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4/20

roots

international magazine of endodontics

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Adj. Prof. Philippe Sleiman

Guest editor

Daily clinical challenges

Endodontics is the art and science of daily challenges, expecting the unexpected, having eyes at the tips of your fingers and employing all your senses. First and foremost, we must not forget that we hold medical degrees, and indeed, endodontics can sometimes be very demanding when dealing with patients with special medical histories or some illness or even contagious virus, and we need to fulfil our paths.

Travelling to the office, looking at the day's schedule and not knowing what challenges lie ahead, it is essential to foster a good mood and to spread it to your team in order to have a calm and smooth day, putting all your worries aside.

Accepting the diagnosis as it is and trying to replace nature is something that we never have to do or promise. If the tooth needs root canal therapy or does not, we need to say so. If the tooth is cracked or compromised, we need to accept it and try to explain to our patient and to the referring dentist the best options for treatment. Sometimes, it may be considered a waste of your clinical time, but use it as an opportunity to have a break to check on your family and chat with your staff over a warm coffee. If microsurgery is needed to remove a cyst, better sooner rather than later. One of the major causes of burn-out in dentistry is not delivering what we wish for.

We cannot be in control of everything; mother nature and our body have the upper hand. It is not a reversible treatment that we are doing, and room for error is almost non-existent. This is something that demands great mental preparation in order to keep calm and give the best that we can for our patients—after all, we are performing the most complicated treatment in dentistry; we are doing endodontics.

Adj. Prof. Philippe Sleiman
Guest editor


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Reducing microleakage with Er,Cr:YSGG and/or Nd:YAG lasers

An evaluation

Drs Mina Mazandarani, Maziar Mir & Masoud Shabani, Iran; Prof. Norbert Gutknecht, Germany

Introduction

In endodontics, effective cleaning of the root canal system is essential for ensuring successful root canal therapy with long-lasting treatment outcomes.[1–3] During endodontic instrumentation, various morphological changes occur on the root canal walls, including organic and mineral debris[4–7] and smear layer formation.[2,4,7] Therefore, not only are conventional cleaning and removal of debris and the smear layer important steps in endodontic procedures,[1,2] but chemical irrigation is strictly recommended for use in conjunction with mechanical instrumentation in order to dissolve debris and the smear layer.[8,9] In fact, the methods employed to clean and shape root canal spaces create a smear layer, which may harbour microorganisms that ultimately result in periapical pathosis.[3,7] Many irrigant solutions, such as sodium hypochlorite and ethylenediaminetetraacetic acid (EDTA), are used. Sodium hypochlorite is effective in removing organic tissue remnants,[8] while EDTA is effective in removing the inorganic portion of the smear layer.[9] However, both irrigants are unable to remove the smear layer effectively.[1,3,10]

A successful root canal therapy is based on a number of factors: reduction of microorganisms to the minimum, sufficient and proper root canal instrumentation and disinfection, as well as well-adapted root canal obturation.[11] A crucial disadvantage of irrigant solutions is that their bactericidal effect is limited to the main root canal. Because of the narrow diameter of the dentinal tubules and the high surface tension of the liquid solutions, they are able to penetrate only a small distance into the tubules. The penetration depth of chemical disinfection only reaches 100 µm into the adjacent dentinal tubules.[12,13] However, the bacteria can penetrate over 1,000 µm from the canal lumen,[12] as described by Kouchi et al.[14] and

Group number	Groups	Laser setting	Fibre/Tip size	Time of operation	Sample size
1	Conventional preparation & EDTA & Er,Cr:YSGG & Nd:YAG	Er,Cr:YSGG = (1.5 W, 20 Hz), 140 µs, [Waterlase MD]* Nd:YAG = (1.5 W, 15 Hz) Pulse duration = 160 µs [Fotona]**	Er,Cr:YSGG = 320 µm Nd:YAG = 200 µm	2 mm/sec Rotational	12
2	Conventional preparation & Er,Cr:YSGG & Nd:YAG	Same as * and **	Er,Cr:YSGG = 320 µm Nd:YAG = 200 µm	2 mm/sec Rotational	12
3	Conventional preparation & EDTA & Nd:YAG	Same as **	200 µm	2 mm/sec Rotational	12
4	Conventional preparation & Nd:YAG	Same as **	200 µm	2 mm/sec Rotational	12
5	Conventional preparation & EDTA				12
6	Conventional preparation				12
Total					**72**

Table 1: All groups of laser-irradiated root canals and control (n = 72).

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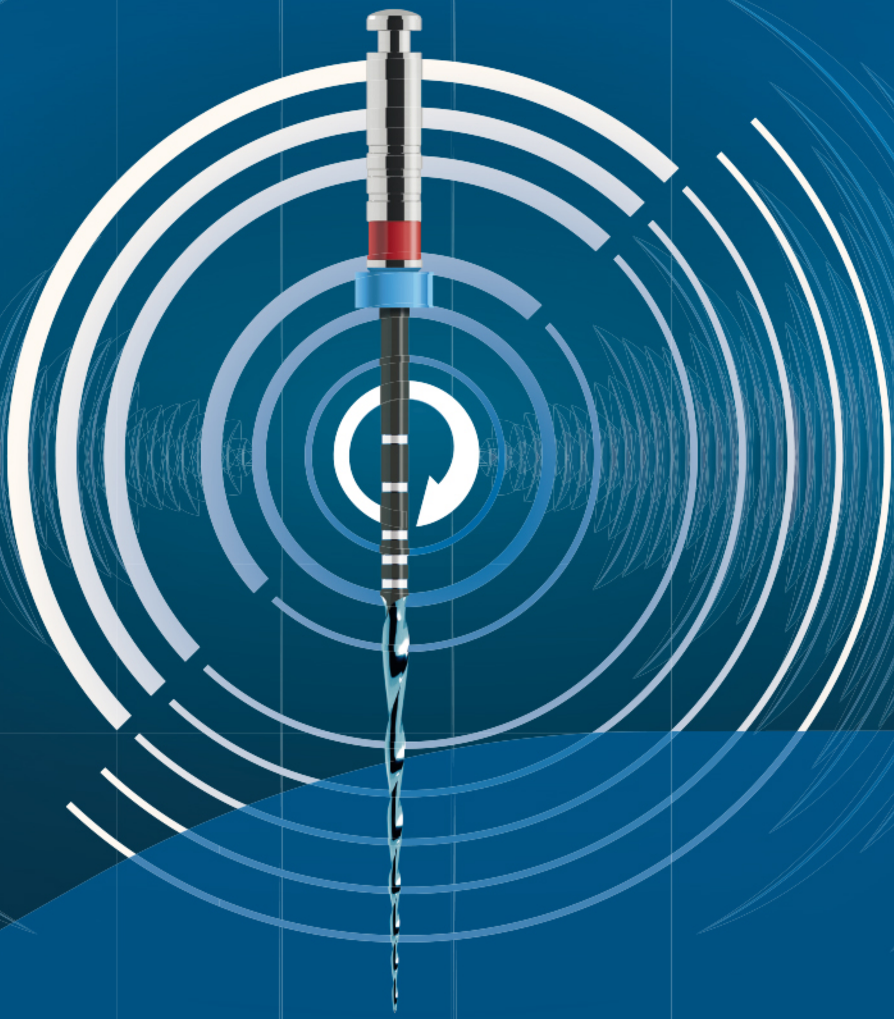

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Root third	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Apical	845 (Gr. 2)	950 (Gr. 2)	975 (Gr. 2)	582 (Gr. 2)	632 (Gr. 2)	483 (Gr. 1)
Middle	183 (Gr. 1)	512 (Gr. 2)	579 (Gr. 2)	517 (Gr. 2)	917 (Gr. 2)	821 (Gr. 2)
Coronal	380 (Gr. 1)	356 (Gr. 1)	504 (Gr. 2)	391 (Gr. 1)	718 (Gr. 2)	962 (Gr. 2)

Table 2: Graded average dye penetration depths (μm). *Gr. = grade.*

Ando & Hoshino.[15] Therefore these bacteria are protected in the deeper layers of dentine. In this protected area, we find Gram-negative bacteria, which are characterised by their unusual migration qualities and their resistance to chemical irrigant solutions. They maintain their virulence against conventional endodontic techniques. And we find that, from this bacterial reservoir, the bacteria will spread to the periapical areas of the tooth, causing inflammation and infection.[12] Since conventional root canal therapy is not always successful, new methods could perhaps enhance the long-term prognosis and overcome the shortcomings of conventional instrumentation methods.[11]

Today, lasers are used in endodontics to dramatically improve the prognosis of root-filled teeth.[12] Laser irradiation produces different effects on the same tissue, and the same laser can produce various effects in different tissues. Er:YAG and Er,Cr:YSGG lasers have been reported to ablate dental hard tissue[16–21] with minimum injury to the pulp and surrounding tissue.[17–19,22–25] The Er:YAG laser has been reported to ablate enamel and dentine effectively, because of its highly efficient absorption in both water and hydroxyapatite,[16,20,21] and the Er,Cr:YSGG laser, which uses a pulsed beam system, fibre delivery and a sapphire tip bathed in a mixture of air and water vapour, has been shown to be effective for cutting enamel, dentine[18,20] and bone.[18] Moreover, this specific property, combined with a water spray for both lasers, enables the effective removal of debris and the smear layer.[23,26–31] The surface morphology of root canals can be altered by using a 1,064 nm Nd:YAG laser. Remaining soft tissue as well as the smear layer can be partially or completely removed, depending on the energy level used.[11]

The Nd:YAG laser seems to be the laser of choice in root canal therapy. It is also the best-documented laser in the literature for root canal sterilisation. Most of the studies concerned with the Nd:YAG laser in endodontics deal with the quantitative evaluation of bacteria reduction.[12] Laser irradiation has been widely introduced in endodontic treatments as an aid to disinfection and the removal of debris and the smear layer from instrumented root canal walls and might be a solution for the various limitations and shortcomings of mechanical and chemical disinfection. Microleakage continues to be a main reason for failure of root canal therapy, where the challenge has been to achieve an adequate seal between the internal tooth structure and the main obturation material, gutta-percha.[32] It has been found that approximately 60 % of endodontic failures are due to inadequate obturation of the root canal system.[33,34] Although gutta-percha is the most popular core material used for obturation, it cannot be used as the sole filling material because it lacks the adherent properties necessary to seal the root canal space. Therefore, a sealer and cement are always needed for the final seal.[35,36] The Resilon/Epiphany system uses a new obturation material that bonds chemically with the internal tooth structure, thereby decreasing the possibility of microleakage.[32]

The scientific investigation of fundamental problems plays a decisive role in understanding the mechanisms of action of exposing biological materials to laser irradiation and their consequences.[37] The purpose of this study is to analyse microleakage differences when removal of the smear layer is done conventionally, chemically (with and without EDTA) and with Er,Cr:YSGG and/or Nd:YAG laser irradiation and Resilon/Epiphany is used as the obturation material.

Materials and methods

In this study, 72 freshly extracted caries- and restoration-free single-canal bovine teeth[38,39] stored in normal saline (0.9 %) at 4 °C were used, after scaling with scalpels or hand instruments to remove residual tissue and calculus and rinsing thoroughly with tap water. Samples were randomly divided into six groups of 12 teeth each. The working lengths were established as 1 mm short of the apexes. The canals were hand instrumented with Kerr files (Maillefer) to the size of ISO 30 to this length in order to create an apical stop. The root canals were thoroughly rinsed with saline solution and gently dried using paper points (Dentsply Sirona). Then Groups 1 to 4 were irradiated by laser, and EDTA (Produits Dentaires; 15 ml, LOT 6217 FL) was used to remove the smear layer for some groups, followed by a final rinse with saline solution (Table 1).

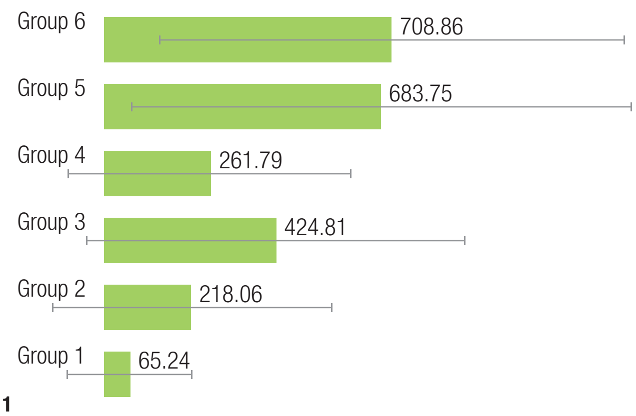
All 72 samples were prepared for obturation using the Resilon/Epiphany system. The canals were dried with absorbent paper points (Dentsply Sirona). A dry paper point was soaked with self-etching primer (SybronEndo; 6 ml, ref. No. 972-2007) and used to coat the root canal walls. The size of the Resilon master cones was then determined. An appropriate amount of the dual-polymerising Resilon sealer (SybronEndo; 4 ml) from the automix syringe was expressed on to a slab. The canals were coated with the sealer using the automix syringe, pre-measured Resilon master cones and a file. The viscosity of the sealer was modified by adding a drop or two of RealSeal thinning resin (SybronEndo, ref. No. 972-2006). Subsequent accessory points of Resilon core material were also coated with the sealer and inserted into the canal and compacted through lateral condensation. Once the obturation was completed, the coronal surface was light-polymerised for 40 seconds. The coronal portions of all samples were then restored.

Acid etching was done using a 35 % orthophosphoric acid-etch gel for 15 seconds. After acid etching, all cavities were coated with a layer of primer (Syntac Primer, Ivoclar Vivadent), adhesive (Syntac Adhesive, Ivoclar Vivadent) and bonding agent (Heliobond, Ivoclar Vivadent) and light-polymerised (Translux, Kulzer) for 20 seconds. Then a composite (Ivoclar Vivadent; Shade A3) was used in increments to seal the coronal 2 mm of the roots and was light-polymerised for 40 seconds. For the dye penetration test, the samples were first coated with two layers of nail polish (Sally Hansen, Del Laboratories), except for the last apical 2 mm, which was left exposed so that the dye could only penetrate the canal via the apical region. The samples of each group were then kept in separate containers of distilled water and incubated at 37 °C for five days, to stimulate clinical conditions.

