twenty-first century.

Prof. Nagy, Slow Dentistry has come a long way. How did you observe the process?
Besides my academic career, I have been practising as a dentist for more than 40 years. I clearly remember that, at the very beginning when I opened my private office in Hungary, people used to measure the success of a dentist according to the number of patients who were queueing up in the waiting room. Then again, if a dentist could treat them in a very short time, he or she was considered a very good dentist. I know that it was almost half a century ago, but I still remember that, and it was obvious that we had a very long way to go. You can imagine the changes that have happened in my country since then, changes that were even more evident when SARS-CoV-2 began spreading everywhere in the world, but the changes started before that.

Is Slow Dentistry only important when it comes to specialties like endodontics or oral surgery, for example, or would any general dental practitioner benefit from this approach?
I would emphasise that the cornerstones of Slow Dentistry are beneficial for every single dentist, as well as dental hygienists and dental assistants. These cornerstones not only describe the rights of patients, but also help dental professionals to be able to maintain long-lasting quality work in a safe environment, which will elevate the standard of their private practice and boost their businesses probably more than advertising—what they have been paying for over the years.

The necessary time for patient appointments is vital for successful treatment, well-being, understanding and safety. Do you think patients realise that they have this power?
I think that, most of the time, patients in my country are still not completely aware of their rights. Sometimes, they choose a dentist according to the interior design of their dental offices (which I also find important) as an inaccurate measure of the quality of treatment.

Ten years ago, after spending a long time in dental schools, also overseas, I introduced a subject into the dental undergraduate curriculum called communication in dentistry. Communication needs not only skills but also time for patients and professionals. The idea of Slow Dentistry has helped me to reinforce this initiative of teaching communication in dental schools, which allows

What is Slow Dentistry® about?

Slow Dentistry brings to light that all the extra time a doctor spends with a patient is time dedicated to understanding underlying health issues, to reaching an accurate diagnosis, to planning the best treatment, to spot-on execution, to less stress, to better and safer dentistry.

us to have the necessary and appropriate discussion before and throughout the treatment procedure.

Currently, you are the Slow Dentistry honorary global ambassador for Hungary. How did that come about, and what do you aim to accomplish through this role?
If you consider where Hungary started half a century ago, you would understand the great importance of this role. Also, dental tourism is very popular in our country. Patients arrive from another country for full-mouth dental treatment and typically remain for seven to ten days. I am very sceptical about the quality of the long-term success of those treatments.

I would like to introduce a collaboration between Slow Dentistry and the Hungarian Dental Association through which we could grant the Slow Dentistry badge to those dental offices which are working strictly according to Slow Dentistry's principles. It could be a great help for both Hungarian and foreign patients in choosing their dentist in order to receive quality treatment in the safest environment.

Dr Miguel Stanley, who founded Slow Dentistry and wrote in Part 1 of this series that "The general public currently has no idea of their rights at a dental appointment." What is your take on this?
Throughout my career, I have been able to work in different countries. Dental education has always been famed in our country, and there is a high percentage of practical learning opportunities for our students. After graduation, practitioners tend to forget what they learned about quality and safety and how to apply this. Slow Dentistry summarises and structures those most important rules

"Communication needs not only skills but also time for patients and professionals."

that we have learned over the years and which every single dental professional can follow.

I am also hoping that, after easing of COVID-19 lockdown restrictions, we as Hungarian dental professionals can invite Dr Stanley to a meeting to convey these extremely important messages of Slow Dentistry to our audience, because I believe that a personal discussion with Dr Stanley, who has amazing communication talents, always gives a unique and irreplaceable boost.

Editorial note: Visit www.slowdentistry.com for more details.

about

Prof. Katalin Nagy has received university training and specialty qualifications in oral surgery, prosthodontics and implantology. Her main field of research is oral cancer. Prof. Nagy is currently adviser to the Hungarian health minister on dental issues, being president of the Hungarian Dental Association, and she is head of the Department of Oral Surgery at the University of Szeged, as well as the owner of two private dental offices in Szeged and Budapest in Hungary.

Comparative evaluation of the accuracy of the AirPex and DentaPort ZX apex locators in detecting working length: An *ex vivo* study

Dr Rosalba Diana, Dr Raffaella Castagnola, Dr Mauro Colangeli, Claudia Panzetta, Dr Luca Marigo, Dr Nicola Maria Grande, Dr Filippo Cardinali & Dr Gianluca Plotino, Italy

Introduction

During root canal therapy, shaping, cleaning and disinfection depend on accurate measurement of working length.[1] Incorrect evaluation of working length can compromise the clinical outcome of the root canal therapy.[2] The ideal end point of a root canal therapy has been debated by many authors.[3,4] Clinically, when canal preparation and filling are located within 2 mm from the radiographic apex, in the region of the apical constriction, a higher success rate of the root canal therapy is achieved.[5,6] However, the apical constriction, usually the narrowest part of the root canal, is not easy to detect.[7] Similarly, the cementodentinal junction, the transition between the pulpal and periodontal tissue, is considered the ideal end of a root canal therapy,[8,9] but it is variable and cannot be clinically detected.[4,7]

Radiography, the anatomical average length of teeth, tactile sensation and moisture of a paper point are different methods used to determine working length.[9] Radiography has been used for many years, but it has

the limitation of providing a 2D image of a 3D complex structure. The use of radiographs alone in working length determination led to over-instrumentation in 33% of molars and 56% of premolars.[10] The introduction of electronic apex locators (EALs) into clinical practice allowed, when used with appropriate radiographs, the determination of a more predictable and accurate working length,[11,12] and a substantially lower number of radiographs are necessary when using EALs, consequently reducing patient exposure to X-ray radiation.[13] Vieyra et al. showed that Root ZX located minor foramina 68% of the time in premolar and anterior teeth compared with radiographs, which did so 20% and 11% of the time in anterior and premolar teeth, respectively.[14]

In the last decades, different generations of EALs have been developed. Several studies have been conducted on different EALs to evaluate their accuracy under different conditions.[15–18] The DentaPort ZX (J. Morita) is a third-generation EAL based on dual frequencies (8 and 0.4 kHz), and it is considered the gold standard EAL to which any new device should be compared. Several *ex vivo*[19] and *in vivo*[20] studies have clearly demonstrated its precision. Among these studies, as an example, Connert et al. showed that, in a comparison of nine apex locators using micro-CT, the DentaPort ZX was the most accurate at detecting apical constrictions and major foramina, having an accuracy of 99% and 100%, within a tolerance of ± 0.5 mm or ± 1.0 mm, respectively.[15]

AirPex (Eighteeth, Changzhou Sifary Medical Technology) is a new wireless apex locator that is charged on a charging base. It weighs 15 g, and its dimensions are 4.8 × 2.8 × 1.6 cm. In the literature, no data is yet available on this EAL. Thus, the aim of the present *ex vivo* study was to compare the accuracy of the AirPex and the DentaPort ZX EALs in determining working length in extracted teeth.

Material and methods

In this study, 15 single-rooted teeth, extracted for periodontal or orthodontic reasons, were selected. The teeth were placed in a 5.25% sodium hypochlorite (NaOCl) solution for 2 hours in order to remove organic residue. The remaining tissue was removed from the external root surfaces using a periodontal scaling instrument. Finally, the teeth were stored in normal saline (0.9% sodium chloride) before testing.

To rule out previously treated root canals, open apices, resorbed roots, teeth with two canals or teeth filled with amalgam or composite, two digital radiographs in both buccolingual and mesiodistal projections were obtained. After standard access cavity preparation, the patency of the apical foramen was assessed with size 10 and 15 K-files (Dentsply Maillefer). Samples in which a size 20 K-file reached the apex were ruled out and substituted.

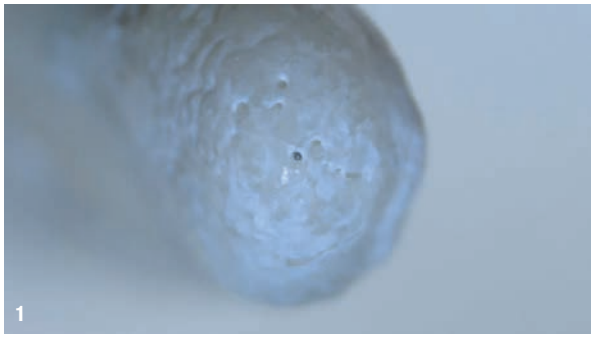

Fig. 1: Determination of the actual working length under a stereomicroscope at 20× magnification. As a particular detail, a grey spot shows the file on top of the major apical foramen.

The actual working length (AWL) was determined by introducing a size 10 K-file into the canal until its tip emerged in the apical foramen under 20× magnification using a stereomicroscope (Zeiss Axiophot, Carl Zeiss) linked to a digital camera (Moticam Pro SMP, Motic; Fig. 1). With the aim of reducing the risk of stopper movement, two silicone stoppers were positioned on the file. After the removal of the file, the distance between the stoppers and the file tip was measured to establish the AWL.

The roots of each tooth were immersed in a plastic box filled with alginate, leaving the most coronal 5 mm uncovered. Alginate was useful for obtaining an environment as analogous as possible to the oral one. The wire of the EAL was connected to the file inserted into the root canal, while the lip clip was immersed in the alginate.

AirPex (Fig. 2) and the DentaPort ZX (Fig. 3) were used according to the manufacturer's instructions. When the AirPex was used, a size 10 K-file was inserted gently until

Fig. 2: The AirPex apex locator. **Fig. 3:** The DentaPort ZX apex locator.

the red bar appeared on the device and then retracted until the apical position was reached (last green bar at the 0.0 mark). When the operator used the DentaPort ZX, a size 10 K-file was introduced through the root canal until the device showed a red line on the display, indicating that the apex had been reached. It was then removed to the last green line on the display.

Measurements were considered valid if the reading remained stable for at least 5 seconds. Each measurement was repeated three times for each tooth and each EAL, and in order to reduce bias, all measurements were taken by the same operator and repeated three times. All working lengths were measured on the file using a digital caliper, and the mean value was considered the result.

All measurements recorded were expressed as means and standard deviations. Positive values indicated measurements that extruded beyond the apical foramen, and negative values indicated measurements that were short of the apical foramen. The measurements were grouped according to the device used to obtain them. Differences between the electronic working length (EWL) and the AWL were paired, and statistical analysis was performed using one-way ANOVA and Tukey tests, a significant difference set at $P < 0.05$.

Results

When considering a margin of accuracy of ±0.5 mm, AirPex showed an accuracy of 84.5% and the DentaPort ZX showed an accuracy of 86.6%. Considering a margin of accuracy of ±1 mm, the two EALs showed an accuracy of 100%. The main difference between EWL and AWL was 0.09 ± 0.33 mm for AirPex and 0.08 ± 0.35 mm for the DentaPort ZX (Fig. 4). No statistically significant differences were found between AirPex and the DentaPort ZX ($P > 0.05$).

Discussion

The aim of this study was to compare *ex vivo* the accuracy of two EALs, AirPex and the DentaPort ZX. The accuracy of the two EALs was evaluated considering the major foramen more reproducible than the apical constriction.[21] Moreover, in the present study, as electronically measured canal length was influenced by the root canal diameter, single-rooted teeth with narrow root canals were selected, and a size 10 K-file was used to obtain AWL and EWL. In fact, Ebrahim et al. reported that, when the diameter of a root canal increased, electronic measurement with a small K-file become shorter[22] and that, in wide apical foramina, the EALs become more reliable at determining the working length of teeth if a tight-fit file was used.[23]

Alginate was used in the present study to simulate periodontal ligament and to ensure the best medium possible for testing the EALs *ex vivo*. Alginate as a substitute for periodontal ligament was investigated by Lipski et al., who showed a 100% rate of correct measurement.[24] On the contrary, gelatine, agar-agar, saline and flower sponge soaked in saline showed a rate of correct measurement of 96.7%, 76.7%, 73.4% and 63.4%, respectively.[25]

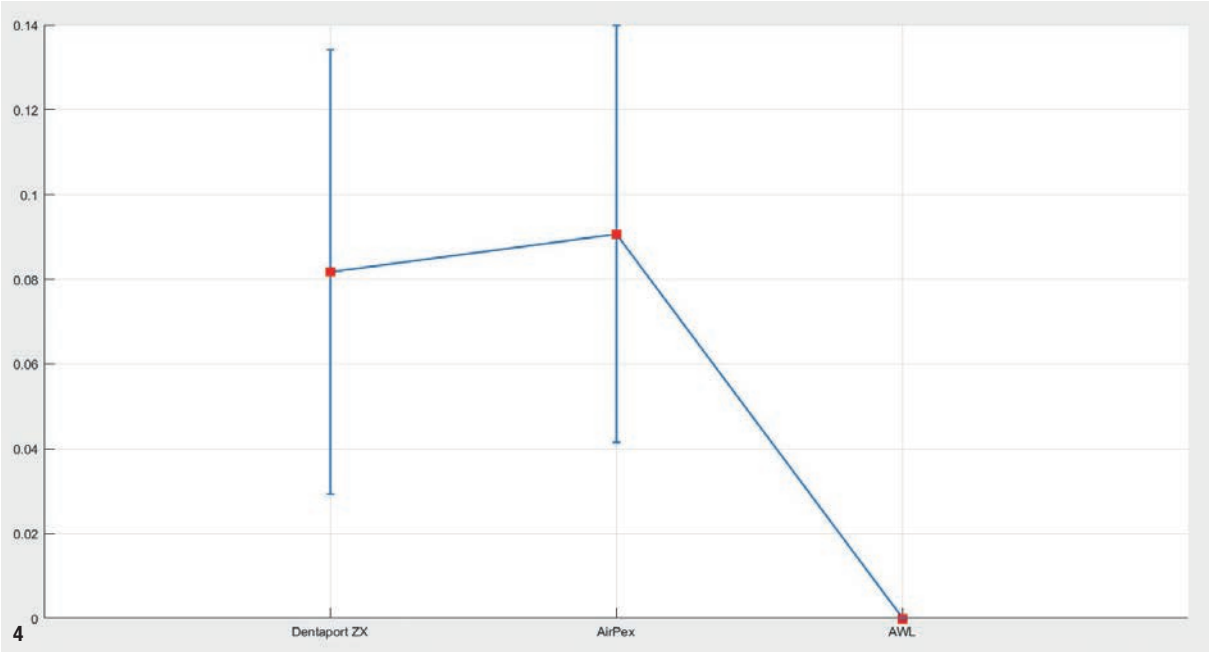

Fig. 4: Main difference and standard deviations between electronic working length and actual working length of AirPex and the DentaPort ZX and actual working length. AWL = actual working length.

The presence of irrigants inside root canals does not affect the accuracy of the majority of the latest generations of EALs.[26] Duran-Sindreu et al. compared *in vivo* the accuracy of Root ZX and iPex in determining working length in the presence of two different irrigant solutions.[27] They reported statistically significant differences between the two apex locators, but their accuracy was not affected by 2.5% NaOCl or 2.0% chlorhexidine.[27] Çınar and Üstün compared *in vivo* the accuracy of Propex Pixi, Root ZX mini and RAYPEX 5 using micro-CT.[29] They found no differences in determining working length measured in the presence of blood, pulp tissue or NaOCl.[28] Tsesis et al., in a systematic review and meta-analysis, concluded that the presence of vital or necrotic pulp has no effect on the precision of EALs.[29] In the present *ex vivo* study, conducted under normal conditions, the EWL measurements were very accurate for both AirPex and the DentaPort ZX.

The results of the present study are in agreement with previous *in vivo* and *in vitro* investigations. Saatchi et al., in an *in vivo* study, reported that the DentaPort ZX showed an accuracy to within ±0.5 mm of 93.8% in the presence of periapical periodontitis and of 93.3% in teeth with normal periapices.[30] Piasecki et al. showed *in vivo* that Root ZX II located the apical foramen accurately to within ±0.5 mm in 83% of the teeth with periapical periodontitis and in 100% of the vital teeth.[31] Stöber et al., under *in vivo* clinical conditions, measured a mean distance of 0.146 ± 0.430 mm from the AWL to the file tip and an accuracy to within ±0.5 mm of 72% and to within ±1.0 mm of 100%.[32] Silveira et al. reported an accuracy of Root ZX of 91.7% in detecting apical constrictions *in vivo*.[33] Comparing working length determination *in vivo* and *in vitro*, Duran-Sindreu et al. reported that Root ZX was accurate to ±0.5 mm 74% of the time *in vitro* and to ±0.5 mm 78.3% of the time *in vivo*.[34] Soares et al. evaluated Root ZX II in detecting major foramina and found an accuracy to 0.5 mm *in vivo* and *in vitro* of 70% and 70% of the time, respectively.[35] The differences in the results shown in these studies for the accuracy of DentaPort XZ could be explained by the different methods used to establish the AWL.

This is the first *ex vivo* study involving AirPex. No previous scientific literature has been published on this EAL. The data showed comparable results with the DentaPort ZX ($P > 0.05$).

Conclusion

In conclusion, AirPex and the DentaPort ZX were accurate in detecting working length, showed no statistically significant differences in accuracy and showed accuracy to within ± 0.5 mm.

Conflicts of interest
The authors declare that there are no conflicts of interest.

Acknowledgements
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Editorial note: A list of references is available from the publisher.

about

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Lane keeping assistance systems in endodontics

Dr Barbara Müller, Germany

A fully automatic navigation assistant for root canal therapy? What may initially sound like robodoc treatment or treatment by remote control will take endodontics a significant step forward on the way to sustainable, reliable preparation. Cases presented in this article illustrate how digital endodontic assistance systems will revolutionise everyday treatment in the future.

Fig. 1: Fully automated CanalPro Jeni endodontic motor.

Strictly speaking, an intelligent lane assistant of the type we are familiar with from road safety was a long overdue, logical progression in technical advancement of apex locators and so on. Whereas clinicians nowadays often assist machines in high-tech surgery, it is only logical that the digital co-pilot should be able to support the endodontic expert on his or her route to the apex, when the field of vision is limited and the anatomy is unclear.

While treating a strongly curved S-shaped root canal some time ago, Italian endodontic specialist Prof. Eugenio Pedullà came up with an idea that was as simple as it was captivating: the vision of autonomous driving could also make root canal preparation far safer and more efficient in dental practice as well. Lane departure warning, traffic jam alerts or cruise control, all useful features of modern mobility development, could just as easily be put to use for endodontic treatment. In collaboration with international dental specialist COLTENE, he then developed the appropriate prototype. Prof. Pedullà was so proud of the device, which has been available since 2020, that he even bestowed his nickname on the new endodontic motor, the “enchanting Jeni”, which finds its way independently through the root canal and adapts filing motion to the conditions prevailing in the respective root section within milliseconds (Fig. 1).

Moving steadily from the coronal to apical aspect

Using this innovative work aid for the first time requires a little bit of getting used to in the beginning. Traditionally, flexible nickel–titanium (NiTi) files are inserted gradually into the root canal in dabbing up and down motions. Up to now, tactile feedback has enabled the dentist to sense the course of the curvature and thus avoid misalignments or blockages that could lead to file breakage. With the innovative CanalPro Jeni endodontic motor, the user works continuously forwards, applying only slight pressure, while the digital co-pilot decides independently on the progress of motion. Complex algorithms control the variable filing motions. The computer’s reaction time is in the millisecond range and thus significantly faster than that of humans. Rotary motion, speed and torque have already been adjusted before the user even notices that he or she may have been applying too much pressure.