After incubation, the samples of each group, again in separate containers, were immersed in an aqueous solution of 2% methylene blue at 37 °C for seven days so that the root canals would be filled with dye solution by capillary action. After this time, the teeth were removed from the dye and rinsed under running water for 5 minutes and incubated again in distilled water at 37 °C for 24 hours. After incubation, the teeth were removed from the dye-containing solution, rinsed and dried. The samples were dehydrated in a sequence of alcohol solutions (70 % for 24 hours, 96 % for 24 hours and 100 % for 48 hours). Then they were kept in a histological cleaning agent (Histo-Clear II, National Diagnostics) for 2 hours and embedded in resin (K Plast) in groups in separate containers and stored in a water bath for four to seven days until the resin had set. The glass containers were broken to remove the resin-embedded samples, and Vaseline was applied into a self-made former container for each sample, to avoid sticking of acrylic to the container.

Dye leakage was assessed after immersion in methylene blue, by examining vertical and horizontal sections under a transmitted-light microscope (Leica DMRX with an integrated Hitachi HV-C20A camera, Leica Microsystems) at an objective lens magnification of 0.63 x (optical lens magnification of 10 x) by means of a computer programme (Diskus, Hilgers Technisches Büro). Then horizontal cuts of 500 μm in thickness were made, splitting the roots into three portions: coronal third, middle third and apical third. The horizontal sections were examined under the transmitted-light microscope at an objective lens magnification of 2 x (optical lens magnification of 10 x) by means of the same computer programme, to assess dye penetration, and the data was saved. It is necessary to note that the digital camera, which connects the microscope to the PC and software, will magnify the image, but the power of magnification is not easy to calculate. Therefore, the final magnification of the image that is shown on screen or printed out depends on the size of screen. That is why we only report objective lens and optical lens magnification in such cases.

Data analysis was performed using StatView software (SAS Institute Inc.), and the extent of leakage in each group was investigated in both vertical and horizontal cuts to gain a near 3D view. The scores were statistically evaluated by three calibrated examiners using the Kruskal–Wallis test to determine the statistical differences among the groups ($p < 0.05$), and comparison of paired groups was done using the Wilcoxon signed rank



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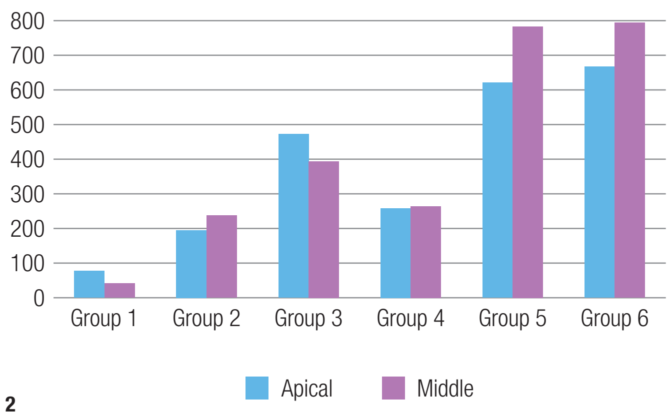

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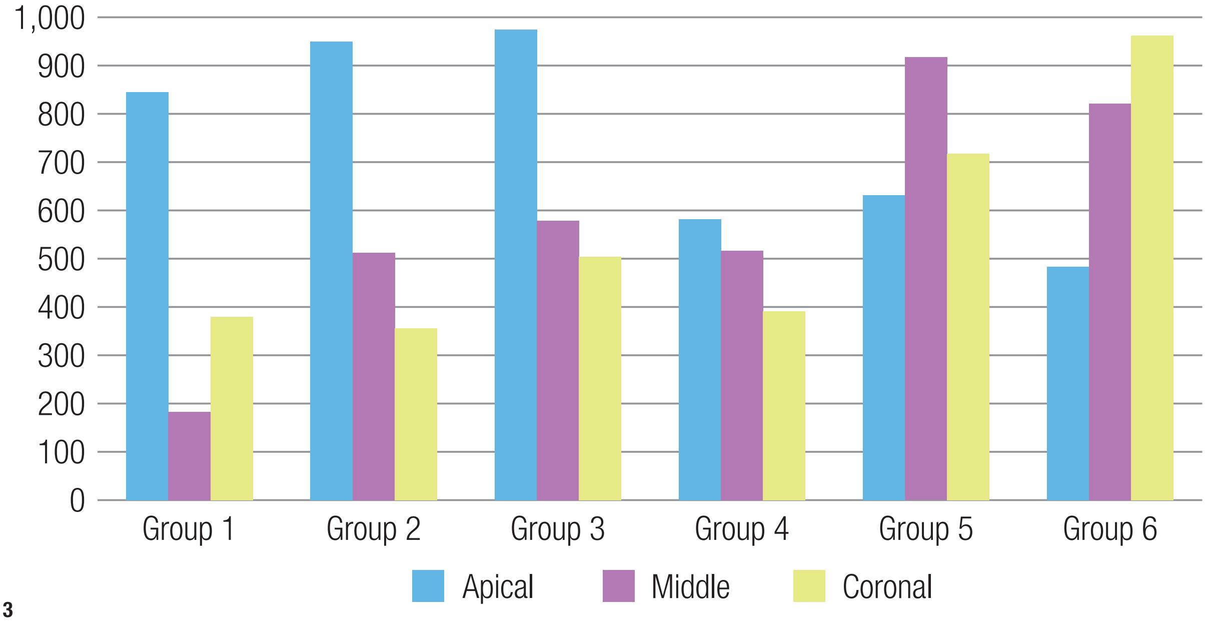
Fig. 1: Average dye penetration depth (μm) in all six groups. **Fig. 2:** Average dye penetration depth (μm) in all six groups based on the images of the vertical cuts of the roots.



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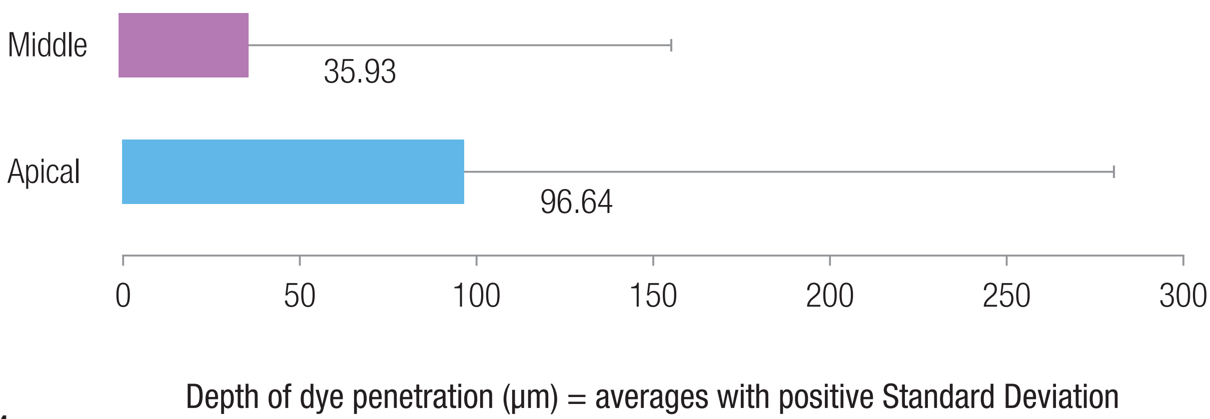

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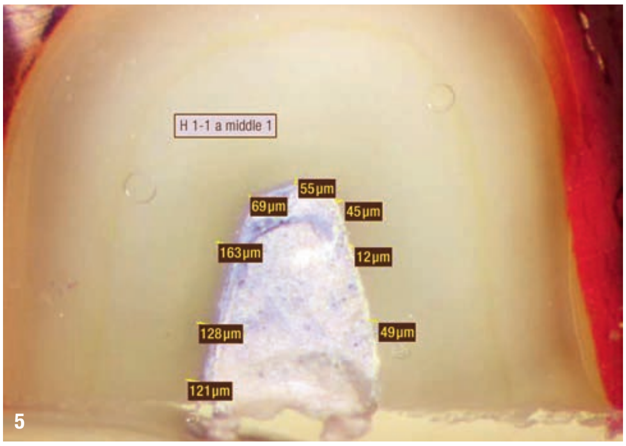
Fig. 3: Average dye penetration depth (µm) in all six groups according to the images that resulted from the horizontal sections. **Fig. 4:** The average dye penetration depth in the apical thirds was greater than in the middle thirds in Group 1, but the standard deviation shows that the difference could not be considered statistically significant ($p > 0.05$).

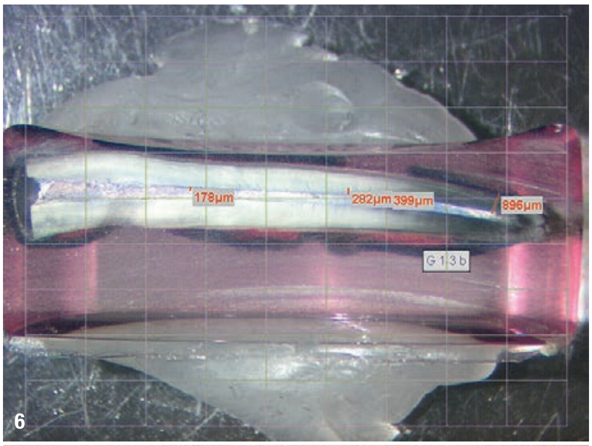
test ($p < 0.05$). The three examiners were unaware of the grouping of the teeth, and differences were reconciled by agreement. Since the magnification achieved by this technique was equal to 0.63x for the vertical cuts and 2x for the horizontal cuts, all the examiners could evaluate the samples at the same time with more comfort compared with using an optical microscope.

The extent of the leakage was scored as follows:
- 0: no penetration
- 1: penetration up to 500 µm
- 2: penetration up to 1,000 µm
- 3: penetration more than 1,000 µm.

Results

Figure 1 shows the average dye penetration depth in the various groups. In this graph, Group 4 shows a lower amount of dye penetration compared with Groups 3, 5 and 6, but has a similar average to that of Group 2. As is seen in Figure 2, the general finding is that in Group 1 the apical thirds show more dye penetration, but in the other groups, we cannot state such an observation. The difference between Group 1 and Groups 5 and 6 was statistically significant ($p < 0.05$), but the differences between Groups 1, 2, 3 and 4 were not statistically significant ($p > 0.05$). In the vertical cross sections of the roots, besides the apical and middle thirds, the coronal thirds were examined as well (Fig. 3). In Groups 1 and 2, there was a greater average leakage in the apical thirds than in the middle and coronal thirds. Overall, there was no reportable difference between the coronal and middle thirds of all the roots. In the vertical cross sections, the apical, middle and coronal thirds were compared regarding the different kinds of laser irradiation and irrigation.





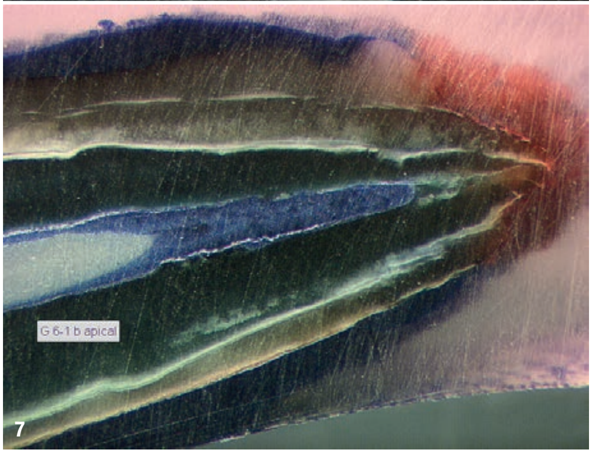


Fig. 5: A sample of cross-section cuts under the microscope. Dye penetration depth was measured by a computer programme. **Fig. 6:** A sample of vertical cuts of roots. Measurements are not as accurate as for horizontal views. **Fig. 7:** The apical region can be seen with more detail in vertical cuts, but even so, the measurements could not be done as accurately as for horizontal cross sections.

For better understanding of these findings, the depth of penetration was categorised as is shown in Table 2. The middle thirds of Group 1 show the lowest amount of dye penetration. The difference between the groups was not statistically significant ($p > 0.05$). However, the comparison between the apical thirds of the first three groups with the middle or coronal thirds of the same groups showed a statistically significant difference ($p < 0.1$). This result was narrower in Group 1. Therefore, the most valid result is that in Group 1, for which both lasers were used, the lowest penetration depths were reported. In this group, the apical thirds showed significantly higher dye penetration depths compared with the middle and coronal thirds (Fig. 4).

Discussion

No study has reported on the combined use of laser and Resilon. In studies that used Resilon as a filling material, a similar efficacy to that of gutta-percha was observed. Thus, the concern of the current investigation was to determine whether Resilon would show an acceptable integrity with the dentinal walls after laser therapy. The graphs and standard deviation overlaps of the six groups show that only the group treated with both lasers plus EDTA had a statistically significantly lower amount of leakage. The difference between the apical thirds and middle thirds of the same group was not statistically significant. As the average dye penetration depths in various areas in each cross section were reported as the resulting raw data of that slide, the horizontal images show more accurate and more reliable results (Fig. 5). But, as is seen in Figures 6 and 7 in vertical section imaging, the depth of penetration is not as easy and clear to measure as it is in horizontal samples. Therefore, for future studies, the use of horizontal cross sections only is recommended.