The experienced endodontic expert, in particular, may wonder whether the assistance of the endodontic motor can be trusted when used in the dental practice. However, a fully automatic endodontic motor is more precise than the conventional contra-angle handpiece alone. In the beginning, it takes a bit of courage to constantly push forwards and rely on the co-pilot to reduce the rotation speed or to let the file rotate backwards if the system detects resistance before noticing anything oneself. Furthermore, the new types of endodontic motors, such as CanalPro Jeni, also fully respect the classic rinsing protocol: an acoustic signal indicates when and how often rinsing should be performed between file changes. This consistent forward motion can ultimately save considerable time during preparation, especially in the case of complex anatomies. In such complicated root canal profiles, endodontic specialists can save between 10 and 30 minutes with Jeni, time that is important for extensive rinsing and disinfection.

Shaping according to the original anatomy

The benefits of modern endodontic assistance systems quickly become apparent, especially with regard to highly curved root canals, as illustrated by the following two patient cases. In Case 1, periapical periodontitis was diagnosed in tooth #37 after CBCT imaging in a patient aged approximately 50 years (Fig. 2). The mesial root canal entrances were difficult to identify because they contained well-adapted, tooth-coloured composite. The treating endodontic specialist, Dr Thomas Rieger from Memmingen in Germany, selected the appropriate sequence of flexible NiTi files

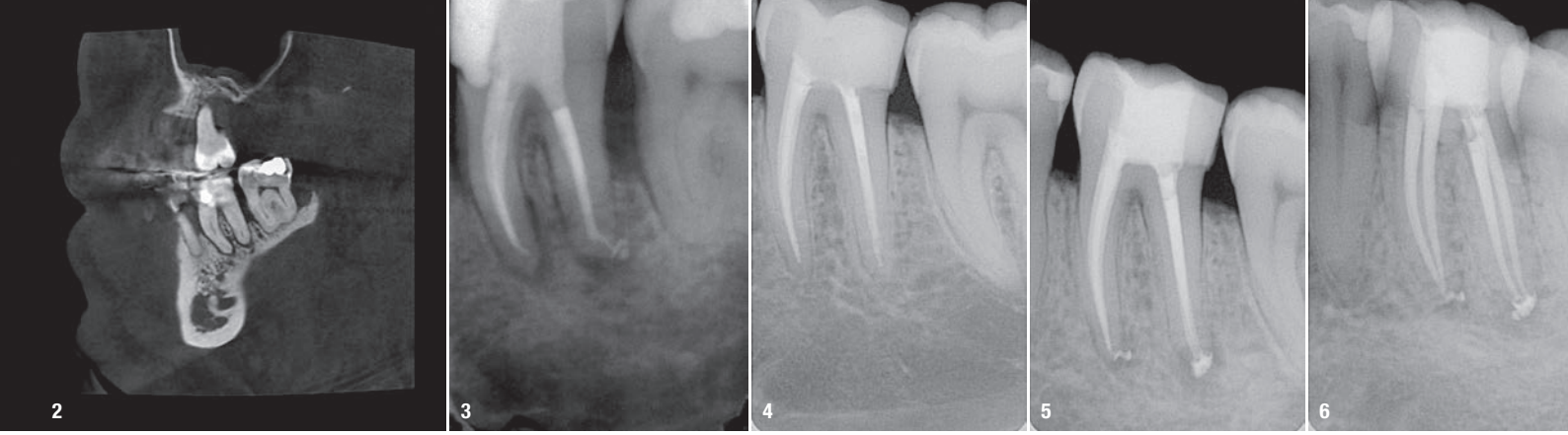


Fig. 2: Pre-op radiographic image of tooth #37 (Case 1). *(Image: © Dr Thomas Rieger)* **Fig. 3:** Post-op radiographic. *(Image: © Dr Thomas Rieger)* **Fig. 4:** Pre-op radiographic image of tooth #36 (Case 2). *(Image: © Dr Silviu Bondari)* **Figs. 5 & 6:** Post-op radiographic images. *(Image: © Dr Silviu Bondari)*

on Jeni's touch screen. The HyFlex CM or EDM and the MicroMega One Curve or 2Shape from COLTENE are already pre-installed in the software. In the latest update, the 30/.07 HyFlex and MicroMega Remover files were added, making a significant difference to an endodontic revision treatment. The new Remover files fit perfectly with the established file systems and quickly and reliably remove inadequate gutta-percha fillings as well as similar endodontic restorations that have become outdated. In the Doctor's Choice program, users can also store up to eight additional filing systems of their choice if they are familiar with the respective motion protocol.

In Case 1, the appropriate access was achieved with an orifice opener. The extreme curvature in the apical third presented a particular challenge during preparation. The following sequence was therefore used: the 10/.05 HyFlex EDM file was followed by the 20/.05, and the universal file 25/~ HyFlex EDM OneFile then performed most of the work in the mesial and distal root canals. The final sequence involved the 40/.05, 50/.03 and 60/.02 files in the distal root canals for final shaping. In this process, Jeni enabled rapid preparation despite the highly curved profile of the root canals. Each file virtually worked itself to its working length. The natural shaping of the root canals is clearly shown in the postoperative radiographic image (Fig. 3).

Frequent rinsing with efficient material removal

A revision treatment by Dr Silviu Bondari from Beuzeville in France also demonstrates that retreatment can be performed quickly and easily with the new endodontic motor. In a 30-year-old patient, removal of the insufficient gutta-percha filling also proved necessary owing to periapical periodontitis in tooth #36 (Fig. 4). At a speed of 1,000 rpm with continuous rotation, a delicate MicroMega Remover file was inserted to over two-thirds of the distal root canal length. The remainder of the root was then treated with a HyFlex EDM OneFile in the contra-angle handpiece at 500 rpm. HyFlex EDM files of size 20/.05 were used in the mesial root canals. The speed was also set at 500 rpm. The HyFlex EDM OneFile was then used in the mesial canals for final shaping of the root canal. A 40/.04 EDM file was used in the distal root canal. The result on the radiograph promised a more durable obturation than the initial treatment five years earlier (Figs. 5 & 6).

Thorough rinsing is recommended in endodontics, especially for the efficient removal of material, be it dentine or old filling material from a revision treatment. If too much material remains in the root canal, the file may block and, in the worst case, even break. At the working speeds of modern NiTi files, even endodontic experts often underestimate how much debris has already accumulated in the root canal. Here too, an acoustic signal helps, automatically sounding when rinsing would prove advisable.

Seamless integration

For dentists who prefer using cordless motors because of their reduced weight, Jeni ticks all the boxes. It can be conveniently placed chairside on a small rolling table and, thanks to its long battery life, no cumbersome power cable is required, so the instrument of the future can be easily integrated into one's practice. Interested dentists will probably be able to conduct the first trials with the new endodontic motor no later than at the 2021 International Dental Show in the autumn.

Conclusion

Digital endodontic assistance systems speed up preparation by controlling the rotary motion fully automatically, making preparation considerably safer and more reliable. This is especially true in the case of irregular root canal anatomies, where the co-pilot will in future help to shape root canals naturally while being a reliable reminder of the appropriate rinsing protocol.

about

Dr Barbara Müller studied agricultural biology at the University of Hohenheim in Stuttgart in Germany and obtained an MSc from the University of Georgia in the US. In 1993, she completed her PhD at Ulm University in Germany. Between 1996 and 2010, Dr Müller held the position of research and development manager at COLTENE, and she has been involved in the development of products such as RoekoSeal, GuttaFlow and HyFlex CM nickel–titanium files. Since 2011, she has been head of the company's endodontic product segment. She has been a guest speaker at numerous events hosted by European dental and endodontic societies.

Principle-driven endodontics: Proven case results

Drs Brett E. Gilbert & Richard Mounce, USA

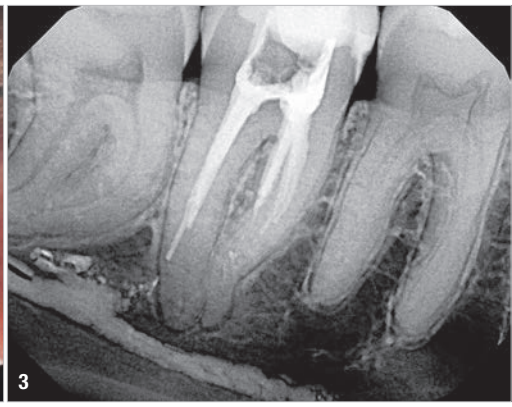


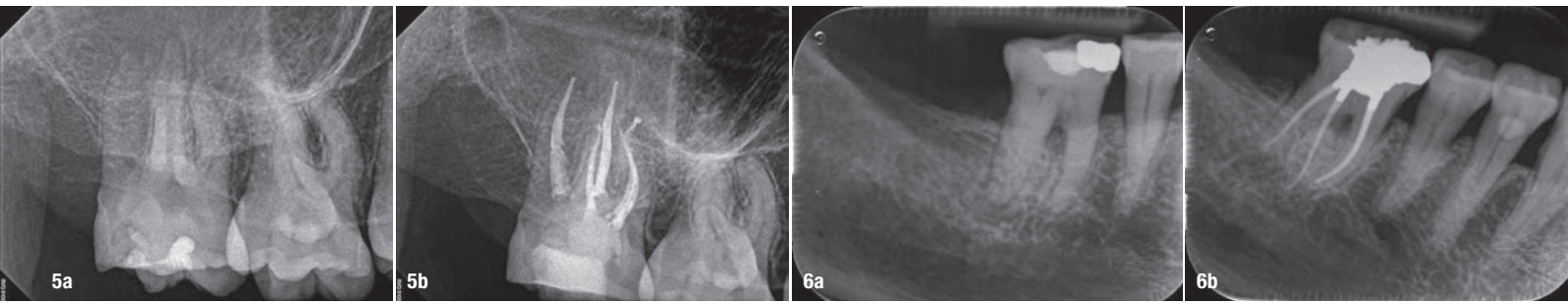
Fig. 1: Sodium hypochlorite accident post-op, extra-oral. **Fig. 2:** Sodium hypochlorite accident approximately five months post-op, intra-oral (different case from that shown in Figure 1). **Fig. 3:** Calcium hydroxide extruded into the mandibular canal through a perforation.

Fig. 4: Cleared tooth showing the true complexity of the anatomy within this molar tooth. *(Image: © Dr Sergio Rosler)*

This article was written to demonstrate that the application of proven literature and/or evidence-based endodontic principles leads to excellent clinical results, irrespective of the materials used. We will describe the key points to achieving excellent results in initial non-surgical endodontic treatment in the key areas of diagnosis, shaping, irrigation, obturation and restoration.

Assessing "proven" and "literature-/evidence-based" techniques and materials is easier said than done. We cannot prove by high-level studies that warm obturation is better than cold lateral condensation, nor can we prove that activated irrigation is superior to passive cold irrigation, among a host of other such clinical questions. However, lower levels of evidence in studies certainly lead us to adopt new techniques but not with the confidence that the efficacy can be proved without doubt to be an improvement over older techniques. An example is a study by Gutarts et al., which showed that 1 minute of ultrasonic activation of irrigating solution resulted in significantly cleaner canals histologically in the mesial root of mandibular molars.[1] This is a low level of evidence (*in vivo/ex vivo*, low N), but certainly compelling and a valid justification to adopt the technique.[1] We will incorporate many of these references, but we want to emphasise that Level 1 studies are not in place to validate these techniques to the highest possible evidence levels.

The above notwithstanding, regardless of philosophies and corporate relationships, it is the overwhelming pref-

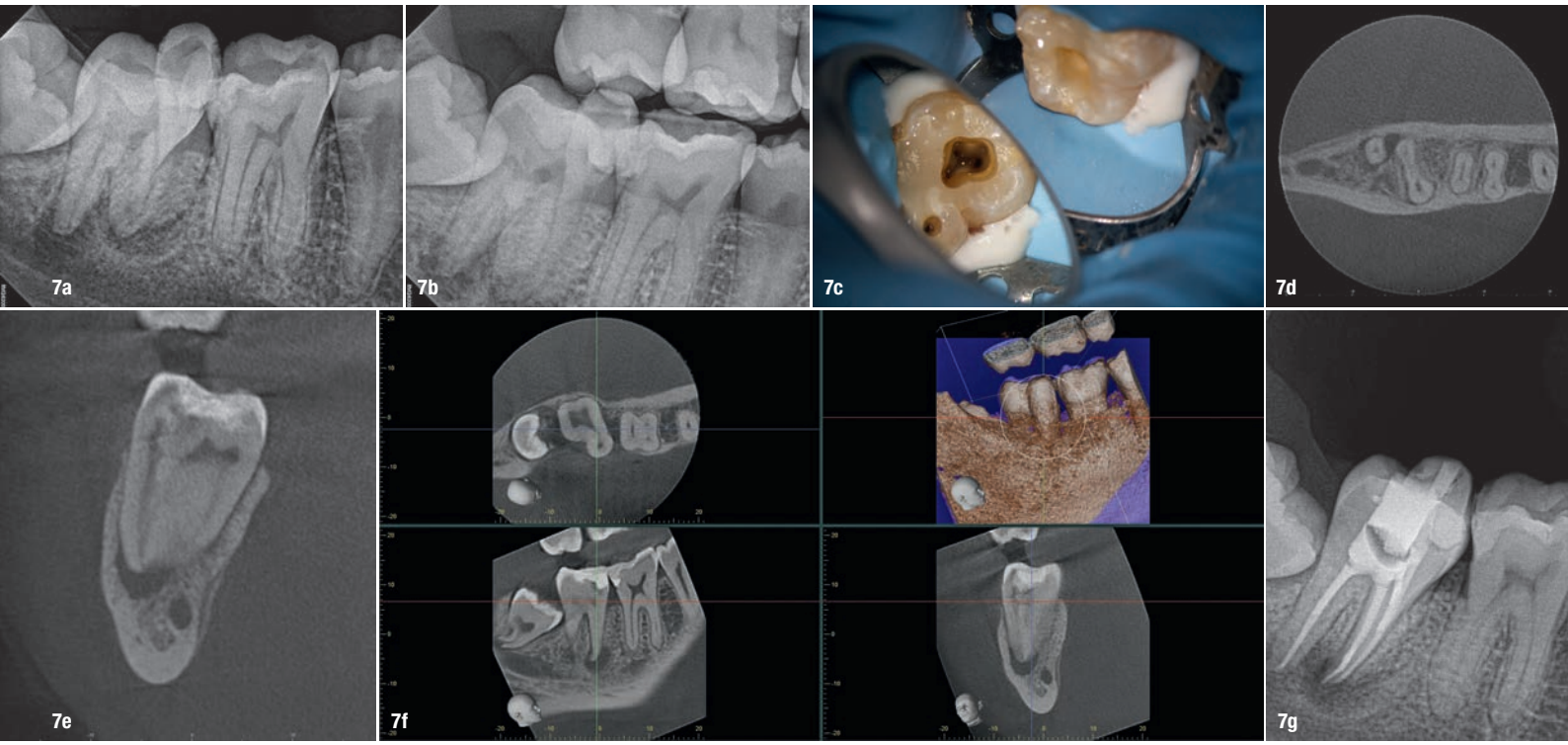


Figs. 5a & b: Case treated with Chlor-XTRA and SmearOFF with EndoUltra activation. Note the excellent cone fit and apical control of obturation. *(Images: © Dr Sam Alborz)* **Figs. 6a & b:** Case treated with Bassi Logic controlled memory NiTi files. Note the visualisation of the third root on this mandibular molar and conservative canal preparation shape. *(Images: © Dr Alex Chan)*

erence of endodontists globally to use warm obturation techniques and activated irrigation (concepts discussed in greater detail later in this article). Specialist preferences also are hedged by the eyeball test, the visual evidence that is observed in treatment in comparison with prior techniques. Hence, this article will focus on key technique objectives that universally are agreed upon.

As a starting place, before ever picking up a syringe, the two single greatest prerequisites for creating excellent endodontic results are time and comprehensive treatment planning. It is essential that the clinician have enough time to carry out the treatment in a relaxed but productive environment, in essence, practising with high efficiency. It is axiomatic that the clinician only starts cases that he or she believes he or she can finish well and never treats a patient solely for money.

All procedures must be carefully pre-planned. Such treatment planning includes performing high-level imaging and a thorough clinical examination to determine a definitive diagnosis. Preoperative treatment planning includes informed consent, assurance of restorability, profound pain control (local anaesthesia), visualisation and magnification (surgical microscope), instrumentation (stainless-steel and nickel–titanium [NiTi]), irrigation and disinfection protocols, obturation and coronal seal strategies prior to endodontic access. A lack of treatment planning strategies is the harbinger of endodontic misadventure (Figs. 1–3).



Figs. 7a–g: Cased treated with PIPs (photon-induced photoacoustic streaming). Note the orifice barrier placed in composite to protect the endodontic treatment from coronal leakage. *(Images: © Dr Paula Elmi)*

While a discussion of each principle-driven step required in a first-time endodontic procedure would fill a textbook, there are a number of key features of well-treated cases that are showcased in this article. Please see the caption that accompanies each case and describes its application of the principles discussed.

As a starting place, assuming a thorough examination and indication for treatment in addition to detailed informed consent, the most difficult gateway to comfortable patient treatment is anaesthesia for the "hot" mandibular molar. Fluency with the Gow-Gates injection as well as intraosseous anaesthesia (X-Tip, Dentsply Maillefer) will in large measure eliminate shortcomings in anaesthesia when standard block injections do not profoundly anaesthetise an anxious patient with a severely inflamed pulp.

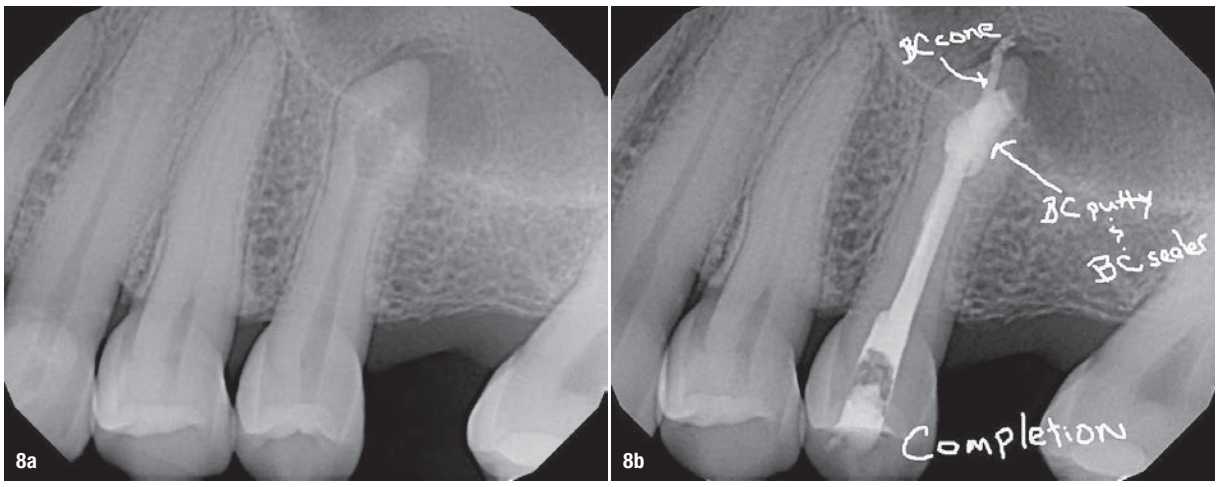
Managing complex anatomy is much simpler if the clinician has a preoperative road map. The CBCT scan provides the road map and the surgical microscope the lens (literally) through which to visualise the result. Aside from a relaxed patient who is profoundly numb, being able to visualise anatomy by taking a preoperative (and possibly intra-operative) CBCT scan and using a surgical microscope during treatment has no substitute. These methods are the current gold standard in that 3D imaging shows the clinician the true reality of a clinical situation as opposed to the suggestion gained from a 2D radiograph. Proper interpretation of imaging prior to and/or during endodontic treatment goes a long way towards taking the guesswork out of identifying canal location and other anatomical complexities as the procedure unfolds. In a 2014 study by Ee et al., it was determined that, with a preoperative CBCT scan, compared with 2D radiographs alone, the treatment plan was modified 62% of the time.[2] That the information gained from 3D imaging changed the plan of treatment more than six times out of ten is a significant game-changer (Fig. 4).[2]

While there are many preoperative clinical features to be considered prior to starting treatment, the key preoperative decision points are the patient's medical and dental history and anxiety level, the position of the tooth, space limitations to reaching the tooth and the canal anatomy. It is incumbent on the clinician to assess every aspect of the case prior to initiating treatment and to give the patient a detailed assessment of what treatment is being recommended.