Conclusion

Resilon as an adhesion-based filling material shows good results in combination with EDTA and both Er,Cr:YSGG and Nd:YAG lasers according to the criteria of this study.

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about

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“Le passage”

Adj. Prof. Philippe Sleiman, Lebanon

1

2

In modern endodontics three major steps can be distinguished (creating an adequate shape, cleaning with chemicals, sealing the system) when creating a certain shape in the canal, and this can vary from one canal to another, even inside the same tooth and same root. Chemical preparation of the root canal space goes hand in hand with the shaping step, having as the main task the cleaning and disinfection of the root canal space, and, with cryotherapy, an anti-inflammatory role in order to reduce postoperative pain and reduce inflammation. The final step is the 3D sealing of the root canal space.

In this article, I will discuss the shaping part, review some important dates in the history of endodontics, and present the latest files and techniques available. In 1907, Dr Kerr created the K-File (Kerr) was introduced as the

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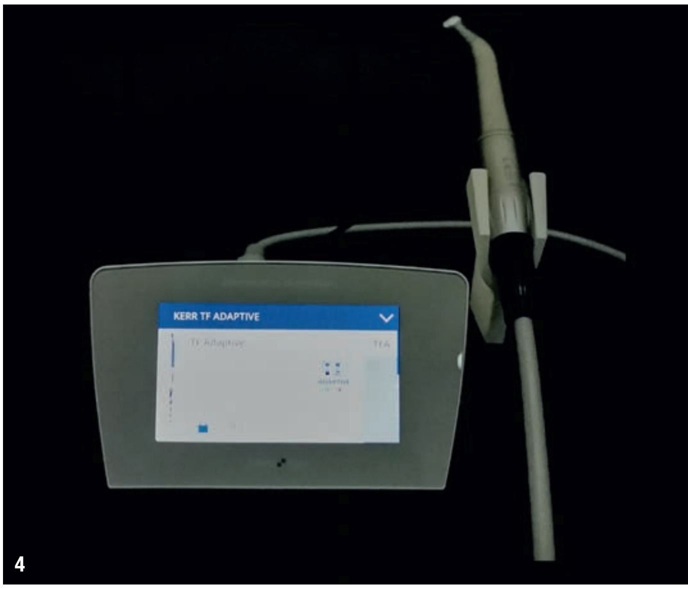

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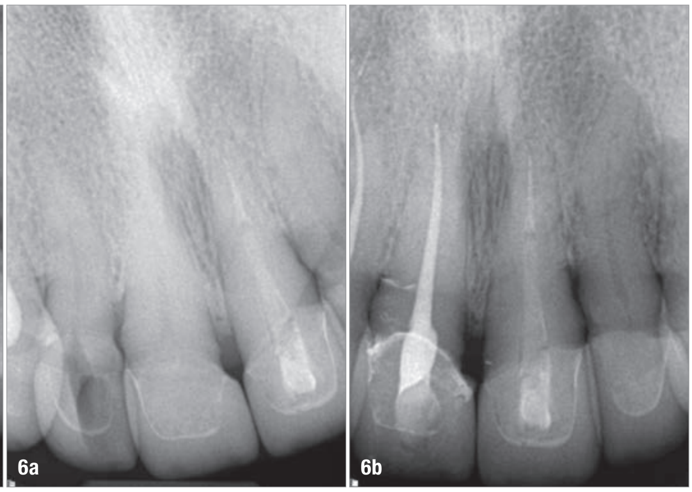
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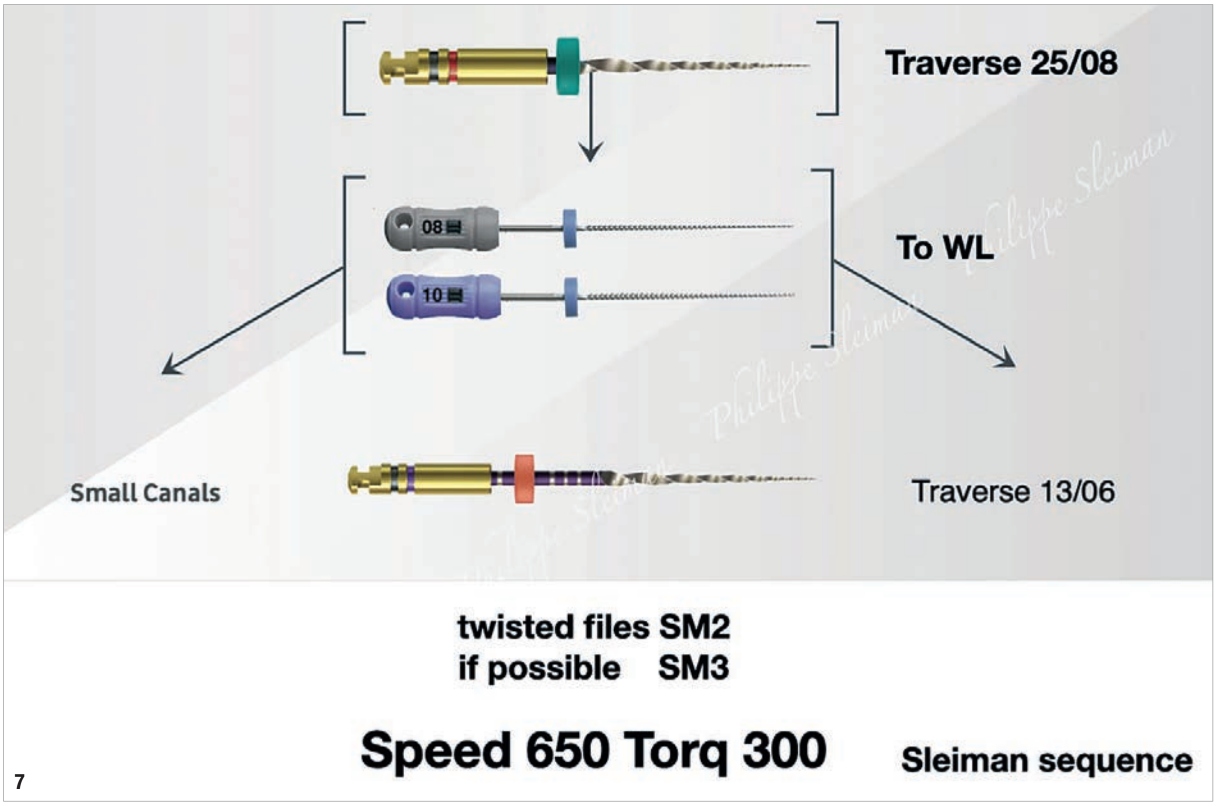
first twisted file to be used for enlarging a canal and is still in use today. Nickel-titanium (NiTi) files were introduced in 1991 and are still in use today. In 2007, at the European Society of Endodontology congress in Istanbul in Turkey, I gave my first lecture on the heat treatment of NiTi files and the creation of twisted NiTi files, and now all NiTi rotary files are heat-treated to different levels to create different properties. More recently, Traverse files (Kerr; Fig. 1), produced with another technique of heat treatment, were introduced, further advancing endodontics.

The focus in this article is on clinical application in different clinical situations. Traverse files are a set of three files (Fig. 2), including a 25/.08 orifice opener of 17 mm in length, making it an ideal kit for all clinical situations as start-up files or initial file for shaping the canals. All Traverse files have a maximum flute diameter of 1 mm (Fig. 3), and this can limit the over-enlargement in the coronal part of the canal and will help the file to engage the space deeper and faster. The two other files are size 18/.06 and 13/.06. The job of these two files is to create a quick and safe access to the apex, that is, a traverse or "Le passage" from the coronal part to the apical part of the root.

The first sequence (Fig. 4) is for large canals or canals that are easy to access. One starts with a 25/.08 Traverse



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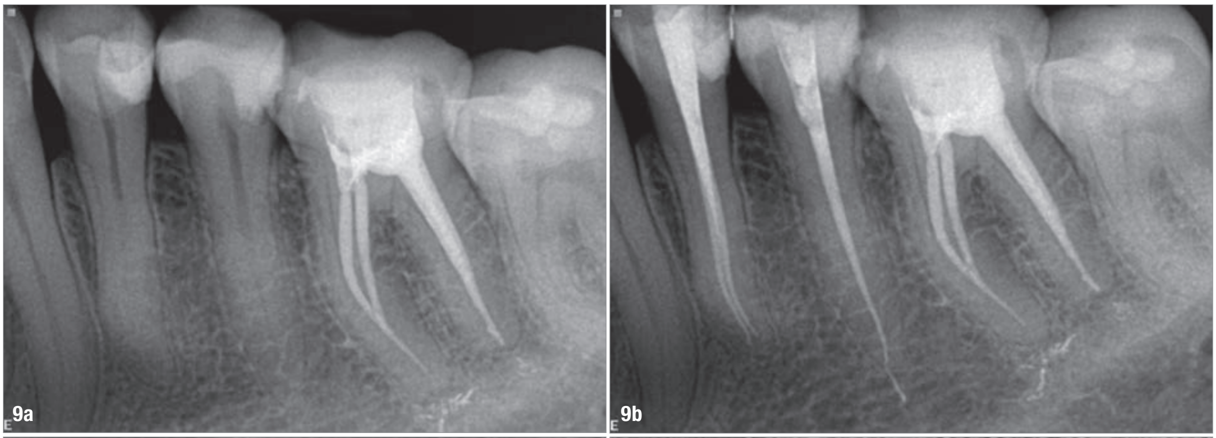
at a speed of 650 rpm and a torque of 3 Ncm; the file will prepare as deep as it can go. This is followed by a 10 K-File to determine the working length and then a 18/.06 Traverse to full working length. The last file is an SM3 TF Adaptive (35/.04) for apical preparation running under Adaptive Motion (Fig. 5). A medium gutta-percha cone can be adapted, followed by 3D obturation. Cases done with the sequence are shown in Figures 5 and 6.

The second sequence is for cases of medium difficulty, and this is the sequence that will be used the most for posterior teeth and mandibular incisors. Figure 7 shows the sequence that I recommend for such cases. For all cases, I start with the 25/.08 orifice opener in the straight part of the canal, and do not need to push it further, at a speed of 650 rpm and torque level of 3 Ncm in continuous rotation. This is followed by an 8 K-File taken to full working length, as determined with the help of an apex locator. A 13/.06 Traverse, using the same settings, is driven with small push and pull movements to full working length. Now one changes the motor settings to Adaptive Motion and uses an SM2 TF Adaptive (25/.06) to full working length and eventually if possible follows it with an SM3. If the SM3 reaches full working length, a medium gutta-percha cone can be adapted. If the SM2 is the last file to reach working length, one can use either the medium or the fine-medium cone as the master cone. Of course, this is to be followed by 3D obturation of the root canal system. Figures 8 to 10 show examples of cases treated with this sequence.

The third sequence is for special cases, such as tiny canals, deep-split canals, calcified canals and canals with multiple curvatures. This sequence, shown in Figure 11, is similar to the previous sequence, except both a 13/.06 and 18/.06 Traverse are employed. One starts with the orifice opener as with all the sequences, followed by



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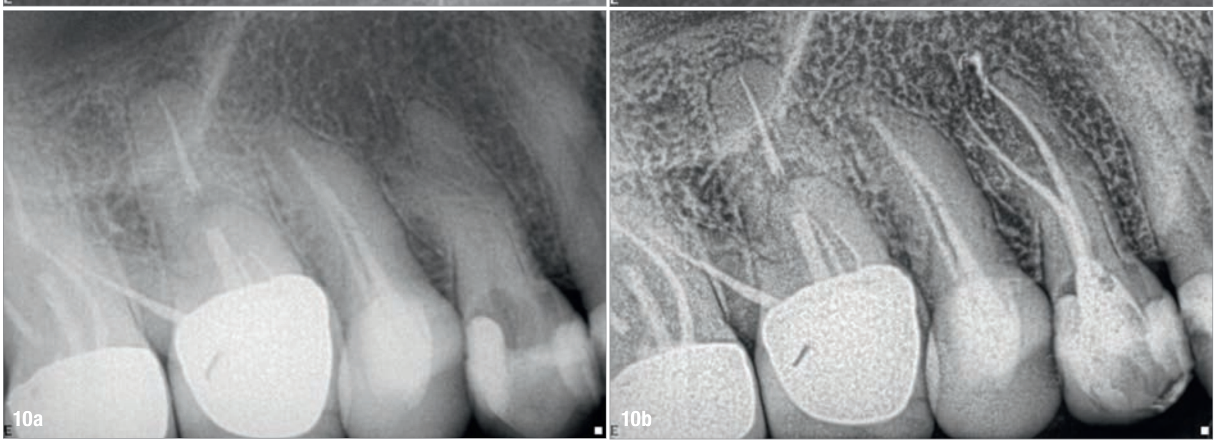