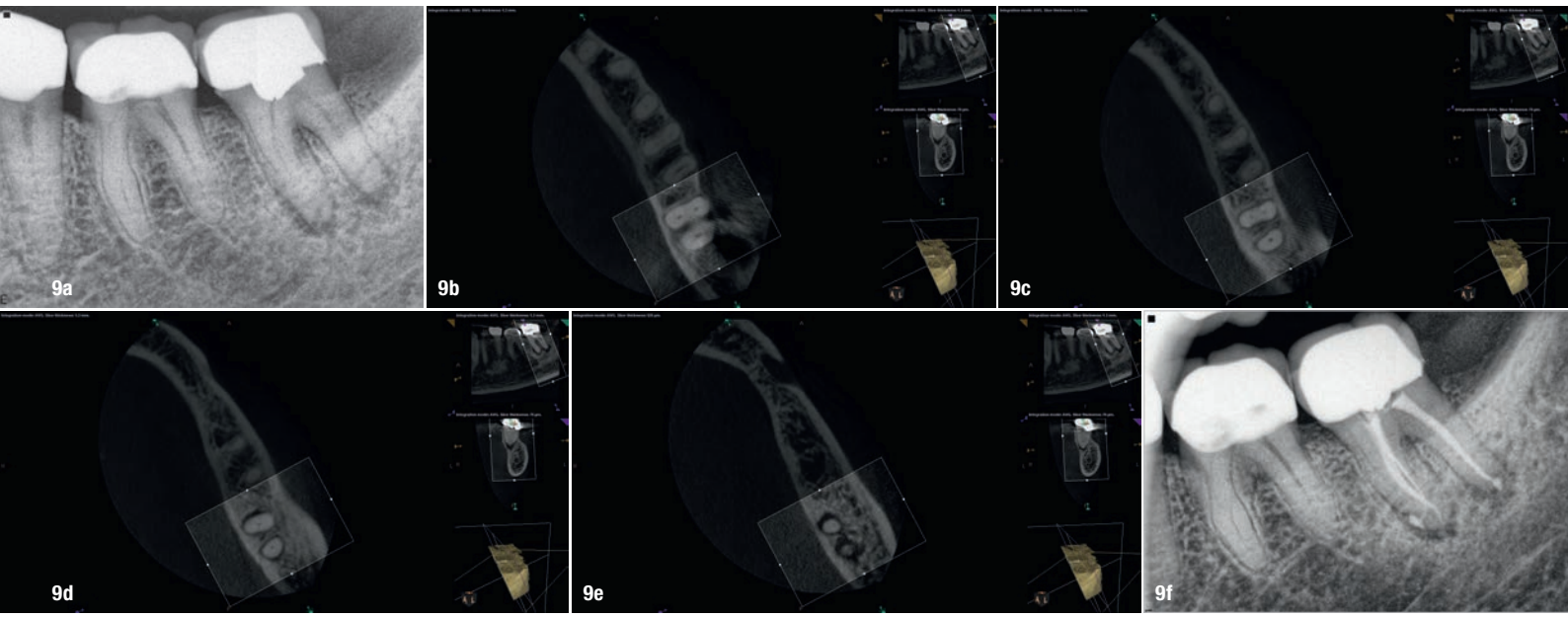
Access should be large enough to enable visual and tactile control, but not so large as to structurally weaken the tooth. Only as much dentine as required to enable adequate cleaning and shaping should be removed, effort being expended to always debride the tissue from the pulp horns and other hidden anatomy within the coronal portion of the tooth. Neelakantan et al. determined that orifice-directed dentine conservation access design (ninja access) significantly compromised debridement of the pulp chamber.[3] Therefore, common sense is the best guideline when access design is considered, assuring that the pulp chamber and all pulp horns are debrided.[3]

Tooth anatomy for the most part indicates how much time will be required using hand files for canal negotiation, especially with calcified canals. Calcification requires fluency with ultrasonic instrumentation to know which tips and units are required to enable the clinician to remove restrictive dentine. For example, in a C-shaped mandibular second molar, using a bur in the furcation predisposes the canal to a future fracture. Alternatively, using the appropriate ultrasonic tip preserves tooth structure and enables a precise removal of tooth structure.

There are literally dozens of instrumentation systems available globally at this time. One of us (BG) uses the Twisted File (KavoKerr) and the other Bassi Logic (Bassi



Figs. 8a & b: Case treated with a bioceramic master cone, sealer and putty. Note the excellent apical control in this blunderbuss apex. *(Image: © Dr Rico Short)*



Figs. 9a–f: Case assisted with CBCT to determine the anatomy preoperatively. Note the multiple cross sections moving apically and the correlation to the 2D view. Note also the conservative taper in relation to the root width. *(Images: © Dr Brett Gilbert)*

Endo). This notwithstanding, the goals of canal shaping are identical regardless of the system used. Regardless of the instrumentation system used, patency is always sought during canal scouting and instrumentation. Clinicians can debate the relative merits of reciprocation versus rotary motion, optimal austenite finish temperatures (austenite transformation temperatures that control whether a file undergoes martensitic transformation), controlled memory files ground by computer numerical control machines versus twisting NiTi in R phase, along with a multitude of different similar clinical issues. Regardless of these nuances, it is the adherence to basic principles of canal preparation that files create a pathway from the coronal to the apical aspect to allow irrigant to flow into all of the canal ramifications, cleaning the root canal system and optimising clinical success.

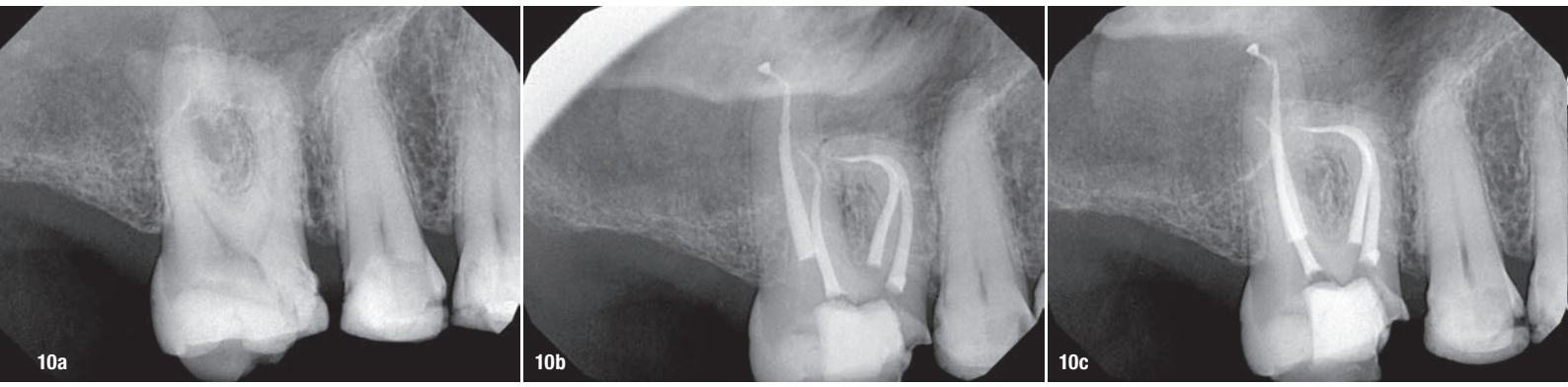
Goals of canal preparation include keeping the canal centred in its original position within the root structure and keeping the apical foramen at its original position and size. One of the hallmarks of all the cases illustrated is that the apical foramen has been respected. Specifically, it has not been moved, transported, zipped or altered in any way. Reaching the apical constriction without transporting the canal and eliminating all debris from the canal and providing a tapering funnel from orifice to apex is a key canal preparation objective.

The final prepared canal shape should be large enough to irrigate and obturate, but not so large as to structurally weaken the tooth. For practical purposes, while treatment philosophies differ, the minimum final prepared taper should be .04 and the minimum final prepared apical diameter size 30 (depending on the initial size of the foramen). Given the advent of controlled memory NiTi, there is little indication for larger tapers, especially in fine 3D apical curvatures.

As mentioned, patency is essential because its obtainment means that the clinician can always reach the apex during every phase of treatment, and its loss means that tissue, toxins and bacteria can remain despite irrigation procedures, especially in the apical third. Apical debris is the harbinger of iatrogenic events, including canal transportation, zipping, irrigant extrusion and a lack of optimal canal cleaning.

Conceptually, root canal system cleansing can be divided into a macro-phase and a micro-phase. Debridement with files is the macro-cleaning. Removal of bacteria and biofilm from the canal walls and dentinal tubules with antimicrobial solutions is the micro-cleaning.

During preparation, it is axiomatic that debris should be removed as quickly as it is produced regardless of whether it is in the chamber or canals. Inserting a NiTi file into a dry canal full of debris in an effort to make apical progress is the harbinger of blocked canals and separated files. This action packs the fine 3D anatomy (apical deltas, fins, cul-de-sacs, isthmuses, etc.) of canals with debris that can become much more difficult to remove later in the treatment process. Alternatively, irrigating after the insertion of every file and recapitulation with hand files is ideal to prevent the subsequent build-up of debris, improve circulation of irrigant apically and optimise irrigant refreshment. Today's rotary files are designed to funnel debris out of the canal in a coronal direction, further facilitating the debris removal.



Figs. 10a–c: Note the expert management of the apical constriction and the acute curvature of the mesiobuccal root. *(Images: © Dr Nestor Cohenca)*

Irrigation regimens differ widely, but the goal of removal of all organic and inorganic material, bacteria, biofilm and toxins from the root canal space is universal. After the canal is prepared, irrigation should be copious. The average volume of sodium hypochlorite (NaOCl) delivered during treatment at the specialty level is approximately 20–50 cm^3 per case or more for a molar tooth. The volume of liquid EDTA ranges from 5 cm^3 to 10 cm^3 per case or more for a molar tooth.

The utilisation of surfactants and enhanced solutions is common at the specialty level. For example, Chlor-XTRA (Vista), ChlorCid Surf (Ultradent) and Hypo-Pure Pro (Kerr Endodontics) are pharmaceutical-grade NaOCl solutions that possess surfactants which reduce solution surface tension and optimise canal wall wetting. Palazzi et al. showed that NaOCl with the addition of surfactant had better penetration into dentinal tubules than did NaOCl alone.[4] Surfactants also improve tissue dissolution and oxidising potential. NaOCl solutions are only chemically effective against the organic component of canal debris, and so EDTA, a chelator, is also used to remove the inorganic component of canal debris, including the smear layer.

SmearOFF (Vista) is a 17% EDTA solution which also contains surfactants as well as chlorhexidine (a powerful antibacterial solution). A commercial alternative to SmearOFF is QMix (Dentsply Sirona). Unlike QMix (which contains chlorhexidine and EDTA), SmearOFF can be mixed with Chlor-XTRA without a rinsing step, as no unwanted precipitates are produced by their mixture (Figs. 5–7).

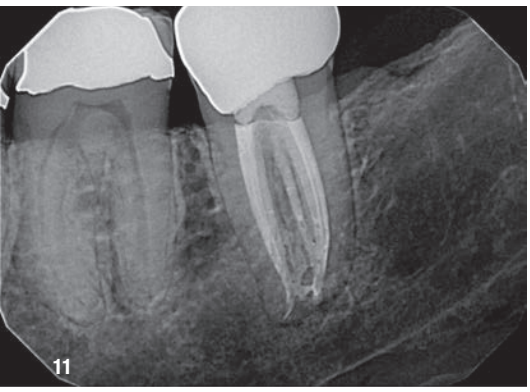
The clinician should know where he or she is in the canal at all times when irrigating. Recommended needle gauges vary depending on the size of the initial and prepared final canal shape. For the majority of canals, a 27-gauge needle is adequate, but in fine canals, a 31-gauge needle can be appropriate. Needle tip designs can include side-ported and close-ended or side-vented among many possible configurations. The placement of a NaOCl solution like Chlor-XTRA to remove bacteria and organic material and SmearOFF to remove the smear layer and inorganic debris using a 27- or 31-gauge needle approximately 2 mm from the apex ensures penetration of these irrigants into the apical third. Irrigation needles should never be locked by the canal walls. Irrigant delivery is always passive and the needle is moved gently, slowly and vertically a few millimetres at a time during extrusion. Under the surgical microscope, irrigant delivery, as described above, occurs with precise control.

It is noteworthy that larger syringes (10–12 cm^3) require more pressure to extrude the solution relative to a 3 cm^3 syringe. It is imperative that the clinician appreciate how much pressure he or she is using on the plunger. One unique alternative to plastic syringes is the Auto-Syringe (Vista) device, which accepts any Luer lock needle tip and extrudes irrigant at various speeds, depending on the setting selected. One of us (RM) uses it routinely (Figs. 8 & 9).

Irrigant activation

At present, there are many ways to deliver and activate irrigant for optimisation. These methods include apical negative pressure (EndoVac, Kerr),[5] sonic activation (EndoActivator, Dentsply Sirona), ultrasonic activation (EndoUltra, Vista),[6] multisonic activation (GentleWave, Sonendo),[7] laser activation (PIPS, Fotona)[8] and mechanical activation (Finishing File, Engineered Endodontics; Bassi Clean, Bassi Endo). All of these activation methods enhance the antibacterial effects of irrigants and result in cleaner canals relative to passive syringe irrigation. In addition, activation removes the accumulation of air bubbles at the apex, which is otherwise known as vapour lock. Air bubbles left at the apex owing to passive syringe irrigation diminish the apical penetration of irrigants.

One of us (BG) utilises a combination of ultrasonically activated and apical negative pressure techniques



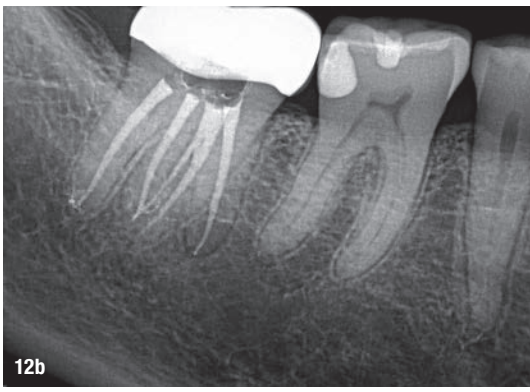


Fig. 11: Note the degree of penetration of sealer and gutta-percha between the primary canals. Obturation of this space demonstrates both the macro- and micro-cleaning referred to in the article. *(Image: © Dr Nestor Cohenca)* **Figs. 12a & b:** Note the attention to detail required to locate all of the canals in this exceptional case done under the surgical microscope. *(Images: © Dr Adrian Silberman)*

(EndoVac) and the other utilises ultrasonic energy (EndoUltra). Regardless of which method is utilised to deliver irrigant to the apical third, it is most critical that the clinician activates the irrigant and does not rely simply on cold passive syringe irrigation. While protocols vary, activating each primary irrigant (both SmearOFF and Chlor-XTRA, for example) three times in each canal for 20 seconds is a sound clinical strategy (Figs. 10–12).

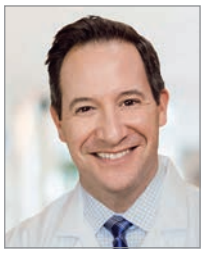
GentleWave deserves a special mention, as it is unlike the other activation systems available. GentleWave delivers a multisonically activated degassed solution (to remove air bubbles that dissipate energy) with negative to neutral pressure delivered via a handpiece over the access in a closed system. The literature basis supporting the system shows impressive cleansing of the root canal systems, but a definitive high-level study on improved healing has not been published to date. The system costs approximately $80,000 per console and $50–$100 per one-time use handpiece. Its future application and expansion globally will be interesting to observe.

And finally, the literature is conclusive that placing a post-endodontic coronal seal at the time treatment is completed, under a dental dam, is closely associated with endodontic success. Please note that all of the cases illustrated had some form of orifice barrier or build-up placed under the dental dam at the time of treatment.

This article has stressed literature-based proven treatment principles over a particular manufacturer's devices or technique recommendations. Emphasis has been placed on an accurate diagnosis, conservative access, patency, minimal taper, activating irrigation, 3D warm obturation and the placement of a post endodontic coronal seal at the time of treatment under the dental dam. We welcome your feedback.

Editorial note: A list of references is available from the publisher. This article was first published in the US in issue 1/19 of roots—the international magazine of endodontics.

about



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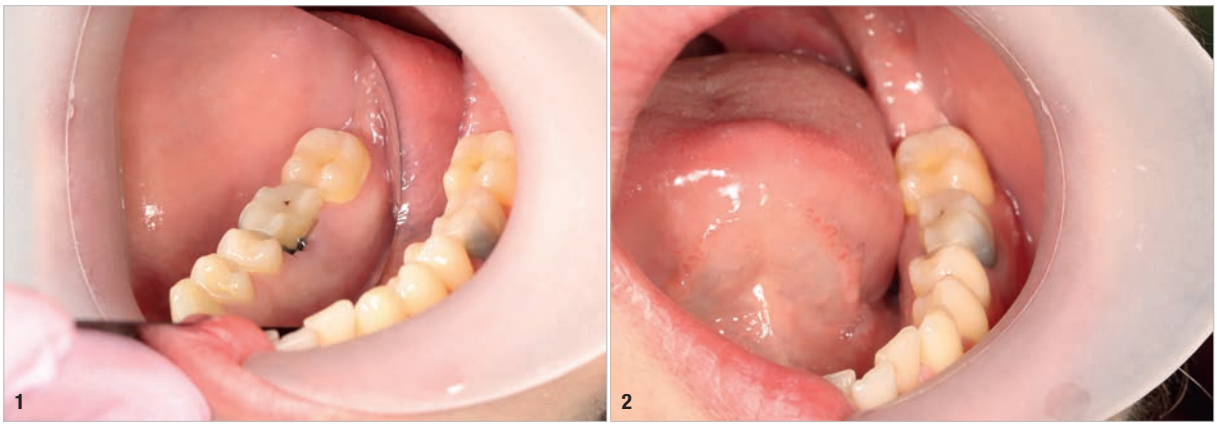
Er:YAG laser for superior endodontic treatment

Dr Igor Križnar, Slovenia



Figs. 1 & 2: Initial situation: tooth #36 with broken lingual wall.

In the field of endodontics, practitioners routinely face the challenge of removing biofilm and debris from difficult-to-reach areas in the root canals. Anatomically complex root canal systems with lateral canals, canal branches, isthmuses and tubules represent a significant challenge for successful endodontic treatment. Irrigation is a general method for cleaning areas that are inaccessible to mechanical instruments.[1]

The Er:YAG photoacoustic technique has been a successful method of removing biofilm and debris from the dental root system for many years. The mechanism of cleaning and disinfection by photoacoustic irrigation is based on the mechanical removal of biofilm and debris via the turbulent movement of liquid (the irrigant) and simultaneously by the chemical reaction of the irrigant itself. Turbulent fluid motion results from the formation of cavitation vapour bubbles and their implosion, which releases a large amount of energy and consequently triggers fluid motion.[2–4]

There are several methods of Er:YAG photoacoustic irrigation.[5,6] The pioneering single-super-short pulse (SSP) method is very successful in generating photoacoustic and shock waves in an infinite irrigation space, but in tight spaces such as a root canal, the cavitation dynamic is significantly slowed down owing to friction on the dentinal walls and the limited space available

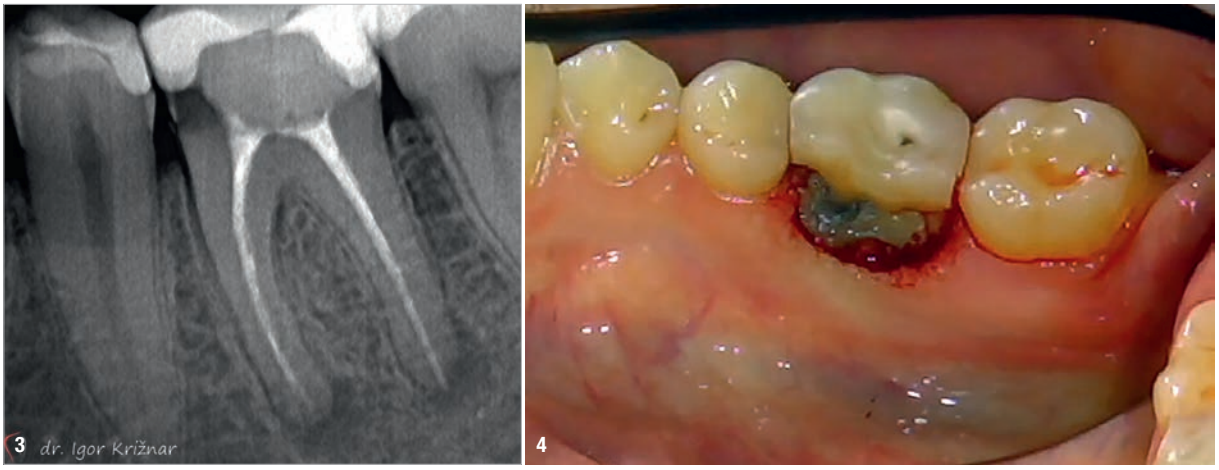


Fig. 3: Radiograph of tooth #36 before crown lengthening and endodontic treatment. **Fig. 4:** Tooth #36 immediately after crown lengthening.

for rapid fluid movement during expansion and contraction of the bubbles. A modified method, known as SWEEPS (shock wave enhanced emission photoacoustic streaming),[5,6] has been developed as an upgrade of the SSP technique and is particularly suitable for very confined spaces.

Unlike the SSP technique, the SWEEPS technique delivers pulses in pairs. The second pulse exerts pressure on the initial bubble, which is generated by the first pulse, and accelerates its collapse and the emergence of a new generation of bubbles. In this way, even in very narrow geometries, shock waves are formed that travel faster than sound (acoustic waves). The optimal time difference between pulses in a pair depends on the volume and anatomy of the confined space.

When the correlation between tooth anatomy and the time between pulses in a pair cannot be defined exactly, a special modality of the method, known as AutoSWEEPS, is used, whereby the time separation between laser pulses in a pair varies continuously between 250 and 650 microseconds, in increments of 10 microseconds. This ensures that during each cleaning cycle there is always an optimal time distance between the pulses, which is necessary for the emission of shock waves and thus for the maximum possible flow efficiency according to the dimensions of the irrigation system.[5,6] The efficiency of either SSP or SWEEPS in removing biofilm and debris can be enhanced with chemical irrigants. In endodontics, the two most commonly used irrigants are sodium hypochlorite and EDTA.

Endodontically treated teeth are often more prone to crown or root fracture compared with vital teeth. Several factors contribute to this, the most important being that non-vital teeth often have less sound tooth structure owing to progressive carious lesions, trauma or previous restorations. Certain clinical procedures may also lead to a higher incidence of tooth fracture in endodontically treated teeth, such as creation of large access cavities, excessive mechanical shaping of the roots, prolonged use of different irrigating solutions (sodium hypochlorite, EDTA) and medications (calcium hydroxide) during endodontic treatment, improper restorative treatment without cuspal coverage in the posterior region, and high masticatory forces in certain individuals. Once the tooth has broken off below the gingival margin, it is often very difficult to restore it properly, and additional clinical procedures such surgical lengthening of the clinical crown or orthodontic extrusion are needed. When placing a new restoration, the biologic width of the tooth has to be respected and the margin of the restoration should be at least 2.15–2.30 mm (preferably around 3.0 mm) from the crestal bone, to allow for a normal epithelial junction and connective tissue attachment to avoid chronic inflammation and periodontal tissue loss.

Figs. 5 & 6: Tooth #36 with broken lingual wall 14 days after crown lengthening.
Figs. 7 & 8: Tooth #36 with composite build-up before endodontic treatment.

Case presentation

A 28-year-old male patient was referred to our clinic for endodontic treatment of a mandibular molar owing to chronic periapical periodontitis. He stated that a few weeks before the appointment, a large part of the tooth had broken off. The patient was healthy, took no medication and reported no allergies. There was no trauma to the dentition in the patient's dental history.

Intra-oral examination revealed moderate plaque control and oral hygiene. All third molars had been removed in the past, and teeth #16, 24, 26 and 36 had already been endodontically treated. The gingiva was quite healthy, pink in colour, and did not bleed on probing. Probing depth was normal around all teeth. There were no pathological conditions on the tongue, mucosa, or hard or soft palate, or in the oropharynx. The occlusion was Angle Class I. The intra-oral clinical examination showed that tooth #36 had a large mesioocclusal-distal (MOD) composite filling and that the buccal wall was intact, whereas the lingual wall of the tooth crown had broken off about 2 mm below the gingival margin. The tooth was slightly tender to percussion and sensitive to palpation adjacent to the apex of the tooth. The mobility of the tooth had not increased. Probing depth was normal, but there was slight bleeding on probing on the lingual side (Figs. 1 & 2).

Analysis of a radiograph showed the large MOD filling and the broken lingual wall of the tooth (Fig. 3). The tooth had been endodontically treated in the past; the root fillings were porous and short in the mesial root. There were bone lesions (chronic periapical periodontitis) under both the mesial and distal roots.

Diagnosis

The diagnosis was chronic periapical periodontitis and a broken lingual wall of the tooth crown.

Table 1

Application	Gingivectomy Step 1
Source	Er:YAG
Mode	SP
Energy	150 mJ
Frequency	15 Hz
Handpiece	HCN 14

Table 2

Application	Osteoplasty Step 1
Source	Er:YAG
Mode	MSP
Energy	165 mJ
Frequency	15 Hz
Handpiece	HCN 14

Table 3

Application	Gingivectomy Step 2
Source	Er:YAG
Mode	LP
Energy	100 mJ
Frequency	15 Hz
Handpiece	HCN 14

Table 4

Application	Gingivectomy Step 3
Source	Er:YAG
Mode	VLP
Energy	80 mJ
Frequency	15 Hz
Handpiece	HCN 14

Table 5

Application	Endodontic cleaning
Source	Er:YAG
Mode	AutoSWEEPS
Energy	20 mJ
Frequency	15 Hz
Handpiece	HCN 14

Treatment plan

Healing after surgical crown lengthening may be painful, and the sutures may interfere with good oral hygiene, in addition to being unpleasant for the patient. An alternative approach is the use of Er:YAG laser irradiation, which is readily absorbed in the water component of the collagen of the gingiva and bone, causing instantaneous vaporisation and enabling a precise and superficial cutting action without the risk of damage to the surrounding bone. Therefore the clinical crown lengthening procedure of gingivectomy and osteoplasty should be performed with an Er:YAG laser using shorter pulse modes (short pulse and micro-short modes, respectively), since there are almost no unwanted thermal effects on the surrounding tissue. The procedure can be finished with longer pulses (long pulse [LP] and very long pulse [VLP]) for coagulation of the blood vessels, thus reducing bleeding and enabling smoothing of the gingiva. In this way, the crown length of the tooth can be increased and a temporary filling can be performed, which enables further endodontic treatment of the tooth.

Treatment procedures

Before the clinical crown lengthening procedure, the periodontal tissue around tooth #36 was analysed. The gingiva was inspected to confirm that the height of the keratinised gingiva was sufficient and that there would be at least 3 mm of keratinised gingiva left after the repositioning of the gingival margin. The gingiva surrounding tooth #36 was locally anaesthetised using Ubistesin (1:100,000 adrenaline; 3M ESPE). The level to which the lingual wall had broken off was marked on the gingiva covering it, and 3 mm was subtracted from this level to mark where the new margin of the crestal bone should be.

For the gingivectomy, an Er:YAG laser was used with the Varian tip positioned perpendicularly in non-contact mode 0.5 mm from the gingiva. Air and water spray were set to 3 and 2, respectively (Table 1). For the osteoplasty, slightly different parameters were used. The Varian tip was inserted parallel to the tooth surface in non-contact mode, and water and air levels were set to 3 and 2, respectively (Table 2). During the treatment, a periodontal probe was used to check the exact level to which the crestal bone had to be osteomised. The procedure was finished with longer pulses (LP and VLP) for coagulation of the blood vessels in the gingiva, thus decreasing the bleeding, and for smoothing of the gingiva (Tables 3 & 4). After the procedures, there was minimal bleeding, and the wound was left to heal for 14 days (Fig. 4).

At the second appointment after 14 days, a temporary composite filling was used to recreate the lingual wall, thus preparing the tooth for endodontic treatment (Figs. 5–8).

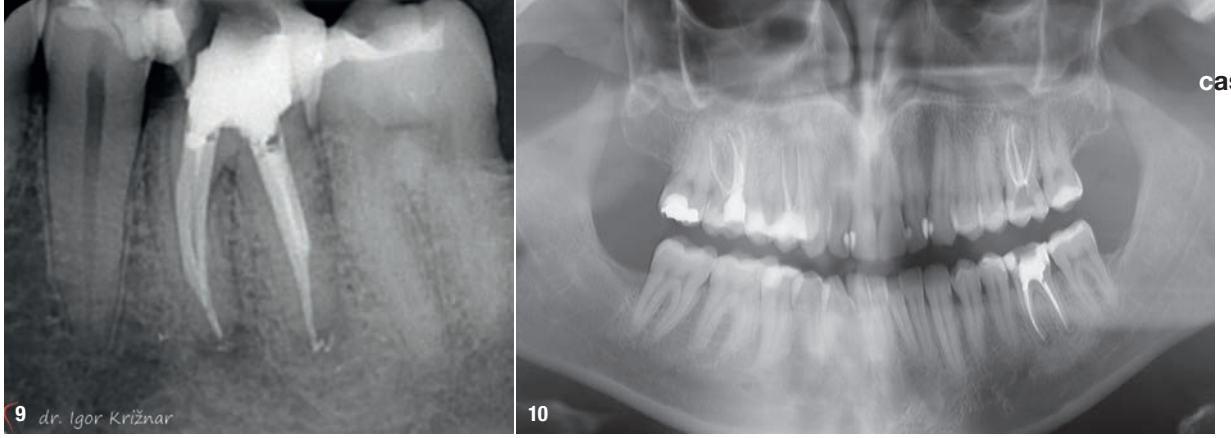


Fig. 9: Radiograph of tooth #36 three months after the clinical crown lengthening and endodontic treatment. **Fig. 10:** Panoramic radiograph three months after the treatment.

A dental dam was placed on the tooth and the working field isolated. An endodontic access cavity was prepared and the root canals were negotiated to the apex with a size 8 hand C-file. Sequentially larger rotary files (HyFlex CM and EDM, COLTENE) were used to working length up to size 30 for the mesial canals and size 40 for the distal canal. Between each filing, the AutoSWEEPS irrigation protocol was used with 2.5% sodium hypochlorite for 30 seconds, followed by a 30-second rest phase, and no water or air. The access cavity was filled with irrigant constantly during the procedure. After the final shaping of the canals, the final irrigation protocol was performed. This consisted of a single 30-second irrigation cycle with EDTA, followed by a single cycle with distilled water and three 30-second cycles with 2.5% sodium hypochlorite, using the laser parameters stated in Table 5. After drying, a calcium hydroxide dressing was placed in the canals and the endodontic access cavity was temporarily sealed.

At the third clinical appointment, the calcium hydroxide was rinsed out of the canals. For the irrigation, a single 30-second EDTA cycle, followed by a single 30-second distilled water cycle and three cycles of 30-second AutoSWEEPS irrigation with 2.5% sodium hypochlorite were repeated, using the same energy setting as at the first clinical appointment. The canals were dried and filled with gutta-percha cones and a bioceramic sealer (Biodentine, Septodont) using the cold lateral compaction technique. A stronger temporary filling made of composite material was placed at the end of the procedure. The patient was referred back to his general practitioner with instructions for a final restoration of the tooth with an endocrown after six months, once the periodontal tissue and the periapical lesions had healed completely.

In the first week of healing, the patient rated his pain one on a scale of one to ten. Fourteen days after the crown lengthening procedure, the gingival margin looked healthy and had reattached at the new level with no observable bleeding on slight probing. It was possible to perform the composite build-up as an endodontic pretreatment with minimal effort. The endodontic treatment was finished without any complications, and the three-month radiographic follow-up showed excellent healing of the periapical lesions (Figs. 9 & 10). For the final restoration, the level of the gingival margin might have had to have been slightly adjusted further using the same procedure.

Conclusion

Our clinical case shows that the Er:YAG laser can be used with great ease and predictability when crown lengthening is indicated. This procedure can be performed as a pre-treatment of the tooth for endodontic treatment or before placing the final restoration. It is easy to perform, but just as important—or even more so—is that it causes minimal to no pain and discomfort for the patient and promotes excellent healing of the periodontal tissue.

Moreover, this case demonstrates the successful use of the SWEEPS mode to increase the fluid dynamics of the irrigant and thereby to improve the cleaning efficacy of the root canals in the treatment of chronic periapical periodontitis. As the sodium hypochlorite reaches even the most apical parts of the root canal system and provides sufficient disinfection, it is not necessary to prepare the canals to larger apical sizes or tapers, which is the case when only conventional irrigation methods are used. This technique truly represents a paradigm shift in the way that endodontic treatment is performed.

about

Dr Igor Križnar graduated with a DMD in 2006 from the University of Ljubljana in Slovenia and began working as an assistant in the department of endodontics and operative dentistry in the Faculty of Medicine. He acquired the professional title of dental specialist in endodontics in 2014. Until the end of 2015, he worked as an assistant at the faculty, where he was engaged in work with dental students in clinical and preclinical practice. At the same time, he worked as a dental specialist at the University Medical Centre in Ljubljana. He was also engaged in research work and earned his PhD in endodontics from the University of Ljubljana in 2016. In December 2015, he entered into full-time private clinical practice focusing mainly on endodontics. In 2019, he completed the Laser and Health Academy master in laser dentistry. Dr Križnar has published numerous scientific papers in various journals and has actively participated in many international and local conferences and symposia.

The use of a new bioceramic material in endodontic microsurgery

Dr Leandro Pereira, Brazil

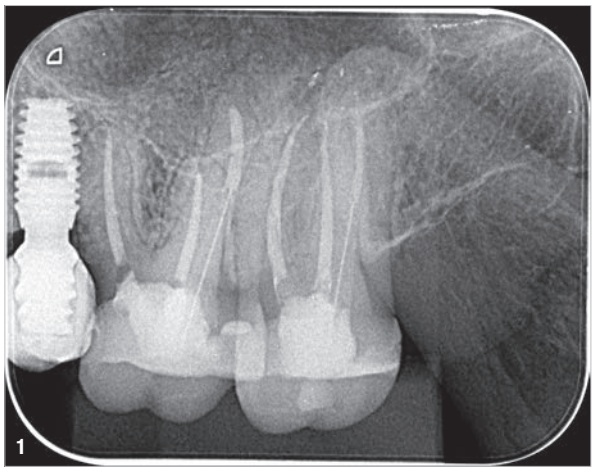


Fig. 1: Radiographic view during first emergency consultation.

Summary

Despite the high rate of success in the treatment of periapical disease with conventional endodontics, failures may occur. Such unfavourable results may be reversed by standard retreatment, tooth extraction or microsurgery. With a rate of positive outcomes of above 90%, endodontic microsurgery is a therapeutic alternative to be considered for the functional and aesthetic preservation of teeth with recurrent periapical disease.

Introduction

Endodontic treatment has a high success rate. However, failure occurs.[1] Conventional retreatment is commonly selected to deal with persistent periapical periodontitis and has an 83% success rate.[2] However, with the growing use of microscopy associated with ultrasound and MTA (mineral trioxide aggregate), endodontic microsurgery has evolved significantly and became a viable alternative to conventional retreatment.[3,4] The evolution of technique has improved the success rate from less than 60%[5–8] to 90%.[6,7,9–12] A success rate of less than 60% for the macro-surgical technique (no microscope and no ultrasound) does not define it as a viable option for treating the complexity of periapical periodontitis.

Case presentation

A female patient, aged 64 and with an ASA I physical status (healthy), blood pressure of 125/85 mmHg, a heart rate of 61 bpm, oxygen saturation of 98%, a temperature of 36.5 °C and a weight of 69 kg, presented to the clinic on 28 November 2017 complaining about pain and swelling around teeth #26 and 27.

During examination, a buccal acute abscess was observed between these teeth, in the apical region. The patient reacted with light pain to tests of apical palpation and vertical percussion. The response to horizontal percussion was negative. Thermal and electrical pulp test results were negative for both teeth.

Radiographically, two porcelain-fused-to-gold crowns and two intra-radicular posts (probably glass fibre) presented with correct adaptation. Endodontic treatment of both teeth was deficient, and periapical pathology could be observed (Fig. 1). Preoperative tomography revealed a buccal cortical bone rupture at the distobuccal root

Fig. 2: Tomogram of the distobuccal root of tooth #26. **Fig. 3:** Tomogram of the periapical lesion of tooth #27.