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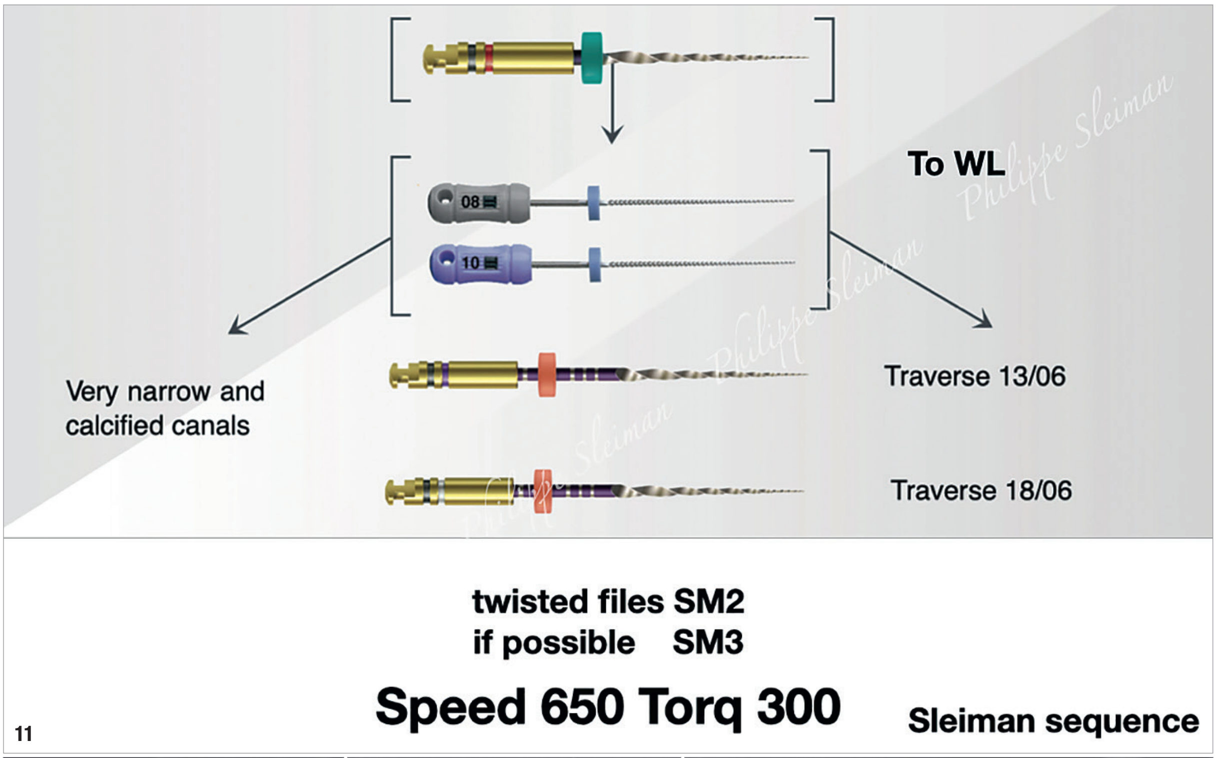

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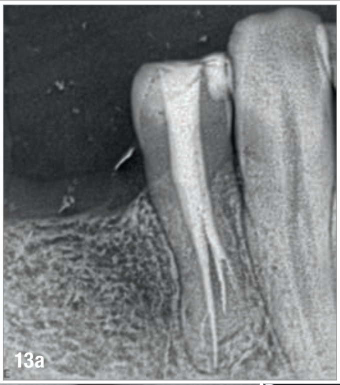
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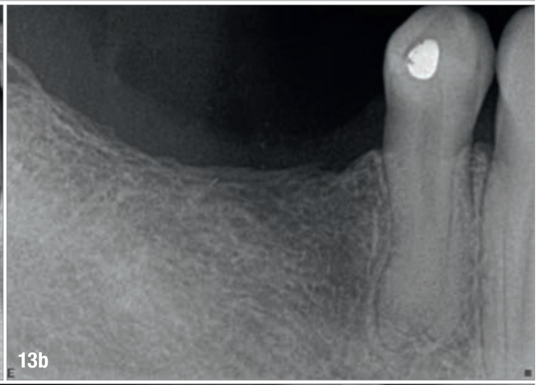
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14b

8 and 10 K-Files taken to working length. The M4 hand-piece can be a great help in establishing a small path. A 13/.06 Traverse is taken to full working length, followed by a 18/.06 Traverse, employing the same settings for speed and torque, 650 rpm and 3 Ncm. Once this step is done, one shifts to Adaptive Motion and uses the SM2 file and if possible the SM3. Figures 12 to 14 show examples treated with this sequence.

about

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Continuous wave of condensation: A new cordless obturation system

Dr Gary Glassman, Canada

1a

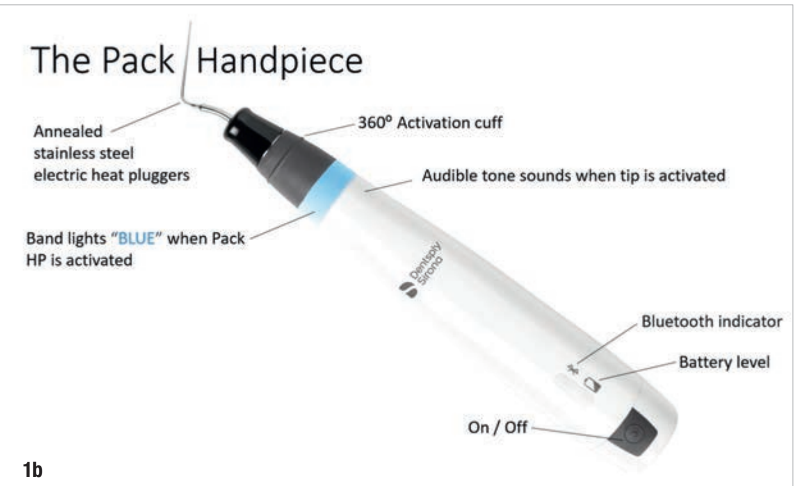
Figs. 1a–c: The Gutta-Smart (Dentsply Sirona) is a cordless obturation system that is easy to use **(a).** The downpacking (Pack) **(b)** and backfilling (Flow) devices **(c)** can sit in a combined docking station that will recharge the batteries.

Introduction

The main objective of endodontic treatment is the prevention and/or the elimination of periapical periodontitis. This is achieved by instrumentation, disinfection and obturation of the root canal system in 3D. Gutta-percha is the most widely used and accepted obturation material because of its biocompatibility, inertness, dimensional stability, ability to be compacted, plasticity when heated and ease of removal for post placement or retreatment.[1] There are a variety of techniques that are used to obturate the root canal system. They can be divided into two basic groups: cold lateral compaction and warm vertical compaction. Warm vertical compaction of gutta-percha using the continuous wave of condensation technique is less time-consuming, provides less microbial coronal leakage,[2] and adapts better to grooves and depressions of the canal walls and lateral canals than cold lateral compaction.[3,4] This article will discuss the technique of continuous wave of condensation using the new Gutta-Smart cordless obturation system (Dentsply Sirona; Figs. 1a–c).

Continuous wave of condensation technique using the Gutta-Smart cordless obturation system

This technique allows a single-tapered electric heat plugger to capture a wave of condensation at the orifice of a canal and ride it, without release, to the apical



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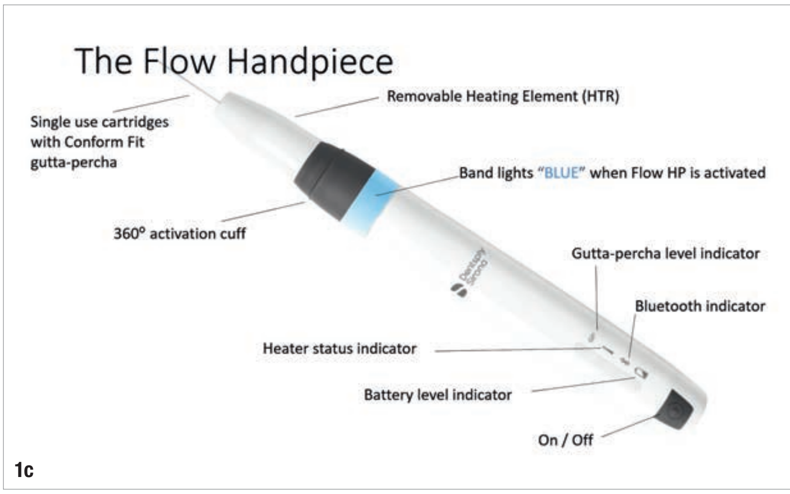

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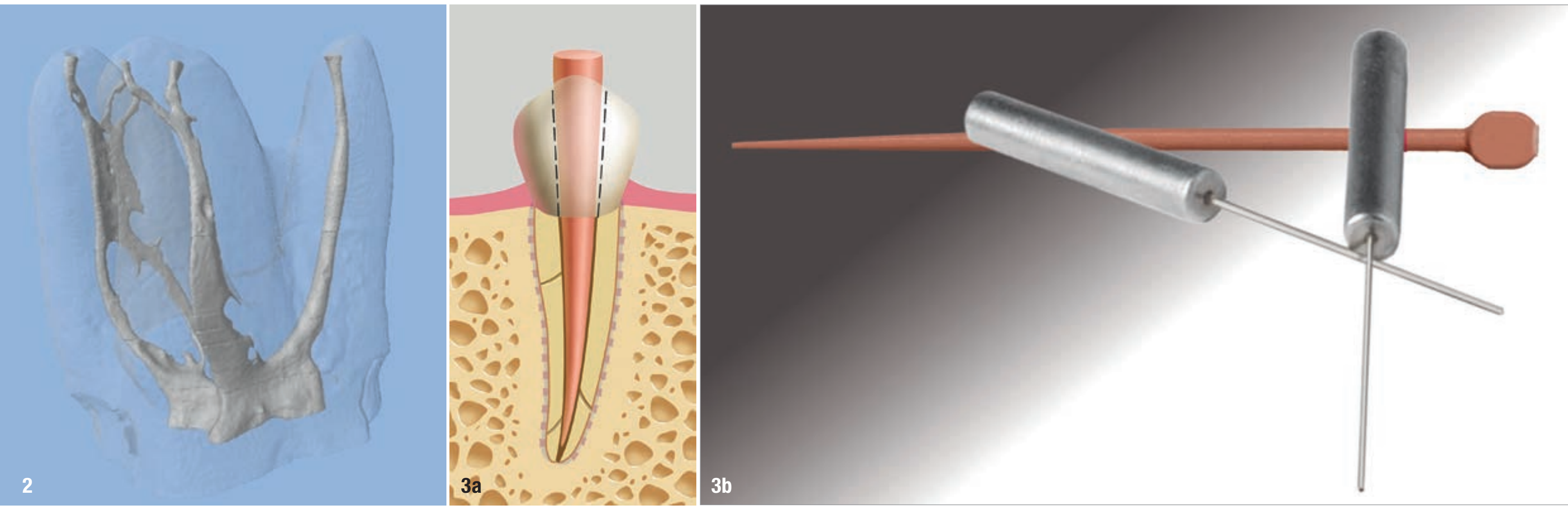


Fig. 2: Micro-computed tomography 3D reconstruction of a maxillary molar, illustrating the root canal system's complex anatomy. These areas must be cleaned of their organic debris and bacterial contaminants by thorough irrigation protocols and then subsequently 3D sealed with thermo-softened gutta-percha. *(Image: © Dr Ronald Ordinola Zapata)* **Fig. 3a:** Cone fitting. A suitably sized Conform Fit gutta-percha cone (Dentsply Sirona) is fitted into the tapered root canal preparation making sure of apical tugback at working length. The cone may then be cut by 0.5–1 mm to accommodate for apical movement. **Fig. 3b:** Conform Fit gutta-percha cone and preloaded gutta-percha cartridges. The Conform Fit gutta-percha fits intimately at the apical one-third of the root canal, and the single-use preloaded gutta-percha cartridge has enough material to fill an average four-canal molar.

extent of downpacking in a single, continuous movement. Because the tip moves through a viscosity-controlled material into a tapered canal form, the velocity of the thermo-softened gutta-percha and sealer moving into the root canal system actually accelerates as the downpacking progresses, moving softened gutta-percha into extremely small ramifications (Fig. 2).

The continuously tapered root canal preparation facilitates the fit of a suitably sized Conform Fit gutta-percha cone (Dentsply Sirona; Figs. 3a & b). The master cone selected should be inserted to full working length and exhibit apical tugback (resistance to displacement) upon its removal. It is simple to fit a master cone into a patent, smoothly tapered and well-prepared canal.[5–8] The cone

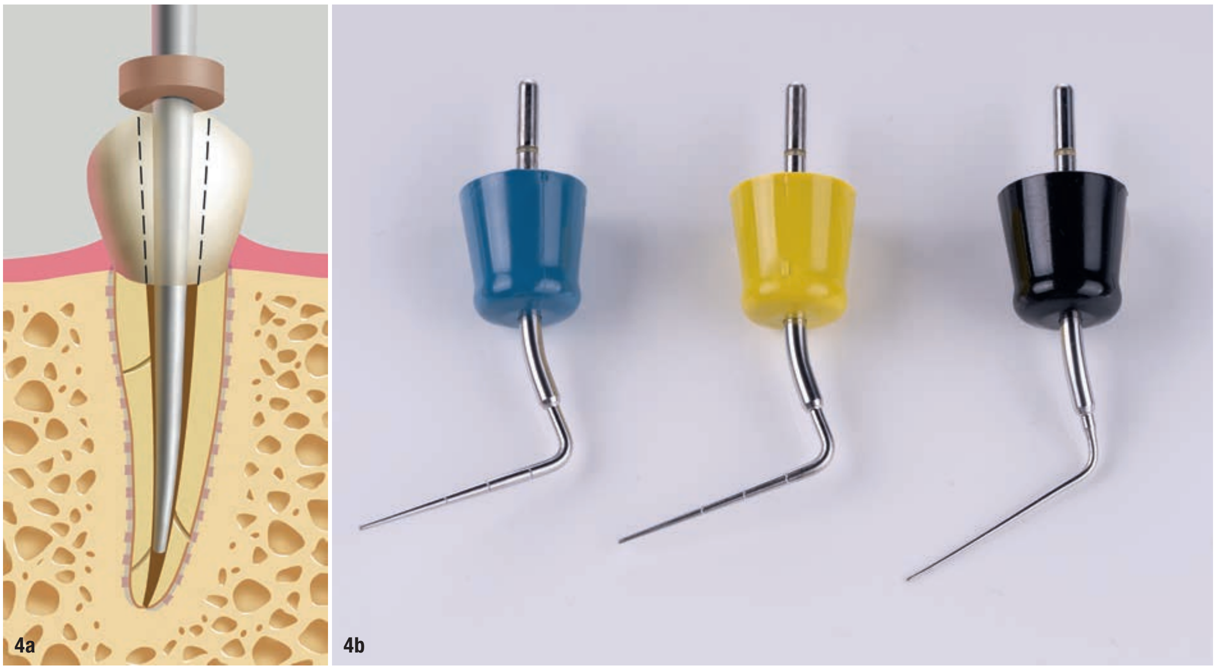
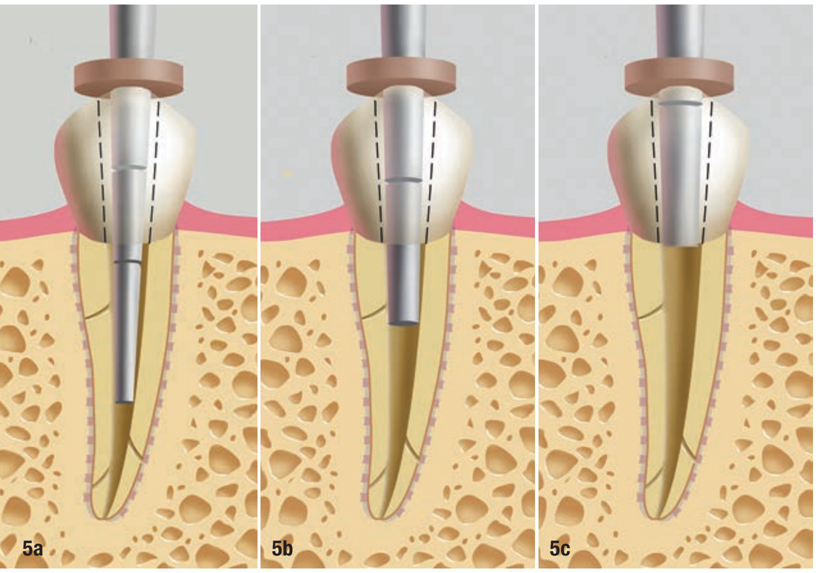