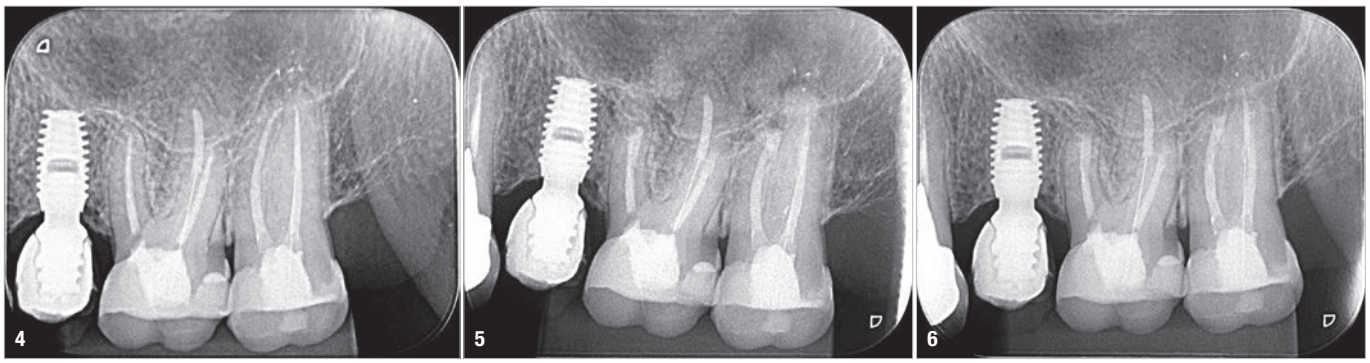


Fig. 4: Pre-op radiograph. **Fig. 5:** Immediate post-op radiograph. **Fig. 6:** Four-month post-op radiograph.

of tooth #26 and periapical disease in teeth #26 and 27 (Figs. 2 & 3).

After careful analysis of all clinical and imaging data, the diagnosis was chronic periapical periodontitis of teeth #26 and 27 probably because of unsatisfactory root canal therapy. As an emergency procedure, the abscess was drained.

Two alternatives were considered to solve the case. The first would have involved removal of the crowns and posts with the purpose of providing access for standard re-treatment. Consequently, after root canal intervention, the posts and crowns would have had to have been rebuilt. The second was a microsurgical approach aimed at root canal retro-filling of both teeth. One major benefit of the latter would have been that the posts and crowns would not have had to have been removed. After detailed explanation of all advantages and compromises of the two options, endodontic microsurgery was selected. For personal reasons, the patient did not return until 8 April 2018 (Fig. 4), and surgery was scheduled for 4 June 2018.

Preoperative medication was 4 mg of oral dexamethasone for pre-emptive analgesics,[13] 1 hour before the procedure. Local anaesthesia was administered with 3.6 ml of 4% articaine and 1:100,000 adrenaline: palatal infiltration of 0.9 ml and 2.7 ml at the site between the attached gingiva and buccal oral mucosa. After anaesthesia, two intrasulcular incisions were followed by a vertical releasing incision. Piezo-syndesmotomy was performed with an ultrasonic tip (PR1, mectron). Because of the infection, the buccal cortical bone had already ruptured, which facilitated finding the apex of the distobuccal root of tooth #26. However, osteotomy was required to reach the apices of the buccal roots of tooth #27 and mesiobuccal root of tooth #26. Piezo-osteotomy was performed with the ultrasonic tips OT12 and OP7 (mectron) and exposed the entire lesion. For the apicectomies, the ultrasonic piezoelectric system was also used (OT12 tip). All apices were cut perpendicular to the long axis of the roots to completely remove any possible ramifications and branching of the root canal system.

With ultrasonic tips P1 and P1T (Helse Ultrasonic), the retro-preparation was performed. The root canals were retro-filled with Bio-C Repair (Angelus). Material insertion at the retro-cavity was facilitated by product consistency and its ready-to-use, premixed presentation. There was no need for specific instruments or applicators to fill the retro-cavity. With this step done, to avoid connective tissue growth into the osseous defect, the apical bone cavity was filled with surgical calcium sulphate (New Osteo, GMReis; Fig. 5). Postoperative images were obtained at baseline and at four months, when it was possible to observe complete bone repair (Figs. 6–12).

Discussion

The operating microscope, ultrasonic inserts and bioactive retro-filling materials, associated with technological and scientific advances, increased the positive outcomes of this type of treatment from 60% to over 90%.

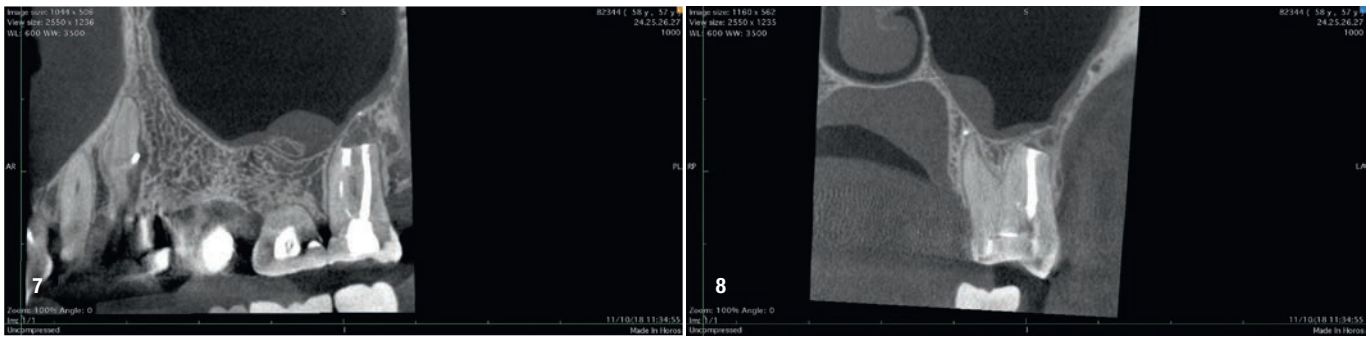


Fig. 7: Four-month post-op tomogram of tooth #27. **Fig. 8:** Four-month post-op tomogram of the mesiobuccal root of tooth #27.

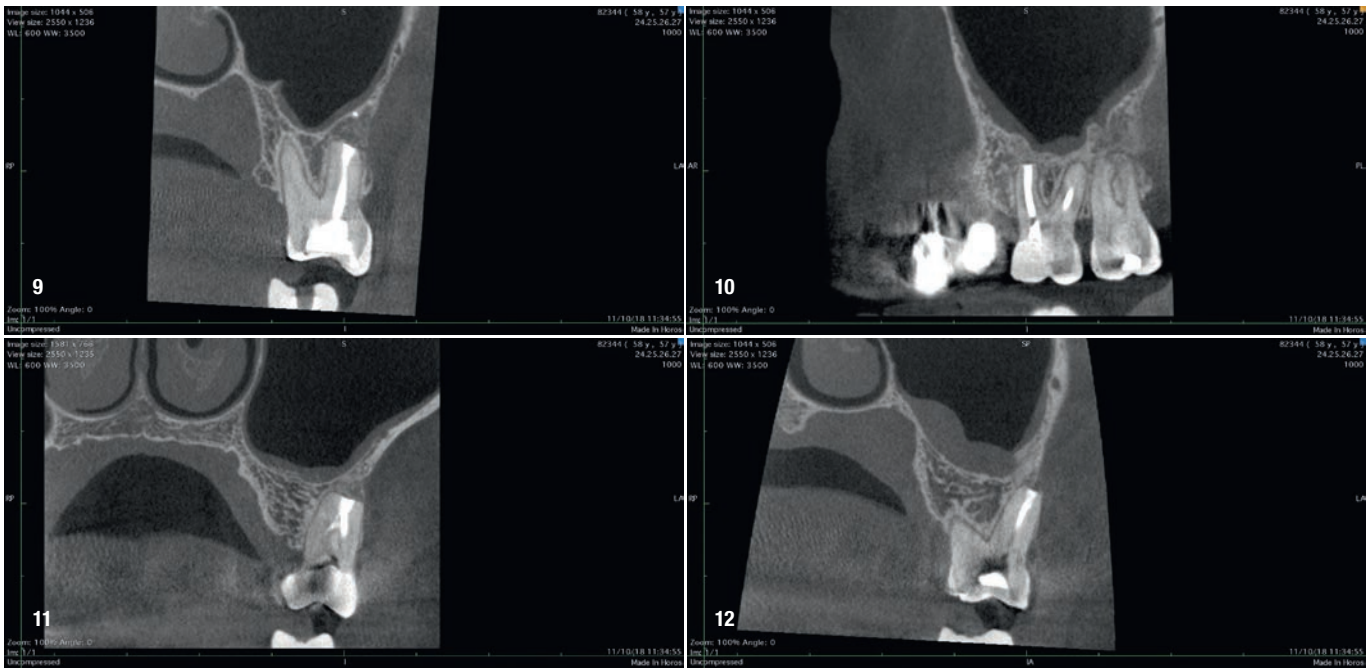


Fig. 9: Four-month post-op tomogram of the distobuccal root of tooth #27. **Fig. 10:** Four-month post-op tomogram of tooth #26. **Fig. 11:** Four-month post-op tomogram of the mesiobuccal root of tooth #26. **Fig. 12:** Four-month post-op tomogram of the distobuccal root of tooth #26.

Selection of the retro-filling material is essential for success.[14] Besides filling the site, the substance must protect the surgical wound, be radiopaque, biocompatible, impermeable, antimicrobial and osteoconductive, and behave optimally in moist environments. Products such as Cavit (3M ESPE), zinc oxide eugenol, calcium hydroxide, amalgam, gutta-percha, tricalcium phosphate and hydroxyapatite have been used to seal retro-cavities.[15] However, none of them was able to re-establish the original architecture of the affected sites.[16]

The introduction of bioactive sealers, such as MTA (the precursor of the bioceramic group), brought great progress regarding sealing properties and biocompatibility. MTA presents the most desired features of a reparative substance: it is biocompatible with tissue and stimulates new formation of cementum, has outstanding behaviour in moist conditions, induces biomineralisation and promotes greater sealing than all other materials.[15–17]

However, MTA has two inconveniences: handling and tooth staining. Both are no longer any trouble with the launch of a new generation of bioceramic products. These offer all the biological characteristics of MTA, but improved consistency and presentation too. Bio-C Repair is an example of these new products that facilitate clinical handling. It is premixed and ready to use, and its consistency enables easy shaping with a spatula, facilitating cavity insertion. The other relevant feature is that Bio-C Repair does not stain the tooth or the surrounding tissue.[18–25]

Conclusion

The synergy of clinical microscopy and ultrasonic devices enables the execution of extremely precise treatments. Endodontic microsurgery, when performed according to modern concepts, is a remarkable therapeutic alternative, being predictable and viable for the conservation of teeth with secondary or persistent periapical periodontitis. A new generation of premixed bioceramic products simplifies retro-filling procedures and may elicit quicker and complete apical bone repair.

Editorial note: A list of references is available from the publisher. This article was first published in the US in issue 1/19 of roots—the international CE magazine of endodontics.

about

Dr Leandro Pereira is a specialist in endodontics, operating microscopy and inhalation sedation and has a master's degree and doctorate in pharmacology, anaesthesiology and drug therapy from the University of Campinas in Brazil. He is a lecturer in the department of endodontics at São Leopoldo Mandic university at its Campinas campus and coordinator of the photography in dentistry programme at the university's Belo Horizonte campus and of the endodontic microsurgery programme at the Brånemark Osseointegration Center in São Paulo. He is a member of the American Association of Endodontists.

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Aesthetics in endodontic microsurgery

Dr Philippe Sleiman, UAE

Endodontic microsurgery is the last resort in dealing with very specific pathology in endodontics in order to save the tooth. A major consideration is the flap design and the aesthetics, especially in the anterior zone, and sometimes things can be more complicated with the presence of crowns and veneers. The initial status of the gingiva, whether healthy or inflamed, and whether there are pockets or not, can influence our flap design, after a careful analysis of the bone situation. Usually, a horizontal incision on the gingiva leaves a scar, and a multiple flap design has a horizontal cut design, a technique that I seek to avoid. The absolute concern is the papilla and the cervical area around the teeth, and this one of the major keys of success in aesthetic consideration in microsurgery.

The incision should be clean and parallel to the axis of the tooth and as close as possible to the tooth. This area should be elevated with the same motion as cutting, using a small, flat microblade (Fig. 1), and this area should not be touched again or scraped when elevating the flap. All the fibres and microfibres must be preserved in order to have a fast recovery later and reattachment of those fibres that will lead to almost immediate stabilisation and prevent a drop of the gingiva in this area.

The second and equally important step is management of the papilla. Using the same blade, one needs to enter

Figs. 2a–3d: Case 1. **Fig. 2a:** Pre-op. **Fig. 2b:** 3-month follow-up. **Fig. 2c:** 4-year follow-up. **Fig. 2d:** 6-year-follow-up. **Fig. 3a:** Pre-op. **Fig. 3b:** 2 years. **Fig. 3c:** 4 years. **Fig. 3d:** 6 years.

into the interproximal area to go as deep as possible to the palatal area, if working in the maxilla, from both sides and to elevate the papilla with the tip of the triangle intact (Figs. 1a & b), and it must remain intact. The area in which the flap has been elevated, especially around the tooth, should be kept hydrated so that the fibres can remain in a good condition.

Replacing the flap in its original place is crucial. Using a modified technique will allow replacement of the flap and the papilla with slight force, directed coronally that will keep the papilla and the flap in their original places and prevent them from dropping, for the best aesthetic results.

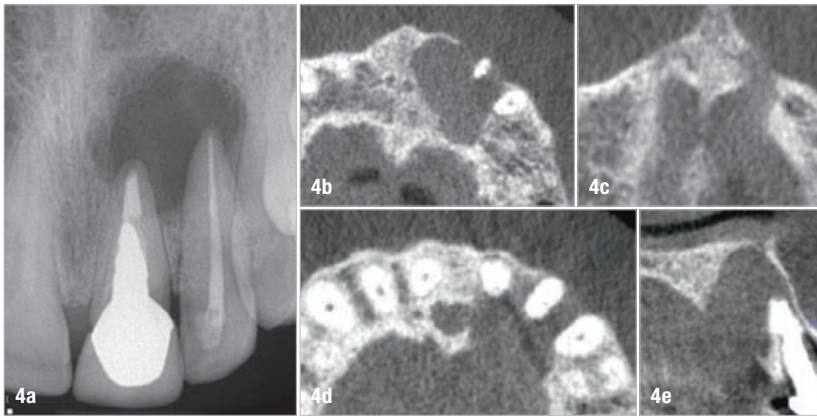
Case 1

The patient presented to the office with a swelling in the maxillary anterior (Figs. 2a–d). According to the patient, she had undergone a previous surgery in the area to treat a cyst, and she was told that bone grafting was performed. We placed a gutta-percha cone that led us to the infected area. The radiographs (Figs. 3a–d) and the i-CAT scan (KaVo Kerr) showed us that the pathology was around the apical part of the teeth, one amalgam retrograde filling had been placed and the area of the bone grafting did not seem right. The patient was very concerned about the aesthetics, as she had veneers and did not plan to have them replaced. This added to the challenge of treatment with such inflamed gingiva.

The surgery was redone, and the three-month follow-up radiograph and photograph (Figs. 2a–3d) showed great results: the gingiva seemed to be healthy and in place. The six-year follow-up photograph showed the stability of the results and the radiograph the bone healing.

Case 2

The patient was referred to our office suffering from swelling and pain in the anterior area. According to the patient, she had had the same episode six months before and root canal therapy was done on the lateral incisor. The clinical examination revealed a swelling on top of both the central and the lateral incisor and that a crown had been placed on the central incisor. The radiographs revealed the presence of a large radiolucency in proximity to the nerves and little residual bone (Figs. 4a–e), around 3 mm on the buccal plate between the lateral incisor and the canine. The central incisor had previously undergone apicectomy and had a very large post that would have made retreatment very tricky.



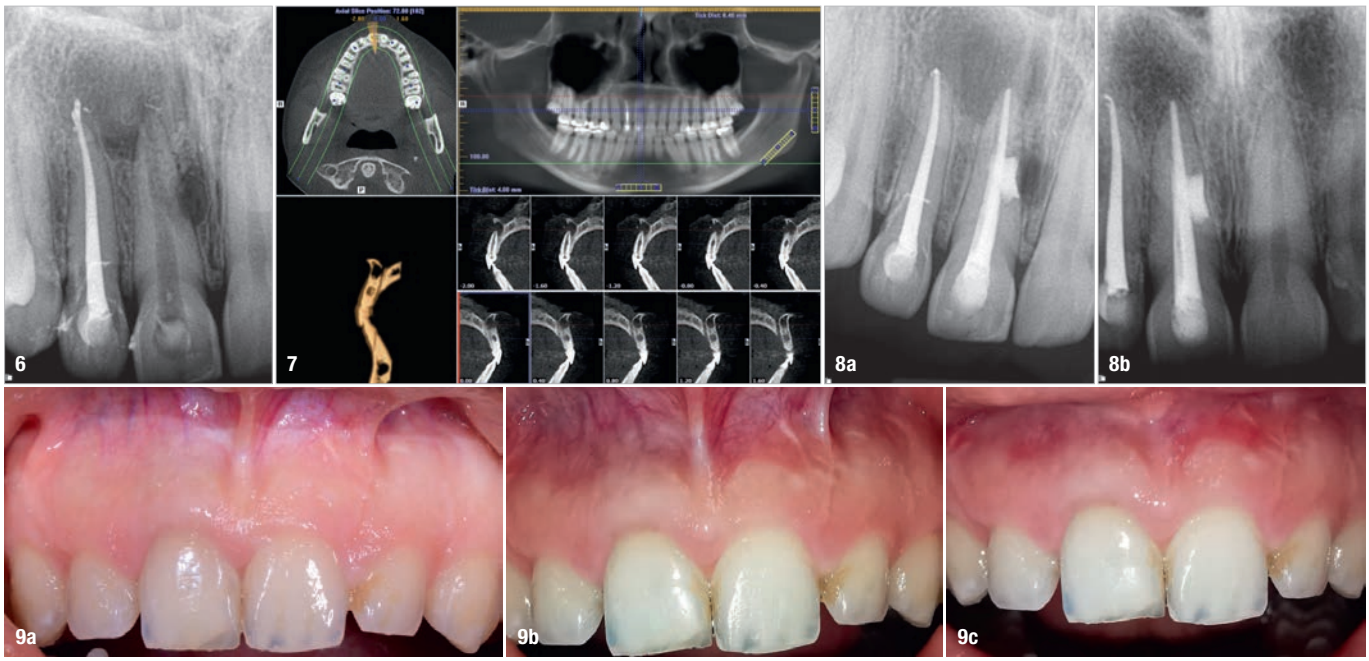
Figs. 4a–e: Case 2.

A zero apicectomy for the lateral incisor and a normal apicectomy redo for the central apicectomy were performed. The postoperative follow-up showed a great result for the papilla, beautiful conservation of the aesthetics and complete bone healing (Figs. 5a–c).