Fig. 4a: Heat plugger fit. It is essential that an appropriate downpacking plugger is pre-fitted into each canal to its binding point. A rubber stop must be placed and adjusted to the appropriate coronal reference point for each canal. **Fig. 4b:** The electric heat pluggers are manufactured from annealed stainless-steel and are available in three sizes: large (60/.06, blue), medium (50/.05, yellow) and small (40/.025, black).



Figs. 5a–c: Stainless-steel and/or NiTi hand pluggers may be pre-fitted into the canals to their binding point. Rubber stoppers are adjusted on these pluggers to the occlusal reference point corresponding to 2 mm short of the apical binding point.

may then be cut by 0.5–1 mm to accommodate for apical movement (the distance from the apical reference point will vary with canal curvature and size).

The intimacy of diametrical fit between the cone and the canal space may be confirmed radiographically. The heated plugger of the downpacking device (most commonly with a .04 taper and 0.5 mm diameter) should fit to within 4–7 mm from the apical terminus to allow full thermo-softening of the apical gutta-percha plug. When the tip of the plugger contacts dentine (the binding point) in the canal, the rubber stop should be adjusted to its corresponding occlusal reference point (Figs. 4a & b).

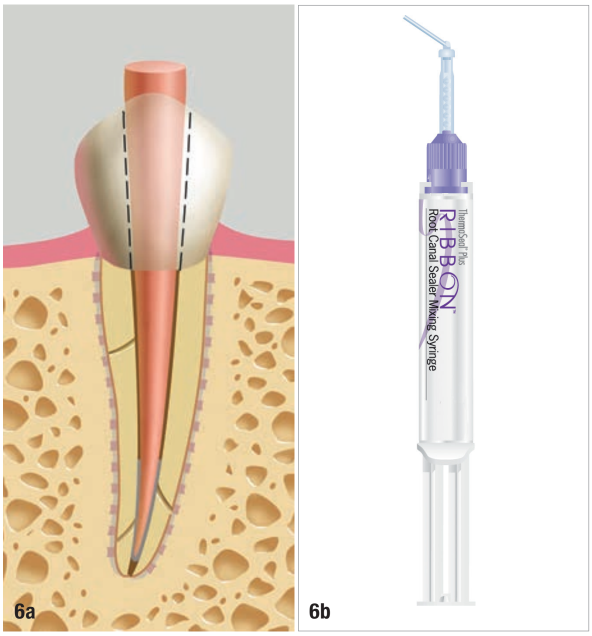


Fig. 6a: The master cone is seated gently in the canal with sealer placed on its apical one-third. **Fig. 6b:** ThermaSeal Plus (Dentsply Sirona) is an epoxy resin sealer characterised by very good mechanical properties, high radiopacity, low polymerisation shrinkage, low solubility and a high degree of stability during storage.

Stainless-steel pluggers may be pre-fitted into the canals to their binding point in preparation for the backfilling. Rubber stoppers are adjusted on these pluggers to the occlusal reference point corresponding to 2 mm short of the apical binding point. These pluggers are placed aside to be used later in the backfilling phase of canal obturation (Figs. 5a–c).

Sealer and master cone placement

The amount of sealer used in this obturation technique should be minimal. The radicular portion of the master cone is lightly buttered with sealer, and the cone is gently slid to length. Placing the master cone in this manner will serve to distribute sealer more evenly along the walls of the preparation and, importantly, allow surplus sealer to harmlessly vent coronally (Figs. 6a & b).[5–8]

The activation cuff on the downpacking (Pack) handpiece can be pressed anywhere above the ridge on its 360° circumference. A band near the cuff lights blue when the tip is activated. The tip will remain heated only as long as the activation cuff is being depressed.

The master cone is seared at the orifice of the canal with the activated heated plugger and then gently seated with a larger stainless-steel plugger. A small dimple may be created in the coronal aspect of the master cone to act as a guide for the activated heated plugger. The activated heated plugger is advanced without interruption through the centre of the gutta-percha in a single motion (about 1–2 seconds) to a point about 3–4 mm shy of its apical binding point (Figs. 7 & 8). While maintaining pressure on the plugger, the activation cuff on the Pack handpiece is released and the plugger will slow its apical descent as the plugger tip cools (about 1 second) to within 2 mm from its apical binding point. After the plugger stops, short of its binding point, apical pressure on the plugger is sustained until the apical mass of gutta-percha has set (5–10 seconds), to minimise any shrinkage that occurs upon cooling (Fig. 9).

Separation burst

After the apical mass has set, the activation cuff on the Pack handpiece is depressed again, for a 1-second surge of heat, followed by a pause for 1 second after this separation burst. The heated plugger is then removed along with the middle and coronal gutta-percha adhering to it, leaving behind the 4–6 mm apical plug of gutta-percha (Figs. 10 & 11). Because these pluggers heat from their tips, this separation burst of heat allows for quick, sure severance of the plugger from the already condensed and set apical mass of gutta-percha, minimising the possibility of pulling the master cone out. The length of this heat burst must be limited, as the goal is separation from the apical mass of gutta-percha without reheating.

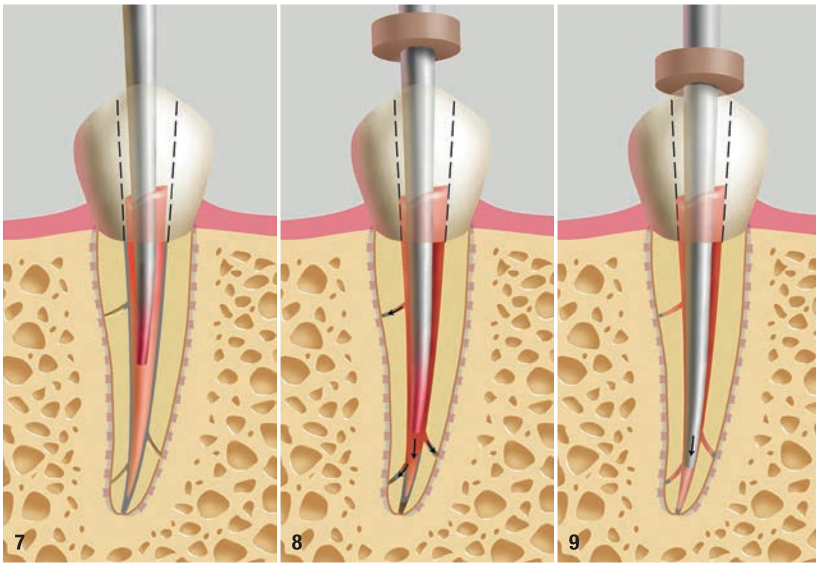
Clinicians must be very alert during the first second of the downpacking so that the binding point is not reached before completion of the downpacking. If heat is held for too long, the plugger will drop to its binding point in the canal and then cannot maintain condensation pressure on the apical mass of gutta-percha during cooling, possibly allowing it to pull away from the canal walls. If binding length is reached by mistake, the heat plugger should be removed immediately and the small end of the nickel–titanium (NiTi) end of a hand plugger may be used to condense the apical mass of gutta-percha until set. Once the downpacking has been completed in all canals of the tooth being treated, a radiograph may be taken to confirm the objective of apical seal.

Backfilling

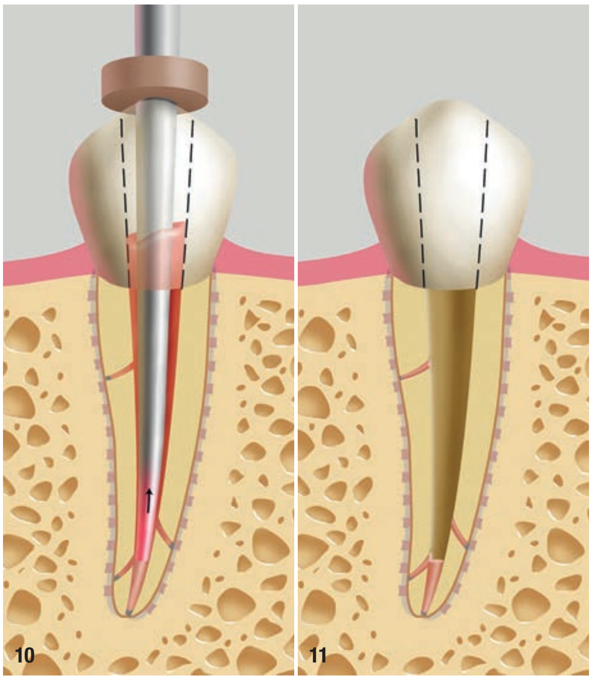
The Gutta-Smart backfilling (Flow) handpiece accommodates disposable preloaded cartridges of gutta-percha, and the dispensing needle tips are available in 20-gauge, 23-gauge and 25-gauge diameters. The one most commonly used is the 23-gauge one, as it is suitable for most canals being treated. There is enough gutta-percha in the disposable cartridges to fill an average four-canal molar.

Before backfilling, a small amount of sealer is lightly painted on to the walls of the root canals with a stainless-steel hand file or paper point. The needle tip is placed into the root canal space until it penetrates the coronal aspect of the apical plug of gutta-percha for just a moment, to re-thermo-soften its most coronal extent. This procedural nuance promotes cohesion between each injected segment of warm gutta-percha and the apical plug so that the two will seamlessly integrate. Segments of 4–7 mm of gutta-percha are then deposited. Injecting or dispensing too much gutta-percha may lead to cooling shrinkage and/or voids, which result in poorly obturated canals within the deeper confines of the root canal space.[8] As gutta-percha is extruded from the applicator tip, the viscosity gradient of the back-pressure produced will push the needle tip (and hence the Flow device) coronally from the root canal space.

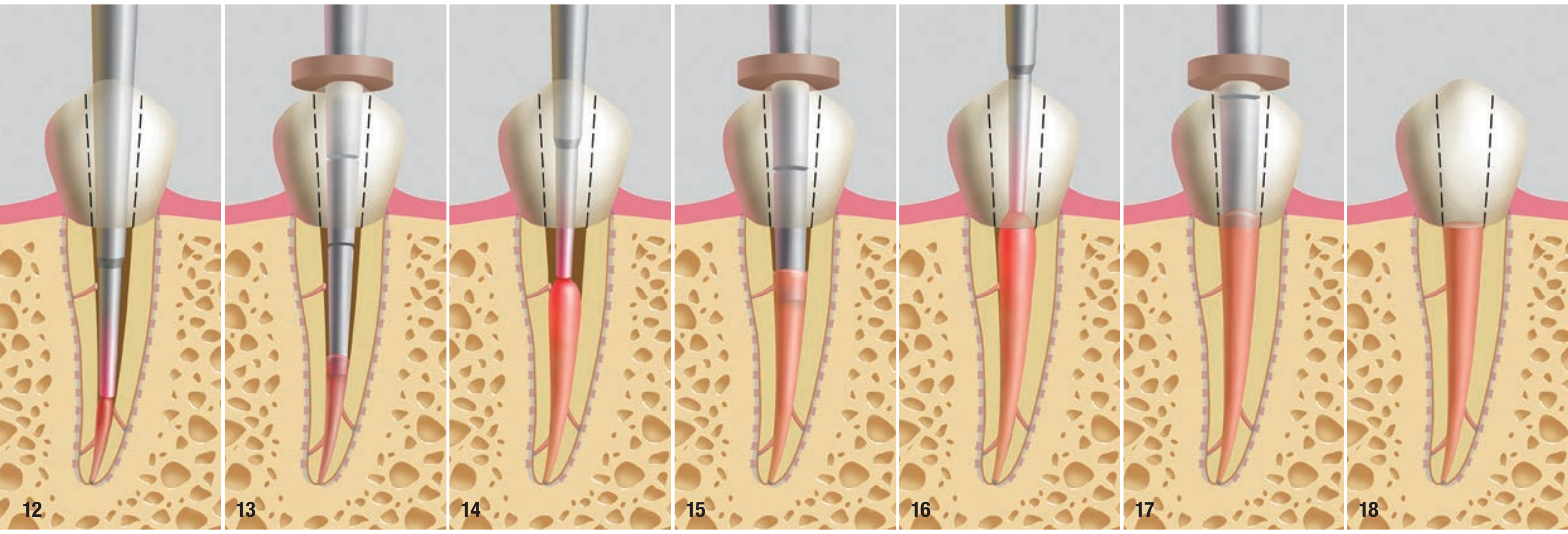
The technique sensitivity requires that, when this sensation occurs, the operator must sustain pressure on the activation cuff button mechanism as the needle tip moves from the canal. The stainless-steel or NiTi ends



Figs. 7 & 8: Initiation of downpacking. With the activation cuff depressed on the Gutta-Smart downpacking handpiece, the pre-fitted, preheated plugger is smoothly advanced without interruption through the mass of gutta-percha to within 4–6 mm of the binding point. **Fig. 9:** Sustained apical condensation. The activation cuff on the Pack device should be released once within 3–4 mm of the apical binding point. The plugger should slow and stop within 2 mm short of the binding point. Apical pressure is maintained for a full 10-second sustained push in order to prevent the cooling gutta-percha mass from shrinking.