Case 3

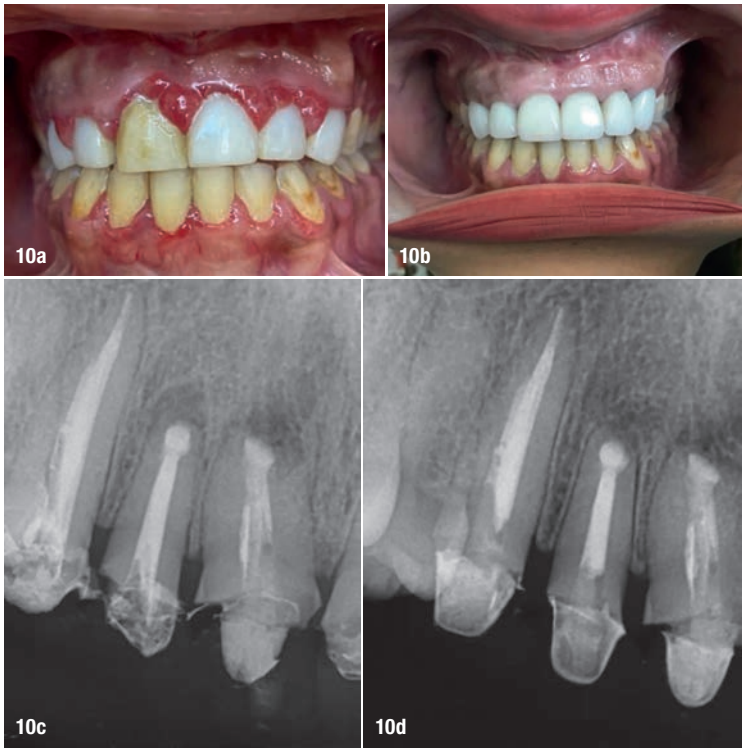
The patient was referred owing to failed root canal therapy, but this was a misdiagnosed case (Fig. 6), as she was suffering from lateral root resorption alongside a cyst in the apical area above the lateral and the central incisor. This infection developed, causing swelling inside her

Figs. 5a–c: Case 2. **Fig. 5c:** 18 months post-op.



Figs. 6–9c: Case 3. **Fig. 8b:** 18-month follow-up radiograph. **Fig. 9a:** 1-month follow-up. **Fig. 9b:** 3-month follow-up. **Fig. 9c:** 18-month follow-up.

upper nostril (Fig. 7), and after consulting with an oto-rhinolaryngologist, she was referred. A zero apicectomy and root canal retreatment were performed, and the lateral resorption was addressed, continually bearing the aesthetics in mind. The one-, three- and 18-month follow-up showed complete bone healing and stable resorption with periodontal ligament formation (Figs. 8a & b) and a beautiful smile (Figs. 9a–c).



Figs. 10a–d: Case 4. **Fig. 10c:** Immediate post-op. **Fig. 10d:** 8-month follow-up.

Case 4

This case was one of the most challenging regarding the aesthetic concerns, as the patient had previously undergone two endodontic surgeries that had failed, and re-treatment involving a complete redo of her crowns and smile was required. The status of the gingiva was not encouraging for any intervention, as the consequences can be unpredictable. The patient was put on mild antibiotics for one week in order to lower the inflammation or infection, followed by gentle cleaning and change of crowns to temporary crowns. This was followed after 48 hours by a long treatment involving redo of the microsurgeries and zero apicectomies combined with root canal retreatment. The major challenge was to manage the gingiva and the non-existent papillae. The eight-month follow-up showed superb bone healing and a new smile (Figs. 10a–d).

Conclusion

Microsurgery in endodontics is both challenging and satisfying. Following protocols can assure successful treatment outcomes.

about

Dr Philippe Sleiman is an assistant professor at the Faculty of Dental Medicine of the Lebanese University in Beirut in Lebanon and an Adj. Prof. at UNC University of North Carolina.

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Restoration of an endodontically treated tooth using a composite bilayer approach

Dr Katja Winner-Sowa, Germany

Introduction

Endodontically treated teeth often suffer substantial tooth loss owing to extensive caries, previous restorative treatment and the endodontic access itself. Their outcome does not depend solely on the obturation of the root canals but also on the quality of the coronal restoration. The residual sound tooth structure is of utmost importance here. Consequently, the maximum preservation and conservation of enamel, dentine and the cemento-dentinal junction, not only upon restoration but also in the long term, deserve maximal attention. In this case report, a composite bilayer approach with a short-fibre-reinforced composite is described as a modern postless adhesive alternative.

Case presentation

After tooth #26 had undergone root canal therapy because of irreversible pulpitis, a large and deep mesio-occlusal cavity was left (Fig. 1). Even though there was considerable loss of tooth structure, the remaining walls were sufficiently thick to opt for a direct restoration. This was also the most minimally invasive approach, as no tooth substrate needed to be sacrificed to shape the cavity. To support the remaining tooth structure and improve the durability of this restoration, a composite bilayer approach was used. The core of the restoration was filled with a flowable fibre-reinforced composite (everX Flow, GC), while at the surface, a universal composite with high wear resistance (G-ænial A'CHORD, GC) was used (Figs. 2–14).

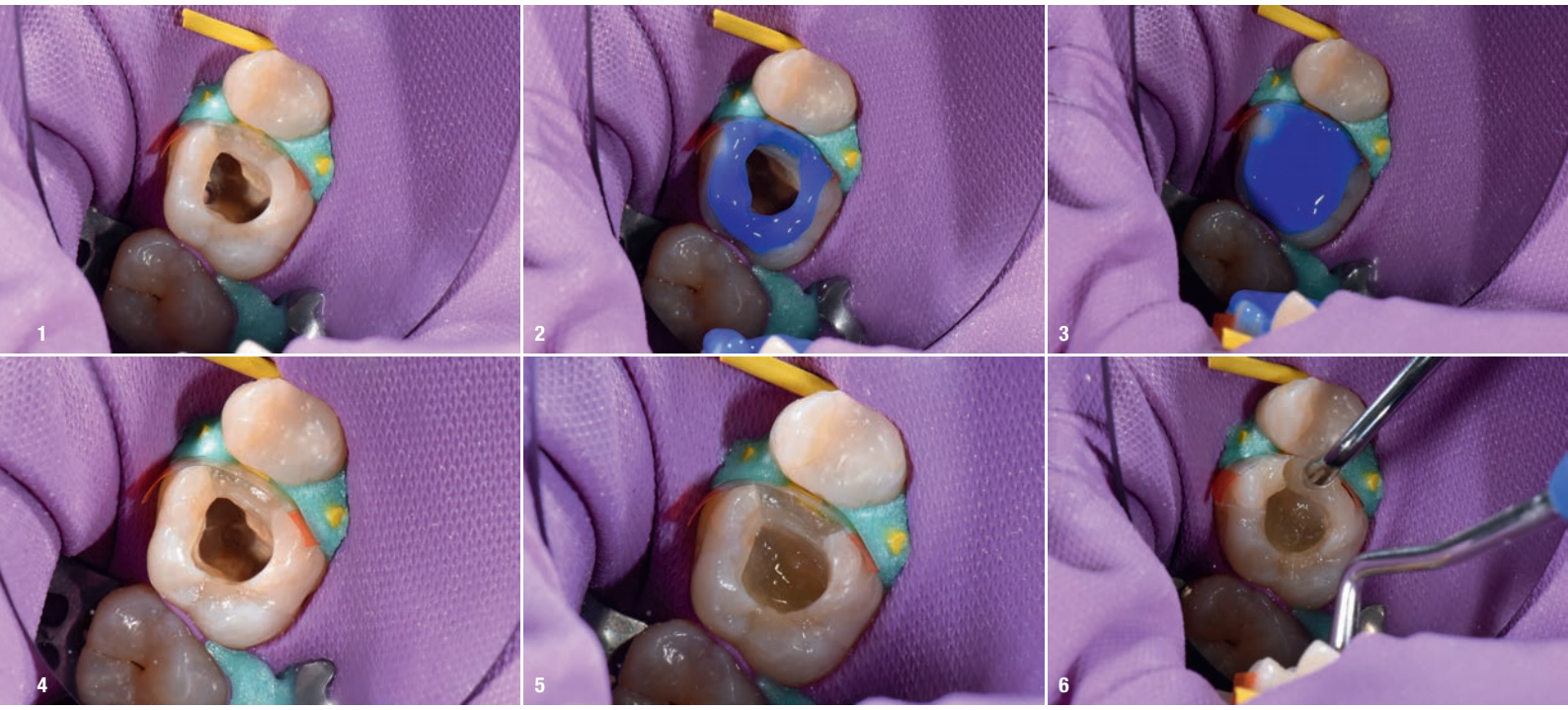

Fig. 1: After sandblasting with alumina, clean cavity surfaces were left, ready for adhesive treatment. **Fig. 2:** The enamel margins were etched for 30 seconds with phosphoric acid gel. **Fig. 3:** The dentine was etched for 15 seconds. **Fig. 4:** After application of G-Premio BOND (GC). This universal adhesive can be used in three etching modes (in this case: total etch). **Fig. 5:** To strengthen the remaining tooth structure, the deepest part of the cavity was restored with everX Flow (Bulk shade, GC). **Figs. 6 & 7:** With a composite instrument, the matrix band was held to the adjacent tooth during polymerisation to ensure a tight contact point.

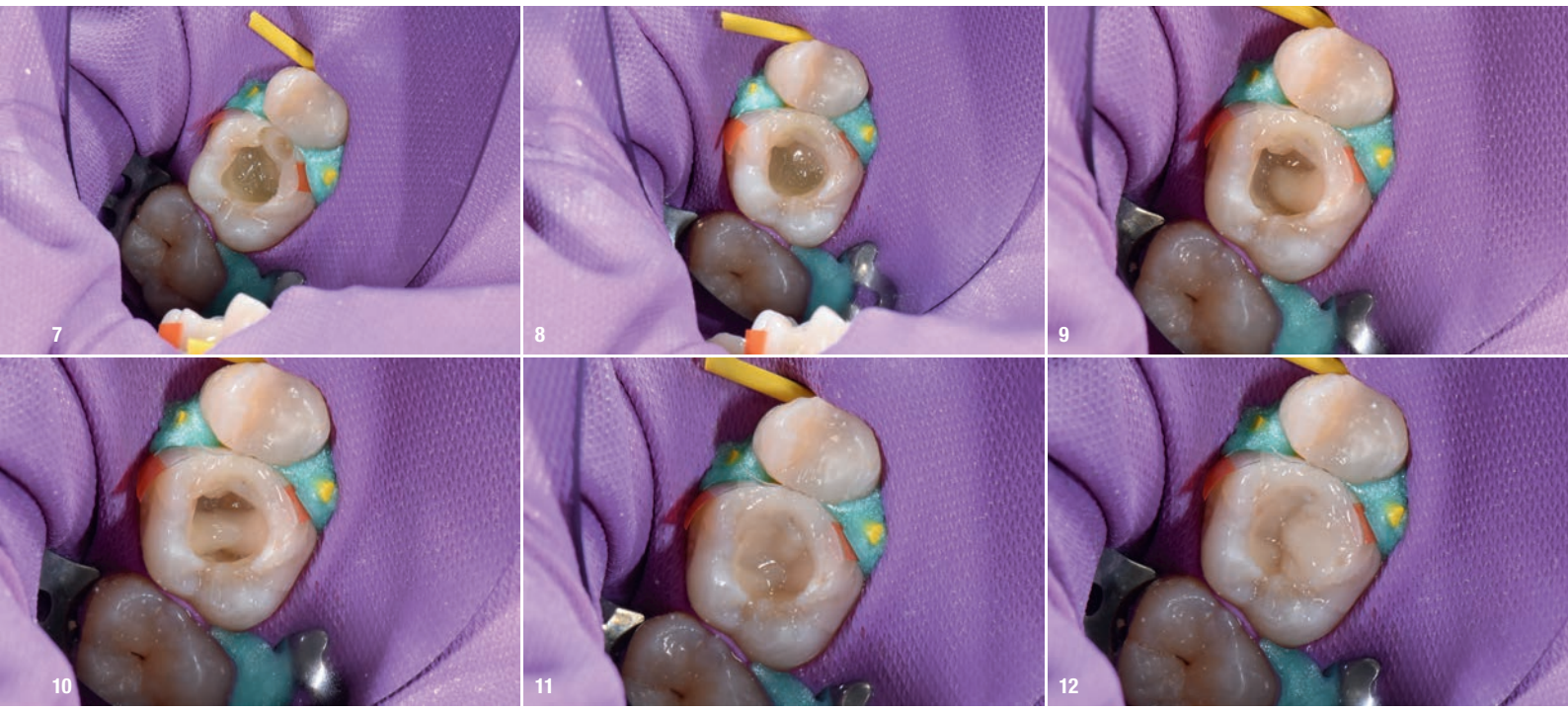

Fig. 8: The mesial wall was built up with G-ænial A'CHORD (Shade A2, GC). This composite has a fine, silky consistency and does not stick to the instrument, which makes it easy to apply. G-ænial Universal Injectable (Shade A2, GC) was used as a liner at bottom of the approximal box. **Figs. 9–11:** Undermining cavity areas were built up with everX Flow (Dentin shade) to increase the fracture toughness. The cusps were built up one by one with G-ænial A'CHORD. **Fig. 12:** Finalised restoration. Note that the enamel was still dehydrated.

Conclusion

When restoring posterior cavities, it is important to assess the loss of tooth substance and to select the right materials to assure a long-lasting restoration. In large, deep posterior cavities, the load-bearing capacity can be increased by using a fibre-reinforced composite (everX Flow) in a sufficiently thick layer, covered by a conventional composite. The function of the overlying conventional composite is to give a wear-resistant surface and to provide surface gloss and aesthetics. G-ænial A'CHORD with its simplified uni-shade system and good handling and mechanical properties is the perfect all-rounder for this purpose.

Editorial note: A list of references is available from the publisher.

about

Dr Katja Winner-Sowa first graduated as a dental technician in 2001. Soon thereafter, she started her dental studies and graduated in 2007 as a dentist from Goethe University in Frankfurt am Main in Germany. In 2012, she finished her habilitation qualification at the University of Westphalia in Germany. She works as a dentist in Münster, where she has had her own private practice since 2012. In 2013, she obtained a master's degree in endodontics from the Düsseldorf Dental Academy in Germany.

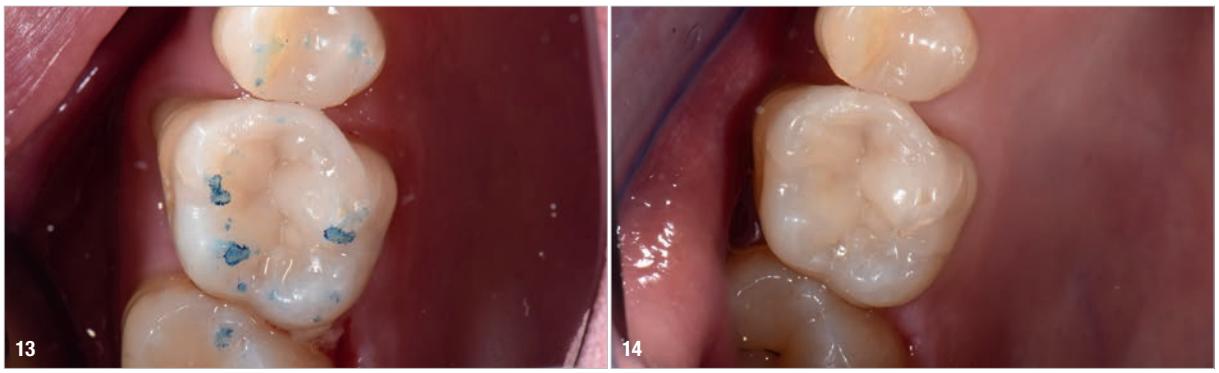

Fig. 13: After the occlusion check. Deflective contacts were removed. **Fig. 14:** After polishing with EVE points (EVE Ernst Vetter). A remarkably high gloss could be obtained with minimal polishing, and the shade blended in very well after rehydration.

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A new era of advanced dental restorative materials has begun

By Monique Mehler, Dental Tribune International

"Many have tried; few have succeeded" is a saying that certainly rings true in the case of Prof. Ervin Weiss from Israel. Several years after he graduated from dental school in his home country, he relocated to the US, where he worked at the National Institutes of Health for three years and trained to become a microbiologist. Back in Israel, he became a lecturer in restorative dentistry, finding his calling in teaching and mentoring the next generation of dental professionals. However, this is not Prof. Weiss's only passion. The combination of his scientific background and sheer endless curiosity led him to reflect on the lack of efficiency of traditional restorative dental composites and their high failure rate. He sought to find an antimicrobial material with permanently integrated activity, but none had been developed, and he was continually told that such a product was an impossibility. Driven by this unsatisfactory answer and his idea, what started as a mission to find a solution to this problem became his legacy: the world's first antimicrobial composite—and it might change dentistry forever.

> "This is the first restorative material in dentistry that treats a disease while restoring function, aesthetics and phonetics,"— Prof. Weiss said when speaking about Nobio's goals for Infinix.

That dental composites have many shortcomings is a well-known and scientifically backed fact. Indeed, it was shown by Mjör in 2005[1] and Kopperud et al. in 2012[2] that up to two-thirds of all restorative dental treatments involve the replacement of failed restorations because they are more prone to recurrent decay (due to the microleakage

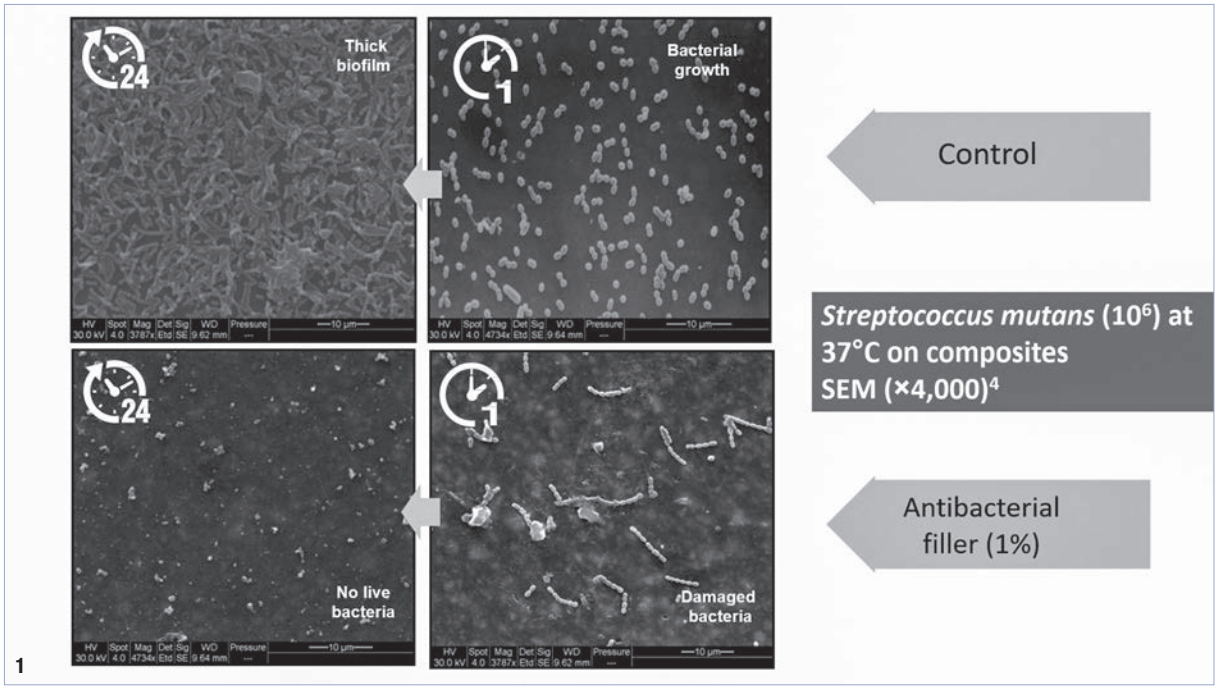


Fig. 1: The control composite (top) shows bacterial growth after 1 hour and a thick biofilm after 24 hours. The antibacterial filler (bottom) shows broken down bacteria after 1 hour and no live bacteria on the surface after 24 hours, respectively. *(All images: © Nobio)*

that results from shrinkage on polymerisation), debonding, technique sensitivity and the degradation of resin by oral bacteria. As reported in a market analysis published by Grand View Research, in the US alone, 200 million cavities are treated every year, and that means about 133 million dental fillings that will fail.[3]

In an interview with Dental Tribune International (DTI), Prof. Weiss stressed that preventive oral healthcare is the only answer to addressing oral disease, and restorative care cannot do so; however, restorative treatment is a necessity at times. This is where Prof. Weiss and his company Nobio come in, offering a technology that "transforms materials, products and surfaces to antimicrobial, with its revolutionary particles, providing strong, safe and durable bio-protection, for life".