Figs. 10 & 11: Separation burst. The Pack activation cuff is depressed for 1 second and then released. The plugger is held in position for 1 second after the button is released, after which it is removed with the surplus of gutta-percha coronal to the apical plug adhering to the cooling plugger, leaving the apical seal intact. All portals of exit may be sealed, primarily with gutta-percha or a combination of gutta-percha and sealer, and the canal is ready for backfilling.



Figs. 12–18: Backfilling. Additional root canal sealer may be placed in the coronal aspect of the root canal with a hand file or paper point prior to backfilling. Gutta-percha increments of 4–7 mm are injected into the canal space and then immediately condensed with the pre-fitted stainless-steel hand NiTi pluggers in sequence using the sequentially larger pluggers as the coronal aspect of the canal is approached. As thermo-softened gutta-percha is deposited in the canal, back-pressure is produced and the needle tip (flow device) is forcibly extruded from the canal space. It is essential that the operator continue injecting as the needle tip is retrieved from the canal in order to avoid inadvertent removal of the newly deposited gutta-percha mass prior to condensation.

of hand pluggers are then used in sequence to maximise the density and homogeneity of the compressed gutta-percha mass. This sequence of thermo-softened gutta-percha injection and progressive compaction is continued until the obturation of the entire root canal space is achieved (Figs. 12–18). Even if a post space is to be prepared, the author advises backfilling right to the orifice of the canals to ensure that lateral and accessory canals that were not sealed on the downpacking are captured on the backfilling.

Discussion

The objective of endodontic obturation is the total 3D filling of the root canal system and all of the lateral and accessory canals associated with it. Brothman demonstrated that vertical compaction of warm gutta-percha approximately doubled the number of filled lateral canals compared with lateral compaction of gutta-percha.[9] The warm vertical technique has shown greater ability to flow into canal irregularities than the cold lateral technique has.[10, 11] Warm vertical compaction was first introduced by Schilder in 1967.[12] With this method, gutta-percha is heated and packed in three to five interrupted waves of compaction. In contrast, the continuous wave of condensation technique was introduced with the goal of simplifying traditional vertical compaction.[13] This technique allows a single-tapered electric heat plugger to capture a wave of compaction pressure at the orifice of a canal and ride it, without release, to the apical extent of the downpacking in a single, continuous movement.[14] The remainder of the canal is then filled with the backfilling Flow device.

The Gutta-Smart cordless obturation system satisfies the objective of sealing the root canal system in 3D and completes the last part of the triad of the imperative of root canal therapy, that being clean, shape and pack.

Editorial note: A list of references is available from the publisher. This article originally appeared in Oral Health Magazine*, and an edited version is provided here with permission from Newcom Media.*

about

Dr Gary Glassman is the author of numerous publications and lectures globally on endodontics and is on the staff at the University of Toronto's Faculty of Dentistry in Canada in the graduate department of endodontics. As adjunct professor of dentistry and director of endodontic programming from 2010 to 2017, Dr Glassman helped develop the dental school curriculum for the oral health science programme for the University of Technology in Kingston in Jamaica. He is faculty chair for DC Institute and chief dental officer for dentalcorp in Canada, as well as endodontic editor of the *Oral Health Magazine* and *Inside Dentistry*. Dr Glassman is a fellow of the Royal College of Dentists of Canada and the American College of Dentists. His personal website is www.drgaryglassman.com, and his office website is www.rootcanals.ca.
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The advantage of using a dedicated carrier to place MTA

Drs Massimo Giovarruscio & Francesca Cerutti, Italy

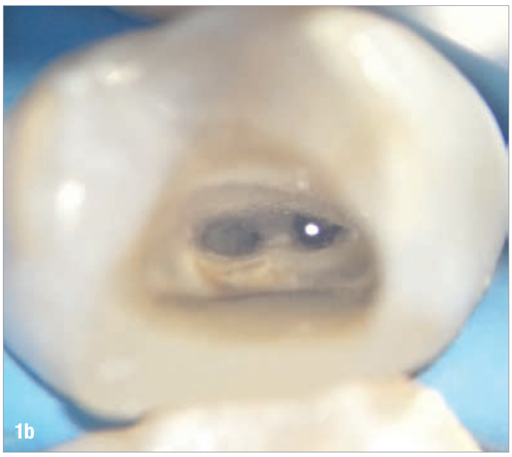
1a

Introduction

Mineral trioxide aggregate (MTA) is a bioactive material promoting osteogenesis and healing that was first introduced to seal communications between roots and external surfaces of teeth.[1] The material is reported to have excellent biocompatibility, marginal adaptation and sealing ability, even in the presence of moisture, and outstanding antibacterial properties thanks to its high pH (12.5). MTA is able to stimulate cementum-like formation, osteoblastic adherence and bone regeneration. Moreover, its sealing, mineralising, dentinogenic and osteogenic potentials make it the preferred choice for numerous clinical applications, such as direct pulp capping, root end filling, apexogenesis and apexification in immature teeth with necrotic pulp, filling of root canals, treatment of horizontal root fractures, treatment of internal and external resorption, and repair of perforations.[2]

MTA consists of a powder (containing silicates and calcium oxide) that has to be mixed with distilled water according to the manufacturer's instructions. Depending on the composition, the initial setting time ranges from 8 to 70 minutes and the final setting time ranges from 40 to 320 minutes. This long setting time is one of the main drawbacks of this product.[3]

The literature has proved the effectiveness of MTA in the therapy of vital pulp, such as pulp revitalisation and pulp capping, with good performance and few side effects.[4,5] One of the major problems when using MTA in vital teeth is bleeding management: several studies have reported blood contamination as a factor that exacerbates discoloration in calcium silicate-based materials, bismuth oxide-free Portland cement also presenting colour alteration subsequent to blood exposure.[6] In this regard, the release of fast-setting MTA can represent a significant



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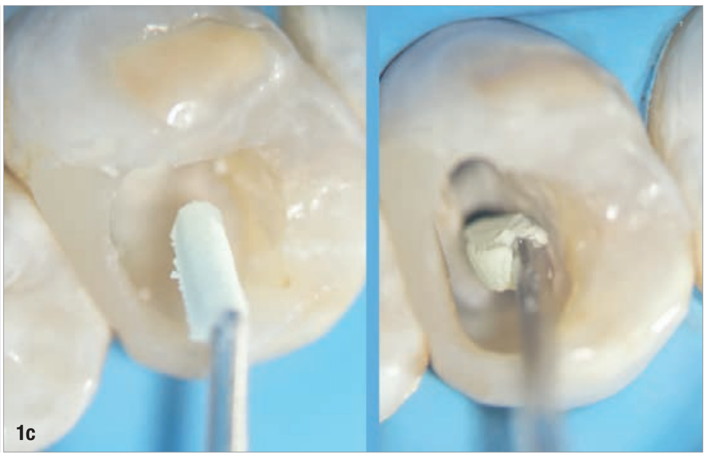

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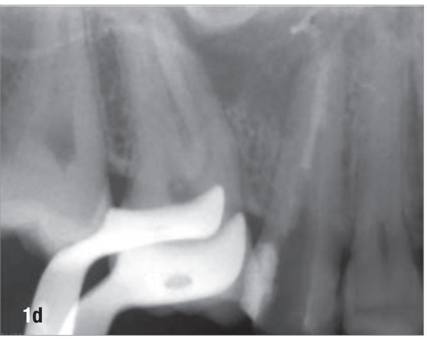
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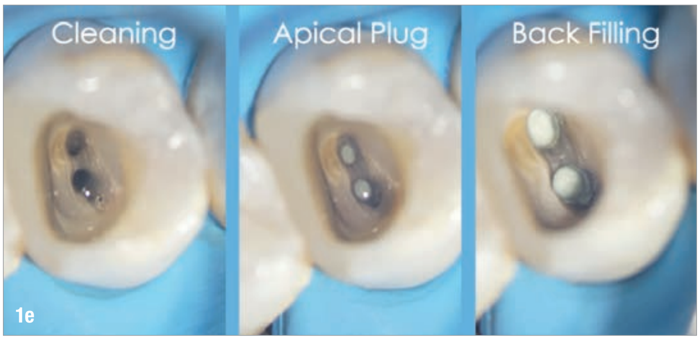

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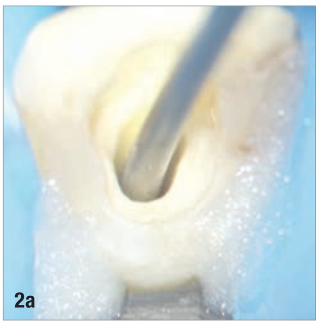
advantage, limiting fluids and blood absorption, preventing discoloration and promoting a pleasant aesthetic outcome.

Several investigations have evaluated other bioactive endodontic cements as pulp capping agents with short-term follow-up. More research with longer-term follow-up is needed to evaluate alternative pulp capping materials to MTA. In addition to the material used for direct pulp capping, there are several other factors that may influence the final outcome; therefore, these variables should be controlled in future studies.[5]

Other bioactive endodontic materials, containing zirconium dioxide to provide radiopacity and guaranteeing superior colour stability, have been suggested to overcome MTA-related problems. The literature reports that some of the bioactive endodontic cements have shown promising results,[7] above all in vital pulp therapy, in terms of cementum deposition over the materials when used for root end filling,[8] while others are associated with a significantly higher inflammation of the periapical tissue compared with tooth-coloured MTA.[9] However, the number of studies comparing these products to MTA is still limited and few histological investigations have evaluated bioactive endodontic cements as root end filling materials. Their shortcomings include short-term follow-up, absence of controls, a large number of excluded specimens, placement of root end filling materials in intact teeth with healthy pulps that had no periapical lesions prior to treatment, preparation of root end cavities without prior canal debridement and filling, and root resection and preparation of root end cavities prior to root canal instrumentation.[6,8] Future investigations with rigorous methods and materials are needed to compare the performances of these materials more accurately.

MTA allows the clinician to achieve good outcomes in perforation repair (with respect to other materials such as amalgam, zinc oxide eugenol cements, calcium hydroxide, composite resin and glass ionomer cements),[10] reaching percentages of success ranging from 86 % to 92 %.[11] Among the factors affecting the outcome of the therapy are the experience of the practitioner who performed the treatment, the negative influence of placing a post after treatment, the presence of preoperative lesions and communication between the perforation site and oral cavity, and the sex (female) of the patient.[6,12] The location of the perforation and the quality of the final restoration had a significant influence on the outcome of perforation repair, while the site of perforation (mid-root and apical) and a perforation size larger than 3 mm were reported as significant predictors for the recurrence of progressive inflammation.[12] Recent studies, on the contrary, have concluded that the success of repairs carried out using MTA was not affected by the size of the perforation.[13–15] One of the main factors to consider when applying MTA is the pH of the surrounding tissue: a persistent infection or excessive bleeding can lead to decrease of the pH, thus altering the setting properties of MTA.[11]