How it works

In essence, Nobio's quaternary ammonium silica (QASi) particles exert concentrated electrostatic stress on bacteria that come in direct contact with the restorative

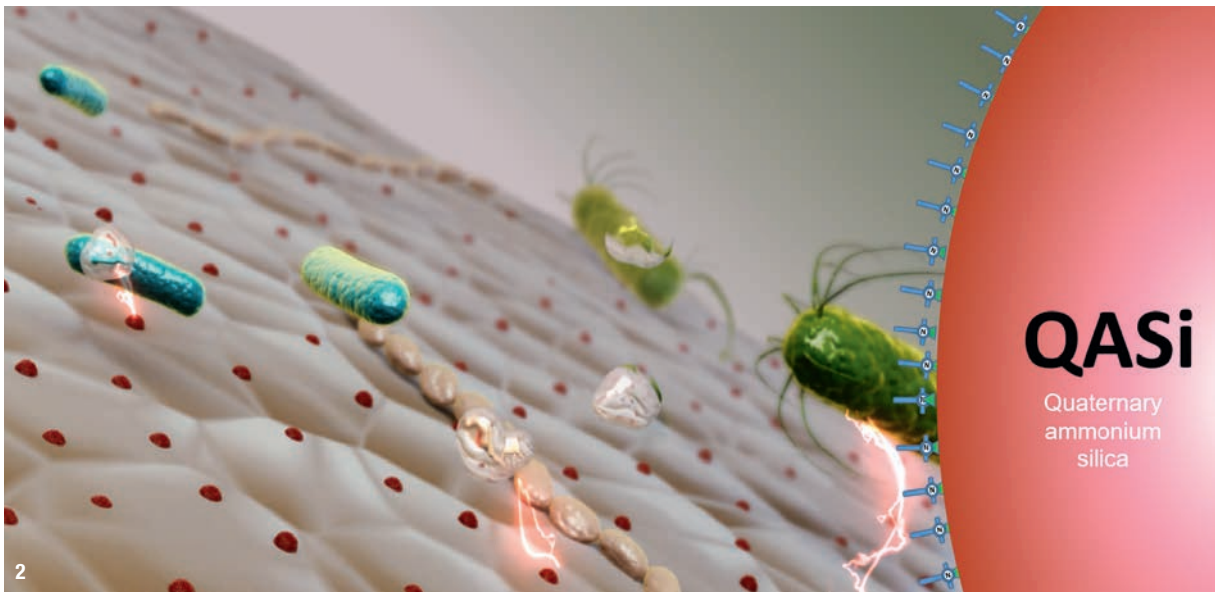


Fig. 2: A detailed illustration of Nobio's quaternary ammonium silica technology demonstrates how the material works in the oral cavity.

> "Now, instead of acting as surgeons and just cutting away the disease and restoring what is left as technicians, dentists can treat the disease itself, much like any other medical treatment."

material, causing their death, Prof. Weiss explained. "When bacteria touch the nanoparticles incorporated into the surface of the composite, the bacteria explode and die. This way, the acidity in the oral cavity is reduced and teeth cannot demineralise," he continued.

By killing these bacteria, which would usually promote demineralisation and subsequent carious lesions, Infinix composites reduce this mineral loss, preserving the restoration over time. Nobio's Infinix family of composite products are the first to be cleared by the U.S. Food and Drug Administration (FDA) for reducing tooth decay. In clinical trials, the antibacterial composites significantly reduced tooth demineralisation.[5]

Laboratory studies have shown that the QASi particles are potent antibacterial agents, do not leach out, inhibit the breakdown of the composite and maintain their antibacterial activity. Infinix composites were the only composites to maintain neutral pH in the presence of oral bacteria and sugar in a comparison with three conventional, widely used composites.[6]

The range consists of four products. For an antibacterial cavity cleansing effect, Infinix Universal Bond is a general-purpose, light-polymerised, self-etching bonding system (prime and bond). It provides strong adhesion between enamel, dentine and all types of restorative materials. Infinix Flowable Composite is a single-step, light-polymerised, low-viscosity flowable composite. It can be used for Class III and V restorations, ideally as a base and liner in direct restorations, as well as a pit and fissure sealant. Infinix Bulk-Fill Flow Composite is a low-viscosity composite with a high depth of polymerisation. It is ideal for posterior restorations, which are more prone to recurrent caries. Infinix Universal Composite is a light-polymerised, high-viscosity universal restorative composite which performs across a variety of conditions.

Clinical study confirms efficiency

From 2019 to 2020, the University of California, San Francisco (UCSF) in the US collaborated with Nobio in

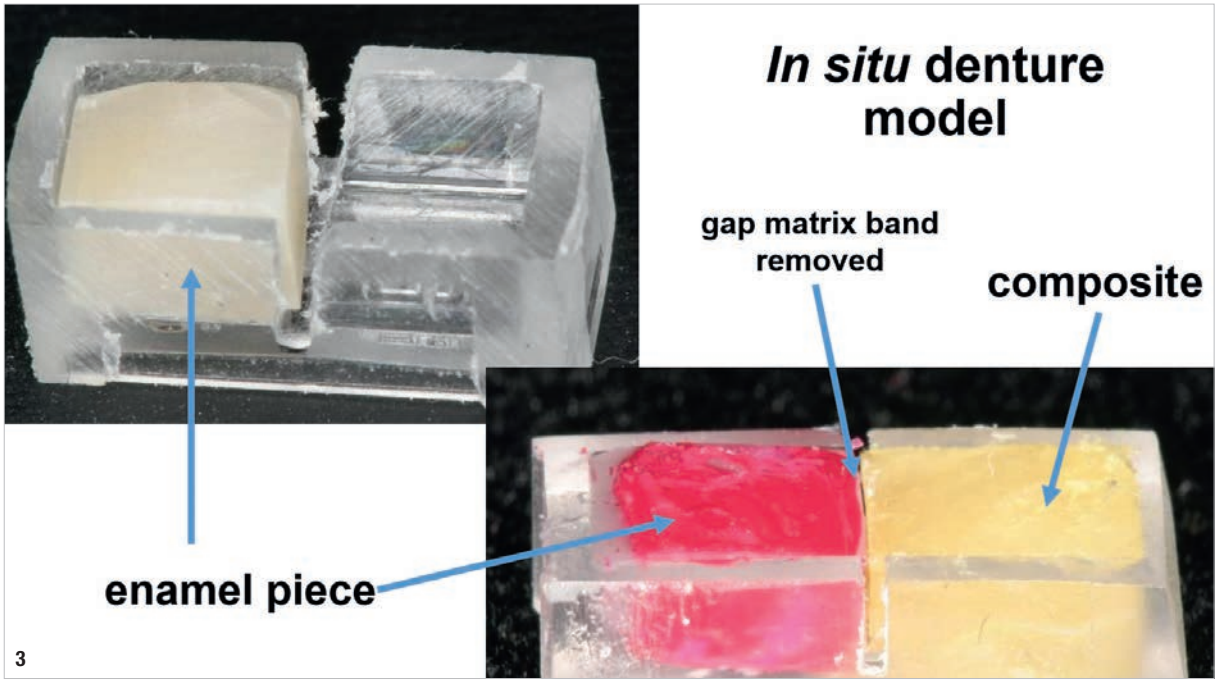


Fig. 3: The *in situ* denture models show the enamel and composite slabs which were used in the University of California, San Francisco clinical trial.

a clinical trial that tested the antibacterial composite in 25 patients who wore mandibular partial dentures with acrylic flanges on both sides of the mouth.[7] The researchers recessed a human enamel slab and a composite separated by a tiny gap into the flanges, employing Infinix in one flange and a standard composite as a control in the other. The participants were not aware of which side of the denture contained which composite. This gap model simulated a faulty tooth–restoration interface and then exposed it to cariogenic challenge.

After a four-week wearing period, samples were assessed in the laboratory using cross-sectional microhardness testing of the enamel. The UCSF researchers found that the average mineral loss for the Nobio side was significantly lower (nearly 70%) than for the control side in every patient.

Welcome to the future

In late summer 2020, the start-up, which Prof. Weiss founded in 2015 with Dr Julia Rothman, received FDA clearance to commercially distribute Infinix. Reporting on this achievement, local online newspaper the *Times of Israel* concluded that the clearance "gives Nobio access to the [US] $1.4 billion dental materials market".

In his interview with DTI, Prof. Weiss said that the COVID-19 pandemic had changed the original roll-out plans for the products. Infinix was to have been made available at the end of 2020 in Israel and the US, but that was changed to spring 2021. In the meantime, free product samples have been distributed to many practising key opinion leaders around the world, and according to Prof. Weiss, the feedback has been very positive so far.

Perhaps, it is rather paradoxical to ask Prof. Weiss where he thinks the future of dental materials is heading, since it seems that he and his team have just set a new gold standard, but for him, the vision is very clear: "We want every possible material to be equipped with Nobio technology so that patients can benefit from this new generation of materials that can shift the balance towards remineralisation and health." Indeed, Prof. Weiss confirmed that the company is already working on core build-up materials used in root canal therapy. Orthodontic cements and PMMA-based resins for partial and complete dentures are next on the agenda.

Editorial note: A list of references is available from the publisher.

about

Besides his role at Nobio and many other positions during his career, **Prof. Ervin Weiss** has trained hundreds of students of dentistry and dental research, published over 150 research articles, and presented more than 200 lectures, abstracts and research studies at international conferences in Israel and abroad. He holds fifteen patents in the fields of dentistry and microbiology. He lives and works in Tel Aviv in Israel, where he runs a dental office specialised in oral rehabilitation together with Dr Michal Dekel-Steinkeller.

Moving away from amalgam: New online tool helps dentists chose suitable restorative materials

By Jeremy Booth, Dental Tribune International

Prof. Reinhard Hickel

To support the dentists during the phasing down of dental amalgam, experts from Foundation Nakao's (www.foundation-nakao.com) management board have created an easy-to-use online educational tool that aims to guide clinicians in their selection of restorative materials. The Restorative Options Decision Tree draws consensus from experts and incorporates in the decision-making process key factors in restorative treatment, such as clinical situation, patient expectation and comfort.

Profs Reinhard Hickel, Clark Stanford, Eric Reynolds, Marco Ferrari and Keiichi Sasaki of the Foundation Nakao management board joined forces to support dentists in selecting appropriate restorative materials, and the Restorative Options Decision Tree project was initiated.

A comparison table of restorative materials was created in order to address different direct and indirect restorative options. Several parameters were considered, including

the site of the restoration, the condition of the remaining tooth structure, the depth and size of the lesion, the possibility to isolate, caries risk factors, economic considerations, and the physical and clinical properties of the different restorative options. The comparison table was later transformed into a decision tree, and after four further steps, the decision tree was finalised and approved.

The decision tree was adapted into a user-friendly online educational tool that aims to facilitate identification of the most suitable restorative materials for each situation. The advice based on the experts' consensus guides clinicians step-by-step in identifying the appropriate restorative materials and procedures depending on the clinical situation, taking into account key treatment factors such as time and cost efficiency, aesthetics, patient comfort and expectations, and preservation of tooth structure.

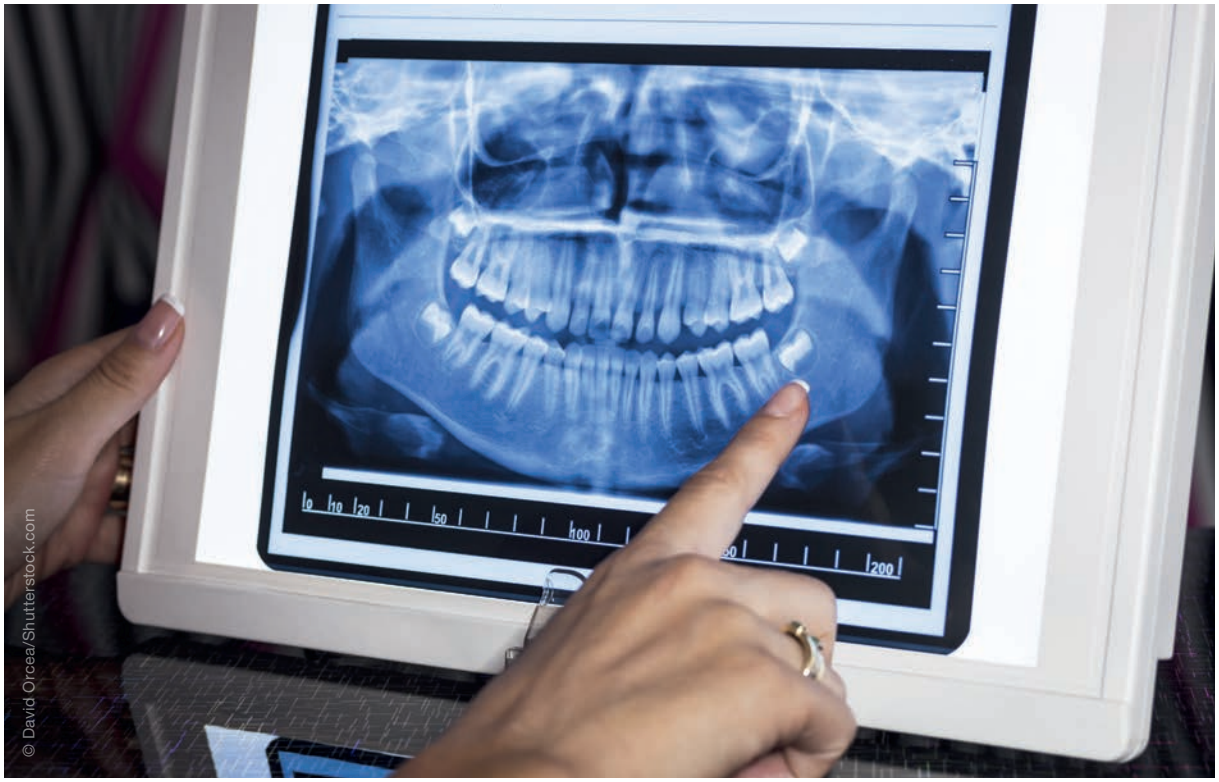
According to Prof. Hickel, director of the Department of Operative Dentistry and Periodontology at Ludwig-Maximilians University of Munich, the new tool will help dentists to consider the various conditions of patients and teeth involved in dental restorations, and to make decisions on which material to use as an alternative to amalgam.

"The phasing down of dental amalgam is happening in nearly all countries. In the European Union a termination may happen in the next five or eight years, but it will happen eventually," Hickel told Dental Tribune International. He said that a reduction in the use of dental amalgam was happening at different speeds around the world, and that it was taking place for different reasons. He explained: "In the US, aesthetics has played a role and patients are opting for a more aesthetic restoration. In Scandinavian countries, environmental factors have been a motivating factor in the phase down—for many other countries, toxicity has also been a concern."

"The phasing down of dental amalgam is happening in nearly all countries" —Prof. Reinhard Hickel, Ludwig-Maximilians University of Munich

Hickel commented that younger clinicians will face fewer hurdles in adapting to the use of new restorative materials. "I would not describe the phase-down as being problematic, it will involve new techniques and education is the key. Dentists will have to learn about and gather new experience using a new generation of restorative materials," he said.

The Restorative Options Decision Tree tool can be accessed at https://zingtree.com.



Based on experts' consensus, a new online educational tool helps clinicians in identifying the appropriate restorative materials and procedures.

Study determines work-related factors that keep oral health providers well

By Franziska Beier, Dental Tribune International

Dr Charlotte Wåhlin. *(Image: © Charlotte Wåhlin)*

Research focusing on factors that are associated with the well-being and healthy and meaningful working life of oral healthcare providers is scarce. Researchers from various health bodies in Sweden have conducted a study that aims at analysing which oral healthcare providers remain healthy at work and which organisational, work-related and health-related factors contribute to this.

A total of 486 dentists, dental hygienists and dental nurses from Swedish dental clinics participated in a questionnaire in 2012 and 2014 that featured questions about demographics, health indicators, and work and organisational factors. Oral health providers with no sick leave or sickness presenteeism were questioned about their perceptions of leadership, support at work, working conditions, job control, job demands, working ability and health. Their answers were then compared with results from oral health providers who reported sickness absence and/or sickness presenteeism.

For data analysis, the participants were classified into three groups: healthy group, semi-healthy group and unhealthy group. Respondents were classified as healthy if they had not reported sick leave or sickness presence in 2012 or 2014. The three groups showed no significant differences in terms of sex, age, professional category, clinic size, number of years in the dental service or working hours per week.

The researchers determined that factors that made it more likely to belong to the healthy group were: good physical work ability, the absence of pain in the neck, wrists, hands and lower back, no musculoskeletal symptoms in the shoulders, perceived low exertion at the end of the working day, and the absence of sleep problems.

Dental Tribune International contacted lead author Dr Charlotte Wåhlin, adjunct senior lecturer at the Department of Health, Medicine and Caring Sciences at

Linköping University, to ask her what consequences should follow the study findings. She replied: "Our message is that it is possible to organise work in such a way that prevents injuries. Employers and employees need to get engaged in systematic work environment management, identify the risks and have a plan on how to handle them. Employers should ask each employee what can be done for him or her to promote health at work. Our results from the study show that employees have different needs and their health clearly varies."

Wåhlin has worked as an ergonomist and occupational health and safety consultant at an occupational health service in Sweden. She said she had become interested in the work environment of dental professionals and that she "provided education to dental professionals on preventive work measures as well as assisted those employees returning to work who were absent because of sick leave".

When asked whether the ergonomic aspect of the dental profession—especially in times of SARS-CoV-2 in which the majority of people are concerned about a viral infection rather than physical harm—is too often neglected, she said that dental professionals could certainly become more involved in preventive interventions. "However, we need to evaluate both physical and mental exposure at the same time to see the whole picture, including factors affecting the individual, the group as a whole and the importance of leadership. My impression is that the dental profession has more acute patients in times of SARS-CoV-2 and that this can really affect the work exposure negatively," she emphasised.

Wåhlin recommends that dental professionals use ergonomic exercises in the daily practice to prevent work-related disorders. "Try to bring in more physical and mental variation during your working day. Stand up when you write medical records, use ergonomic work equipment, for example prism glasses and good ergonomically designed chairs. Also, test different instruments and use different grips, angle your neck by pulling your chin in to reduce strain on your neck, and instead of bending your back, try to fold from your hip."