The literature reports that the presence of bismuth oxide as a radiopacifier in the MTA formula can lead to tooth discoloration.[6] This potential can turn into a great disadvantage in vital pulp therapy, treatment of resorption or perforation repair. To overcome this problem, several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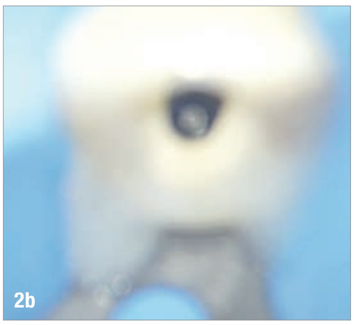
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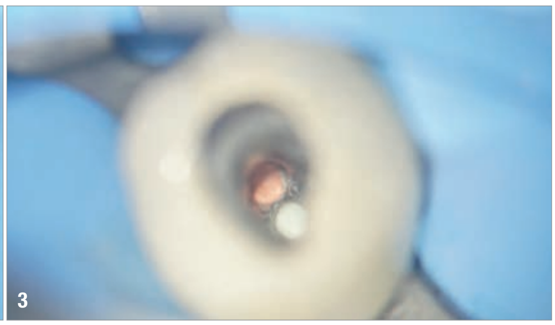
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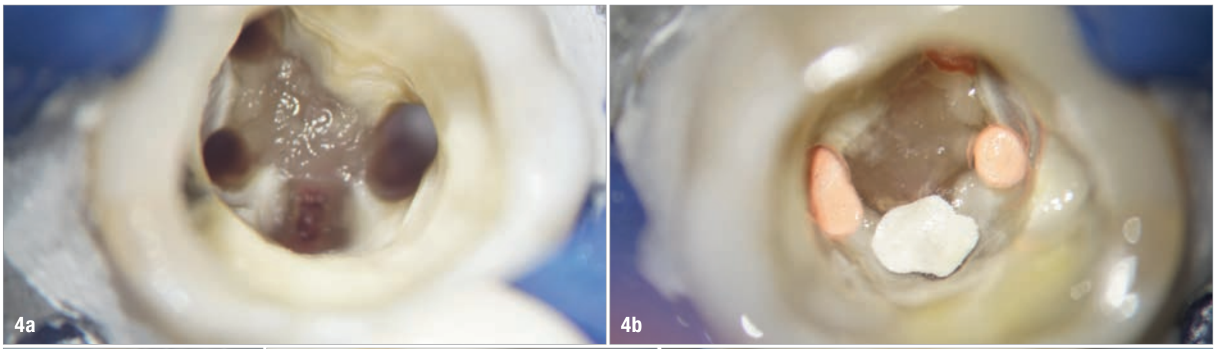
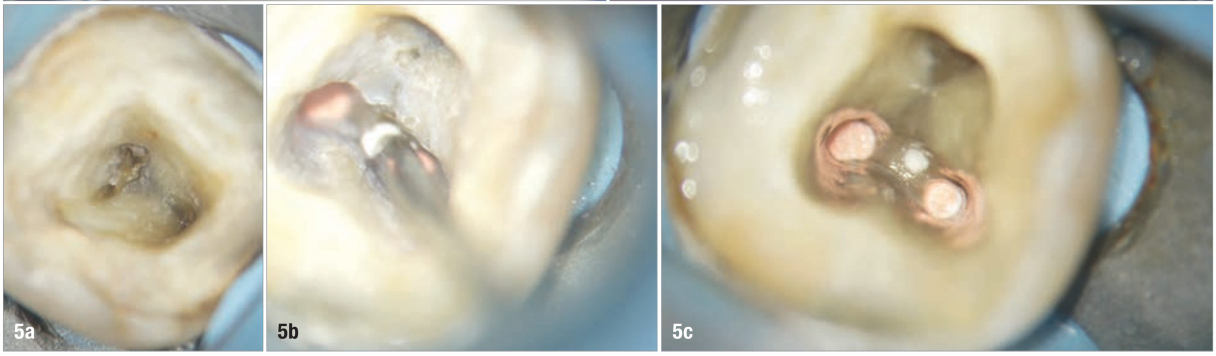




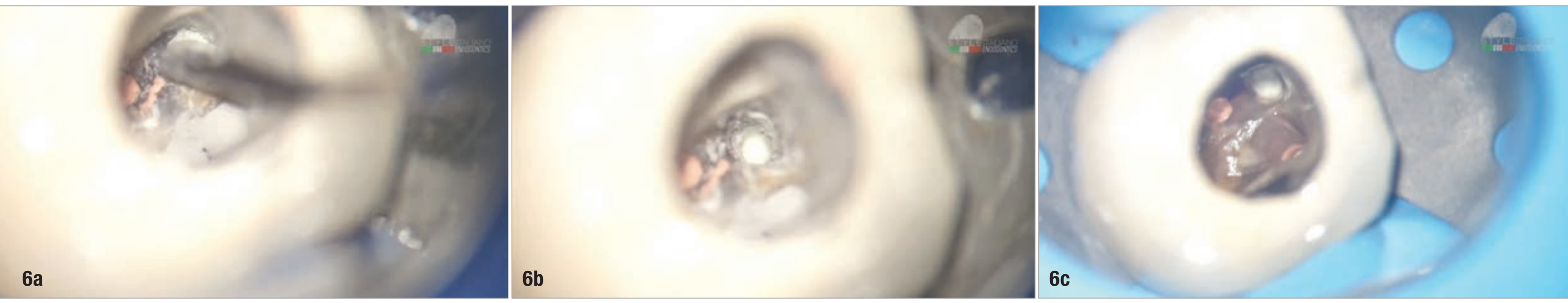
alternative bioactive cements were developed.[5] Some products containing tricalcium silicate, dicalcium silicate, tricalcium aluminate, calcium oxide and tungstate as an opacifier were able to avoid staining and discoloration, without changing the biological or chemical features of MTA.

One of the main drawbacks of MTA reported in the literature, including several surveys, is the difficulty of handling of the material.[16] Achieving the right consistency and being able to put the material precisely where it is needed seem to be concerns for several clinicians. Regarding the correct consistency, it has to be said that following precisely the instructions provided by the manufacturer regarding the amounts of powder and liquid to be mixed and gradually incorporating the liquid into the powder help achieve the optimal consistency of the material in a short time.

Technique

Several techniques have been shown over the years to avoid MTA obliterating the root canals while repairing a perforation (i.e. placing a gutta-percha point, a paper point or a piece of PTFE or cotton into the root canal opening) and to act as a scaffold for the repair material. Another important tool that helps in the precise positioning of MTA is the use of dedicated carriers. Applicators allow a fast, efficient and precise positioning of the material. They exist in different sizes, according to the amount of material to be placed and the area of the root canal to be reached, and they make it possible to charge the material into the carrier effortlessly and deliver the desired amount of MTA to the target site thanks to dedicated tips that can be bent in order to make it easier to position the cement.

The MAP System (Produits Dentaires) is a dedicated carrier that has been developed to adapt to every clinical situation, because it can be associated with tips of different sizes, angles and materials. In general, triple-angled stainless-steel tips are used in endodontic surgery, because they improve the visibility of the operative field and make retrograde obturation easier. The classic curved stainless-steel tips are meant to be used in orthograde treatments or pretreatments, in order to perform direct



pulp capping, root canal obturation during apexogenesis and revascularisation procedures, apexification of immature teeth and root canal perforation repair. An advantage of the MAP System is the possibility of employing nickel-titanium tips: these can be used in both orthograde and surgical procedures, and they allow placement of the material exactly where it is needed because they can be bent as necessary. After sterilisation, the tips regain their initial straight shape.

When using an MTA carrier, it is mandatory to avoid the material hardening inside the applicator, because it could be almost impossible to remove it afterwards. Cleaning the tip immediately after MTA extrusion (better if done with dedicated tools) helps maintain the efficiency of the instrument.

The amount of MTA to be used is dependent on the clinical procedure, but in general, it is not recommended to fill a root canal completely with MTA, because after setting, it would be difficult to remove the material from the root canal. A rigorous protocol and the use of specific tools helps achieve good outcomes in primary and secondary endodontic treatments using MTA as an obturation material.

Clinical application

When applying MTA, for the clinician, it is important to position the material precisely into the site, avoiding the cement spreading into the cavity or being wasted. Without a dedicated carrier, the operator can shape MTA into a bar and deliver it into the cavity by means of a probe or a plugger. Once the canal has been cleaned and shaped, the MTA can be positioned into the root canal and packed until the apical portion has been filled. It is then possible to do the backfilling and restore the tooth (Figs. 1a–f). This technique is not particularly easy to perform, because it requires a skilled clinician to be executed correctly and without a huge waste of MTA.

The use of a carrier makes it easier to deliver the correct amount of MTA precisely where it is meant to be positioned. The MAP System allows the clinician to choose the size of the tip, according to the size of the defect to be filled. The bendable tip can be adjusted in order to easily reach the area to be treated. It is also possible to position a rubber stop to help the operator record the correct reference point. The MTA is packed, leaving the canal walls clean (Figs. 2a & b).

The red colour-coded tip of the MAP System was used in this case to fill the perforation in the premolar shown in Figure 3. A more coronal and larger perforation, however, was filled with MTA using the blue colour-coded tip (Figs. 4a & b). In the case of a tiny perforation, a smaller tip (yellow colour code) was selected in order to reduce waste of material and ensure greater precision (Figs. 5a–c). Figures 6a–c show step by step the filling of a floor perforation in a maxillary first molar using the MAP System.

about

Dr Massimo Giovarruscio is a highly skilled dental professional with extensive experience in endodontics and restorative and aesthetic dentistry. With over 19 years of experience in dentistry, he has developed his reputation within the profession as being an excellent clinician, endodontist and postgraduate lecturer. He is an accredited specialist in endodontics and a clinical teacher in endodontics at the Faculty of Dentistry, Oral and Craniofacial Sciences at King's College London in the UK to both undergraduate and postgraduate students, as well as a visiting professor at the CEU Cardenal Herrera University in Spain in the international master's course in endodontics. He has also developed exemplary communication skills and has a proven track record in private practice in both the UK and Italy, where he works in Rome, Bristol and London, specialising in endodontic treatment and restoration of endodontically treated teeth. Dr Giovarruscio is regarded as an opinion leader in endodontics and restorative procedures related to the endodontically treated tooth. He lectures worldwide and has published many articles in international journals and written several chapters and manuals on endodontics. He is co-author of the book *Manuale di Endodonzia* (Elsevier, 2013). He is an active member of the European Society of Endodontology and of the Italian Society of Endodontics.

Dr Francesca Cerutti graduated from the University of Brescia in Italy in 2007. In 2013, she obtained her PhD in materials for engineering from the same university, and in 2016, she completed a master's degree in aesthetic medicine. She collaborates with Dr Dino Re at the University of Milan in Italy, where she conducts clinical research and, since 2018, has been a visiting professor. Dr Cerutti has published several articles in peer-reviewed journals and has co-authored books on restorative dentistry and endodontics. She has spoken at national and international congresses on post-endodontic restoration and aesthetic reconstruction of teeth. She is a reviewer for international journals such as the *Journal of Adhesive Dentistry*, the *European Journal of Paediatric Dentistry* and *Biomaterials*. Dr Cerutti is a member of the Italian Society of Endodontics and served as editorial coordinator of the *Giornale Italiano di Endodonzia* from 2008 to 2011. She is a silver member of Style Italiano Endodontics.

Eliminating the challenges of crown removal or endodontic access through restorations

Dr Gregori M. Kurtzman, USA

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Fig. 1: Great White Z diamond-coated burs utilised for zirconia crown removal or endodontic access and metal cutter carbide bur for use on all-metal crowns or the metal base of porcelain-fused-to-metal restorations.

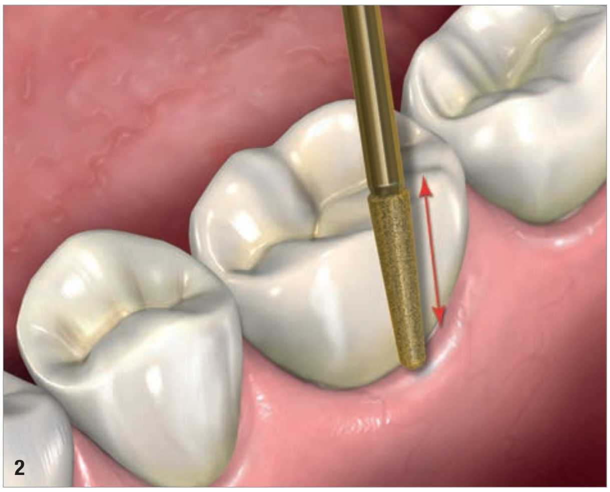
Introduction

Clinically, teeth with fixed restorations may need to undergo endodontic treatment or require replacement of the crown. There are a host of reasons for removal of existing fixed restorations, including replacement of the crown related to recurrent decay, replacement after endodontic treatment, fracture of the existing restoration or conversion to a fixed abutment for a bridge. There also may be situations where the existing crown will be maintained, but endodontic treatment needs to be performed on that tooth, so preserving the current restoration is required. Various materials have been utilised for fixed restorations, some metal-based, others ceramic and metal or all-ceramic in nature. The direction over the past decade and longer has been to eliminate metal in fixed restorations owing to the increasing demand for more aesthetic restorations by the patient and the consequent introduction of new stronger and more aesthetic ceramics. Ceramics, whether they are feldspathic, leucite or lithium silicate-based, are fairly easy to cut through when needing to access the pulp chamber to perform endodontic procedures or remove the crown to replace the restoration. Yet, the industry has been steadily moving in the direction of zirconia restorations, be they monolithic or as a base for an overlying ceramic. The increase in zirconia restorations has become a frustration to the practitioner when these restorations need to be removed or accessed through.

As with any procedure, selection of the correct tools and technique improves performance while decreasing the time to achieve the desired results and eliminating frustration on the practitioner's part. In this article, I will discuss methods to access through and remove zirconia-based restorations, as this is the material that causes the most frustration for practitioners in this regard. Additionally, techniques for metal-based restorations will be addressed.

Not all ceramics are the same

Zirconia hardness, as measured by Vickers hardness, is reported in the range of 700 to over 1,200, depending on how the material is treated during manufacturing and how it is fired after milling.[1] Hardness of zirconia restorations can decrease over time with consumption of acidic drinks (e.g. carbonated drinks and citrus juices), but this affects non-zirconia-based ceramics to a greater extent.[2] Flexural strength is also greater for zirconia monolithic restorative materials, decreasing for zirconia hybrid ceramics and further for lithium silicate and leucite-based ceramics.[3] These properties correlate with the abrasiveness of the restorative material.[4]



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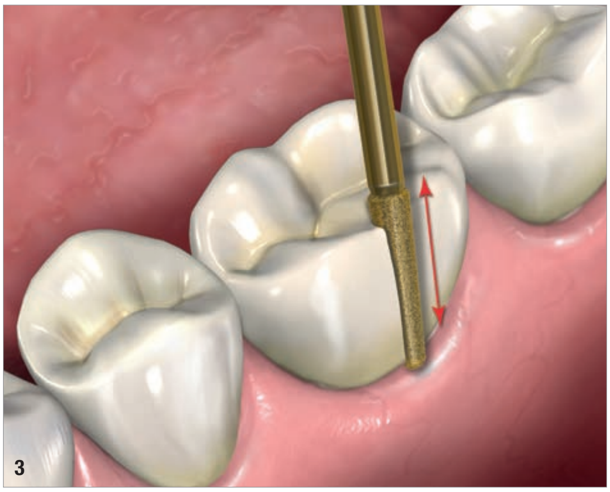

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Fig. 2: The diamond-coated bur is held against the buccal surface of the crown with light pressure and moved in a direction that is parallel to the long axis of the diamond-coated bur to create a slot through the ceramic. **Fig. 3:** The diamond-coated bur continues to be used in a direction that is parallel to its long axis, sawing through the ceramic until either dentine (ceramic crown) or metal (porcelain-fused-to-metal crown) is encountered.