She added: "It is also important to angle the patient's head instead of your own and to dare to fold the dental chair far back. Other helpful tips are to take walking meetings and to schedule administrative tasks for the middle of the day. Talk with each other, collaborate to create variation in your work tasks!"

The study authors concluded: "Understanding the relationship between working conditions and well-being is crucial to being able to design specific interventions for oral healthcare providers which will improve their working conditions and health. We suggest that future intervention studies should focus on how workplace resources influence employee health and well-being."

Editorial note: The study, titled "Work and health characteristics of oral health providers who stay healthy at work—a prospective study in public dentistry", was published online on 6 April 2021 in the European Journal of Physiotherapy*, ahead of inclusion in an issue.*

To reduce strain on the neck and resulting neck pain, it is recommended that the neck be angled by pulling the chin in.

Back pain—a clinician's nightmare

Dr Ali Nankali, UK

Back pain is one of the most common complications of an incorrect sitting or standing posture. It may appear gradually or suddenly. Many dental practitioners only realise how much of an impact back pain can have on their practice once they experience it. Luckily, although some people suffer from long-term shoulder or back pain, this pain can be reduced within a few weeks or months of treatment.

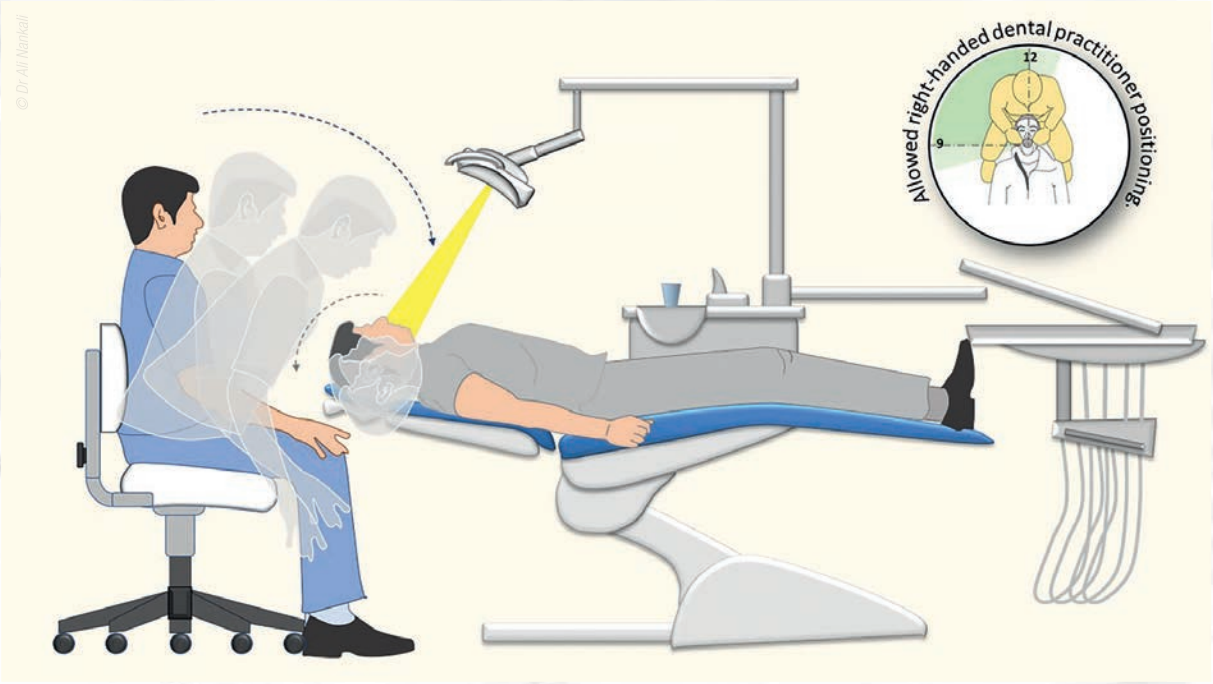
Back pain is one of the main disadvantages of a dentist's profession. Some studies show that over 70% of dental practitioners suffer from chronic back pain. In one study on back pain prevalence and intensity in French dentists, female clinicians reported more frequent and intense pain than men, especially in the neck and upper back areas. In the same study, age and years of practice had a direct relationship to the intensity of pain and discomfort.

Dental students are starting to experience musculoskeletal pain as well—an alarming observation that should be taken seriously. I am a clinician myself and have taught both postgraduate and undergraduate dental students for many years. I have also been involved in various research projects and studies. In my experience, it is clear that incorrect posture and positioning is what causes back pain among clinicians.

The problem usually begins when a dental student starts to work with a phantom head at an early stage of his or her studies. A student who is just starting practical exercises is often too eager to absorb all the information and to complete the programmed tasks. Tutors might talk in-depth about the required posture and positioning, yet young practitioners often think that by minimising the working distance and getting closer to the treatment area, they will be able to get a better look at what they are doing and, consequently, achieve a better outcome. This is a false assumption.

After a while, many tutors, myself included, get tired of repeatedly talking about the importance of correct posture. Unfortunately, the students in question do not realise that the problem is only getting worse, and they become aware of it only when they start treating their first patients. Since they have a gap in their learning, they

Some studies show that over 70% of dental practitioners suffer from chronic back pain.



Besides causing discomfort, back pain caused by incorrect posture and positioning may also undermine clinicians' confidence and affect treatment outcomes.

do not have enough confidence to correct their posture and positioning, and therefore the incorrect posture and positioning will remain.

For the last seven years, I have paid special attention to the topic and discovered some interesting facts. For example, I now know that the wearing of glasses is one of the main factors affecting posture. Regular reading glasses, provided by an ophthalmologist, have a 22–25 cm focus point. Therefore, the student or practitioner maintains the recommended distance in order to see clearly. Asking for new glasses with a focus point of about 40–45 cm is an easy solution that could help tremendously.

Another interesting fact is that practitioners know better than anyone that they have incorrect posture and positioning, yet they do not know how to correct it. The lack of confidence does not allow them to challenge their habits on their own, and so they often seek help.

Choosing the right dental care unit

Being a member of the dental community, I realised that the first step for many professionals who suffer from back pain is getting a new patient chair. I contacted Planmeca, a well-known dental unit manufacturer based in Helsinki in Finland, to explore its opinion on the topic. Planmeca offers a selection of dental care units with many different configurations. Discussing the issue, Planmeca Senior Vice President Jukka Kanerva explained that the company's product philosophy has always been that its equipment needs to adapt to the user's ways of working, not the other way around.

Planmeca is a global company, and its products are distributed in over 120 countries. In order to successfully function in all these markets, the company's dental units have to adapt to different market requirements. "For example, the preferences of Japanese dentists differ greatly from those of their French colleagues. People come in different shapes and sizes, and dentists like different types of instrument delivery systems," Kanerva explained.

"Also, some like to treat their patients while sitting down, some while standing. This means that the design of the dental unit needs to adapt to several different variables. For this reason alone, our Planmeca Compact i5 dental unit has an almost unlimited number of different customer configurations available. All our units can also be customised for left-handed users," he continued.

As we can see from Planmeca's response, manufacturers are happy to provide practitioners with what is needed. Kanerva assured me that Planmeca follows ergonomic guidelines and studies closely since these are the backbone of its product development process. He commented: "We (Planmeca) also gather feedback from our customers by using many different methods, such as clinic visits by our usability specialists and trade show visits by our sales staff."

"Of course, anyone can submit their ideas through our website, and these submissions are saved in our database and analysed. The most common requests are those pertaining to a particular way of working, and these vary from country to country. Ease of use and ergonomics are the key attributes that dentists around the world are

Planmeca dental chair production in Helsinki in Finland.

looking for. We are constantly following trends and developments in the industry." He also added that Planmeca has several qualified in-house dental professionals who help improve the daily dental workflow from a clinician's point of view. Additionally, the company says that it tests its products in cooperation with dental clinics. So what, then, are the main factors that a dental unit manufacturer has to consider?

"There are several key requirements regarding the design and manufacturing of dental units. First of all, wide and smooth movements of instrument delivery are crucial because the unit needs to adapt to different working positions. Wide movement range of the patient chair as well as the shape of the chair's backrest are also important since they help to ensure that the clinician can get as close to the patient as possible and find and maintain the best working position," Kanerva explained.

"In order to maintain an ergonomic way of working while treating a patient, all necessary equipment and instruments need to be close by, with the instruments always in the peripheral vision of the practitioner. In this way, hand and arm movements can be limited to the fingers, wrist and elbow, and larger shoulder and torso movements can be avoided. We have also designed special mid-bending instrument arms that further contribute to an ergonomic workflow since they make instruments especially light to use."

As we can see from the manufacturer's explanations, it is in its interest to listen to practitioners' requirements. However, statistics demonstrate that many clinicians are still suffering from back pain. Many dentists who do not know how to manage back pain try to work in a standing or a different sitting position, which, unfortunately, is reported to lead to more intense pain, especially in the upper and lower back areas. Having said that, there are some situations where practitioners should stand to perform the required tasks. These include when extracting a tooth and when taking impressions.

Maintaining the correct posture

Maintaining a good posture helps practitioners achieve superior outcomes and protects them from future problems such as back pain. It allows the practitioner to see the working area properly, which optimises performance and minimises the risk of iatrogenic damage. Contrary to popular belief, keeping the eyes closer to the working area does not help the clinician to have better control of a handpiece. In fact, being too close to the target area, less than 25 cm away, will not only decrease the level of accuracy but will also create discomfort for the patient.

When talking to practitioners, I realised that many of them are turning to self-help sources. I found out that these sources are relatively expensive and written in a very general manner. To help clinicians, I spent nearly three years with both right- and left-handed students and practitioners to create and publish a textbook named Posturedontics. This textbook aims to show the best position and posture for treating each tooth surface area. The book was published a few years ago and has received excellent feedback. Some practitioners mentioned that it is difficult to use the book at first, but as soon as you understand it, you benefit from it.

In most cases, if a practitioner needs to move his or her head or change posture, he or she has not been able to see the working surface area correctly during the proce-

dure. Not maintaining the most suitable posture for each task will most likely affect the treatment outcome too. To give practitioners guidance on the topic, I started to run courses on posture and positioning on UKDentalCourses (www.ukdentalcourses.com/short-term-cpd).

Studies demonstrate that about 85.5% of clinicians have a forward head posture, whereas 68.8% have a round shoulder posture. For this reason, 36.1% of practitioners suffer from scoliosis and hyperlordosis. Most studies on working posture demonstrate a high risk to the lower back and neck. However, appropriate posture muscle strengthening exercises for the neck area can play an important role in minimising this risk.

Although it is clear that a dentist's back pain is mainly caused by an incorrect posture, alternative diagnoses should be ruled out by examining or reviewing the signs and symptoms. If a serious underlying pathology is suspected, the dentist should be referred to the right specialist for relevant guidance. Medication, exercises, surgery and cold or warm therapies are the most common methods of treatment depending on the definitive diagnosis. However, the pain will return if the practitioner does not improve his or her posture and positioning.

To remain active in their daily activities, practitioners are advised to take over-the-counter painkillers such as paracetamol or ibuprofen. In my opinion, this depends on the severity of the pathology, as taking medicine might temporarily make you feel better, but it will not solve the problem permanently. Exercises such as lower back pain exercises, bottom to heels stretches, knee rolls and pelvic tilts could be of help.

In conclusion, a young learner needs to understand the importance of his or her posture and positioning from day one and follow the instructor's recommendations.

Exercises such as stretching could be of help.

Incorrect posture and positioning not only cause discomfort such as back pain but also undermine a clinician's confidence and affect treatment outcomes. Existing self-help sources are highly limited, and practitioners need more help on the topic. Dealing with back pain is crucial, and postponing the treatment may result in more complications.

about

Dr Ali Nankali is a clinical senior lecturer at Barts and the London School of Medicine and Dentistry at Queen Mary University of London and the president of UKDentalCourses, an online education platform that offers continuing professional development opportunities to dentists worldwide.

High-quality microscope solutions

Heads-up dentistry now within reach of all clinicians

Operating microscopes provide complete visualisation inside a patient's tooth with up to 29× magnification and integrated LED illumination. According to the American Association of Endodontists, higher magnification, especially through the use of a microscope, improves treatment outcomes and should be the standard for all dentists performing endodontic procedures.

The potential for microscopes to transform the dental industry is tremendous. All clinicians who want to provide the highest level of patient care, grow their practices through new and improved procedures, and extend their careers with heads-up viewing and better ergonomics will benefit from higher magnification through a microscope. Now, the latest generation of this technology is within reach for all areas of dental care.

Zumax Medical's microscopes are known for their superior high-definition optics, smooth balancing arms and economical pricing. A six-point magnetic arm enables the microscope to move fluidly at the push of a button and stabilise upon release. An integrated high-definition recording system allows clinicians to document and share procedural information.

Zumax's microscopes also allow the clinician to bypass the oculars for heads-up viewing in either 4K or 3D, eliminating musculoskeletal strain from poor ergonomics. Visualisation is easily extended to a smartphone device for real-time viewing and sharing of treatment details with patients and other clinicians.

"We are excited to bring this microscope technology to physicians all over the world," said Karl Wang, CEO of Zumax. "As a medical technology manufacturer working closely with clinicians around the world, we've engineered the latest high-tech features into a sleek, modern design."

At the beginning of 2021, Zumax launched three new models: the OMS2380 R2, the OMS3200 R2 and the OMS3200 PRO. For more information, please contact sales@zumaxmedical.com.

About Zumax Medical
Founded in 2005, Zumax Medical is a professional manufacturer of medical optical instruments located in Suzhou in China. The company was awarded the Chinese National High-Tech Enterprise designation in 2013.

Zumax provides products for various fields, including dentistry, ophthalmology, otorhinolaryngology, head and neck surgery, and community and general medical practice. In the dental arena, Zumax is a standing member of the professional board of dental equipment and technology branch of the China Association of Medical Equipment, a member of the academic committee of dental equipment branch of the Chinese Stomatology Association and a member of the China Association for Medical Devices Industry.

www.zumaxmedical.com/dental-microscope

The Jeni endodontic motor goes on tour

COLTENE travels through Germany with its new workshop programme

If you are thinking about buying a new car, you usually try out the object of your desire first, with a test drive. It is much the same when it comes to the fully automatic Jeni endodontic motor from COLTENE, the international dental specialist: dentists can conveniently test-drive the assistance system at a location near them—from a short trip around the block all the way to a day-long road test.

Trip around the block or road test?

The innovation leader in Germany is taking the new CanalPro Jeni endodontic motor on the road in spring for its major city tour. Because the coronavirus restrictions still pose major challenges for dental practices, COLTENE is offering a new format for further education and training: at a number of locations across the country, dentists will have the opportunity to test-drive the Jeni endodontic motor at a time and place that suits them. In addition to 15 original dates, the company has already announced others. After starting in Germany, the tour will be extended to Europe in the autumn.

The choice is between a short test drive of the assistance system as part of a 2.5 hour introduction or an extended road test, that is, a full-day seminar. Both workshops will be led by renowned and experienced endodontic specialists and the COLTENE team of experts and address the special features of the intelligent endodontic motor.

While mechanical reprocessing is now an established standard in endodontic practices, CanalPro Jeni works differently to filing motion options known to date and navigates independently through the treatment. Here there are a number of popular sequences to choose from for the flexible nickel–titanium (NiTi) files. The user works forwards continuously from the coronal to apical aspect, applying only slight pressure, while the motor decides on the progress of motion. Based on complex algorithms, the software can control the variable filing motions at millisecond intervals by constantly regulating rotational motion, speed, torque and file stress. This makes the treatment even safer and therefore more comfortable.

Endodontic innovations live

The course will start with an introduction to the new Jeni reprocessing system with HyFlex CM and EDM NiTi files. This will be followed by some theory and then a practical session, including numerous hand-on exercises on a practice block and tooth. This way, even endodontic beginners will soon become competent and efficient at reprocessing with the Jeni. Dentists will also receive all relevant information for billing endodontic treatments correctly, profitably and in accordance with legal requirements.

To see what dates are currently available please go online to: events.coltene.com. The previous webinars on CanalPro Jeni and the HyFlex and MicroMega file systems can be accessed at any time from the COLTENE webinar archive: COLTENE Mediathek | GoToStage.com.

An informative explanatory video on the COLTENE YouTube channel provides an introductory insight into the endodontic motor functionality: https://youtu.be/Qw3uc3hSTkg. In addition, the COLTENE team of experts is available at all times to advise and support dentists, dental technicians and practice staff. You can contact them via e-mail (info.de@coltene.com) or through one of the social media channels, where you will find questions and answers about specific use or support for optimal application and combination of dental materials and tools.

www.coltene.com

International events

12th IFEA World Endodontic Congress

12–14 August 2021 (online event)
India
www.ifea2020india.com

CEDE—Central European Dental Exhibition

7–9 October 2021
Łódź, Poland
www.cede.pl/en

16th International Congress of the International Federation of Dental Anesthesiology Societies

17–19 September 2021
Moscow, Russia
www.ifdas.org

World Clinical Laser Institute (WCLI) 2021 Asia Pacific Symposium

9–10 October 2021
(onsite and online event)
Dubai, UAE
https://events.wcli.org

57th Annual Meeting of the Canadian Academy of Endodontics

18 September 2021 (online event)
Canada
www.caendo.ca

Dentex—International Dental Equipment Exhibition

21–23 October 2021
Brussels, Belgium
www.dentex.be/en

IDS—International Dental Show

22–25 September 2021
(onsite and online event)
Cologne, Germany
www.ids-cologne.de

Italian Society of Endodontics (SIE) National Meeting

12–13 November 2021
Bologna, Italy
www.endodonzia.it

FDI World Dental Congress

26–29 September 2021 (online event)
Australia
www.fdiworlddental.org/fdi-world-dental-congress

AAE Annual Meeting

27–30 April 2022
(onsite and online event)
Phoenix, US
www.aae.org

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- the complete article;
- all the image (tables, charts, photographs, etc.) captions;
- the complete list of sources consulted and
- the author or contact information (biographical sketch, mailing address, e-mail address, etc.).

In addition, images must not be embedded into the MS Word document. All images must be submitted separately, and details about such submission follow below under image requirements.

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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 fewer 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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Please use single spacing and make sure that the text is left justified. Please do not centre text on the page. Do not indent paragraphs, rather place a blank line between paragraphs. Please do not add tab stops.

Should you require a special layout, please let the word processing programme you are using help you do this formatting automatically. Similarly, should you need to make a list, or add footnotes or endnotes, please let the word processing programme do it for you automatically. There are menus in every programme that will enable you to do so. The fact is that no matter how carefully done, errors can creep in when you try to number footnotes yourself.

Any formatting contrary to stated above will require us to remove such formatting before layout, which is very time-consuming. Please consider this when formatting your document.

Image requirements

Please number images consecutively throughout the article by using a new number for each image. If it is imperative that certain images are grouped together, then use lowercase letters to designate these in a group (for example, 2a, 2b, 2c).

Please place image references in your article wherever they are appropriate, whether in the middle or at the end of a sentence. If you do not directly refer to the image, place the reference at the end of the sentence to which it relates enclosed within brackets and before the period.

In addition, please note:

- We require images in TIF or JPEG format.
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Questions?

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roots

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