The typical reasoning is that the harder the material and the more abrasive the ceramic, the more pressure (force) needs to be applied to cut it. Diamond-coated burs are used to cut ceramics because carbide burs are ineffective at cutting ceramics. When a carbide bur contacts a ceramic, the ceramic rapidly wears the carbide bur's flutes, creating irregularities on the carbide surface that may lead to microfracturing of the ceramic surface. Microfractures will not present an issue when removing the crown, but if the plan is to preserve the crown after endodontic treatment, it may lead to crown failure related to crack propagation over time. Whereas a diamond-coated bur abrades the surface being contacted, a carbide bur cuts.

Ceramics need to be abraded in order to penetrate the material; they cannot be cut, as it leads to structural damage (microfractures) and is an inefficient preparation method. Metal needs to be cut, and essentially a carbide bur mills the material it is preparing.

Monolithic zirconia or zirconia-based restorations

All-ceramic restorations constitute the majority of what has been used in the US with increasing frequency over the past ten or more years, and zirconia, especially in the posterior, is the dominant material chosen owing to its higher strength then other ceramic types. As zirconia is being manufactured with greater translucency, its use in the anterior will increase, especially in those patients with parafunctional habits that other ceramics may not withstand long term. The technique and materials that will work on zirconia, being the hardest ceramic material in use currently, will also work on ceramics that have lower material hardness.

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Fig. 4: A slot is next cut across the occlusal surface in a similar manner that is continuous with the slot cut on the buccal surface, again moving the diamond-coated bur parallel to its long axis. **Fig. 5:** Crown removal of an anterior crown requires the buccal slot to continue over the incisal edge to the lingual surface.

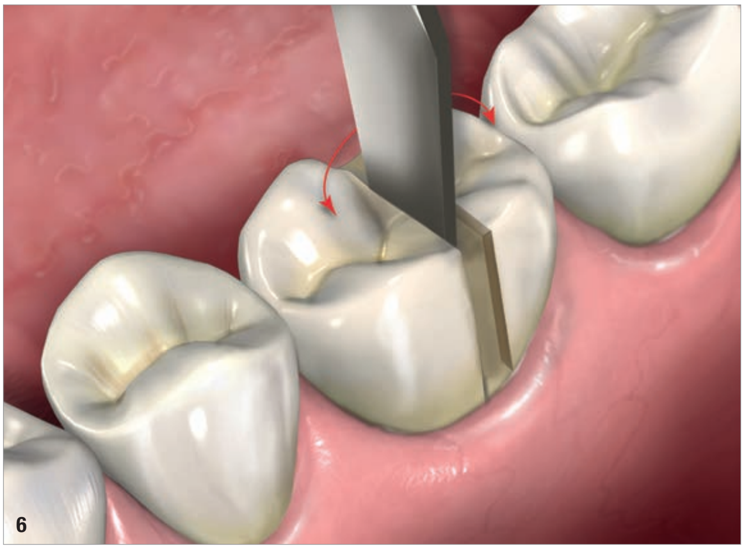

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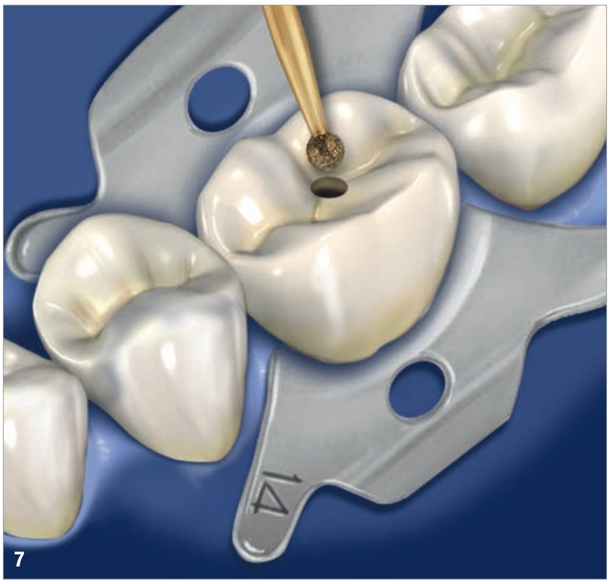
Fig. 6: A flat-bladed instrument tip is inserted in the buccal groove and rotated left to right to create torque to split the crown at the slots.

Choosing the correct tool is as important as the technique used with that tool. The belief that a hard ceramic material requires a coarser diamond-coated bur is actually not accurate and has driven practitioner frustration when attempting to remove or access through zirconia restorations. Additionally, instinctively, when we are preparing a hard material, we tend to subconsciously apply greater pressure to the instrument in an attempt to cut through the material. Add to this that, when we want to cut a slot into the crown to allow the crown to be split to remove it, we tend to push the diamond-coated bur's long axis into the crown, directing force towards the centre of the tooth. Conversely, when creating access through the crown to initiate endodontic treatment, we push the diamond-coated bur down against the ceramic in an attempt to create a hole in the restoration and contact the underlying dentine. Unfortunately, these inefficient methods lead to practitioner frustration.

Utilisation of medium-grit diamond-coated burs with the correct technique allows faster, more efficient access through zirconia, whether creating a slot to split the crown or performing endodontic access to the pulp chamber. As the technique has similarities and minor differences depending on whether crown removal or endodontic access is being performed, I will address these differently.

The key to removal of a zirconia crown is creating a slot across the buccal and occlusal or incisal surfaces so that torquing force can be applied to the slot and split the crown while preserving the underlying tooth structure. A medium-grit, slightly tapered diamond-coated bur (Great White Z [GWZ] 856-018, SS White Dental; Fig. 1) is used in a high-speed handpiece with copious water with light pressure against the tooth and moved parallel to the bur's long axis in a sawing motion (Fig. 2). This is begun on the mid-buccal surface, creating the slot from the crown margin to the junction with the occlusal or incisal surface, depending on what tooth is being treated. The slot is periodically checked to avoid penetration into the underlying dentine (Fig. 3). Once the slot has fully penetrated through the zirconia, with a posterior crown, an additional slot is cut across the occlusal surface that is continuous with the buccal slot (Fig. 4). When the crown being removed is on an anterior tooth, the incisal surface of the crown requires a slot deep enough to reach the underlying dentine (Fig. 5).



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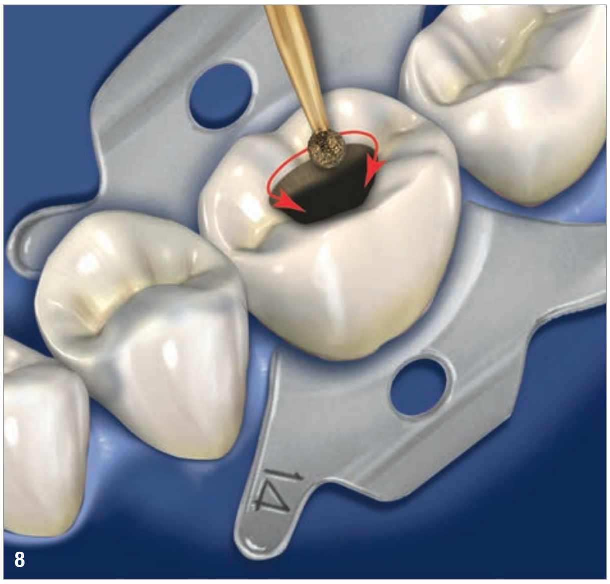

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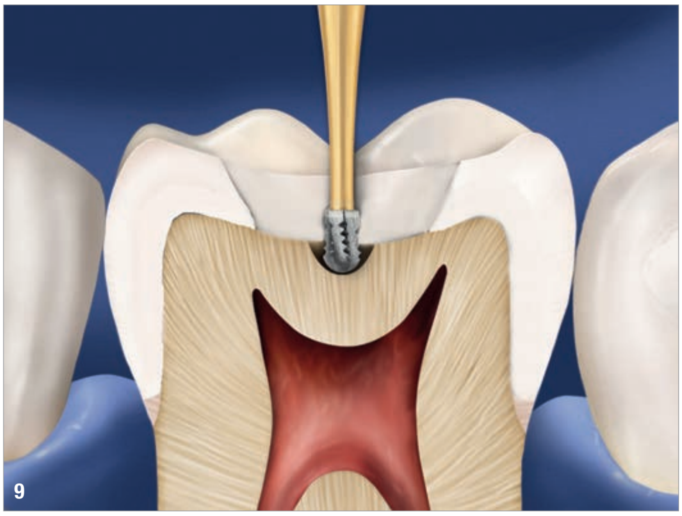
Fig. 7: A round diamond-coated bur is used with light pressure to outline the access form desired. **Fig. 8:** Once the crown material has been penetrated to the dentine in the outline form, access through the crown is completed.



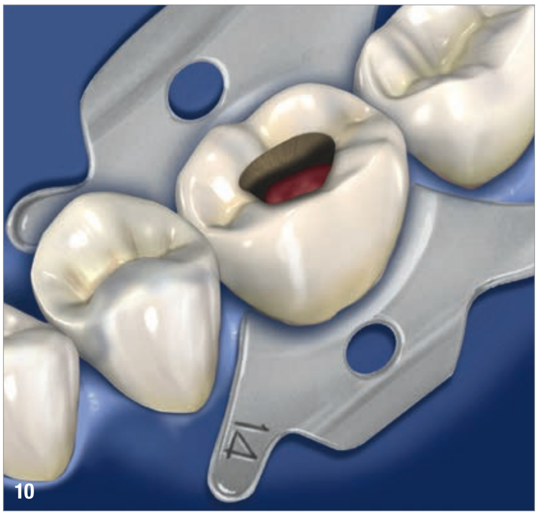
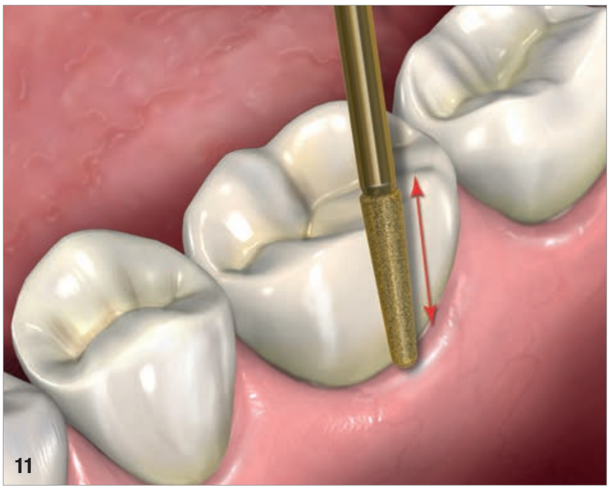


Fig. 9: After access through the zirconia or ceramic crown with the round diamond-coated bur, a carbide bur is utilised to complete endodontic access to unroof the pulp chamber. **Fig. 10:** Unroofing the pulp chamber may be accomplished with the diamond-coated bur or a carbide bur (practitioner preference), and the endodontic access is completed.

As the crown may be fairly thick in this area, depending on how the original tooth was prepared or what remained of the tooth prior to preparation, in some cases, this slot may be ≥ 3 mm deep.

A flat-bladed instrument such as a crown remover is inserted into the buccal slot, where the occlusal or incisal slot is continued and a rotational torquing motion is made to split the restoration into two halves and separate it from the prepared tooth (Fig. 6). It is not advisable to attempt this with a flat-bladed composite instrument, as the torque generated will either break the tip of the instrument or warp it. Crown removal instruments are better designed for this and can withstand the forces generated without instrument breakage. Should the crown not split into two pieces, verify that both grooves are continuous with the dentine and deepen them if ceramic remains in the slots. If the slots have penetrated to the dentine, and the crown is not splitting, continue the slot 2–3 mm on to the lingual surface. Should that still not allow crown splitting, using the same diamond-coated bur, remove ceramic interproximally at the expense of the crown being removed, in order to create space to allow the crown halves to separate when torqued with the instrument.

Dental adhesives are less retentive to zirconia than to tooth structure, and there is debate whether a true adhesive bond occurs to this substrate.[5] Upon crown removal, often the luting material is still bonded to the dentine, and this can be prepared off during re-preparation of the tooth. This also applies to zirconia-based restorations that have an overlying ceramic for improved aesthetics, whereas ceramics such as lithium silicate,



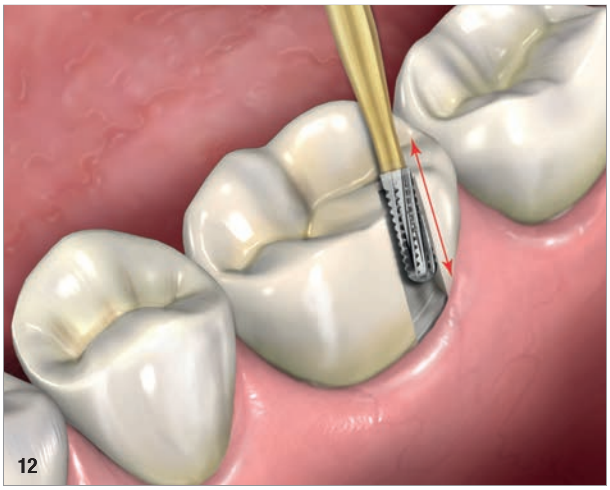


Fig. 11: The diamond-coated bur is used to create the slot in the ceramic to the metal substructure with a porcelain-fused-to-metal crown. **Fig. 12:** The carbide bur is utilised to continue the slot through the metal to the underlying dentine.

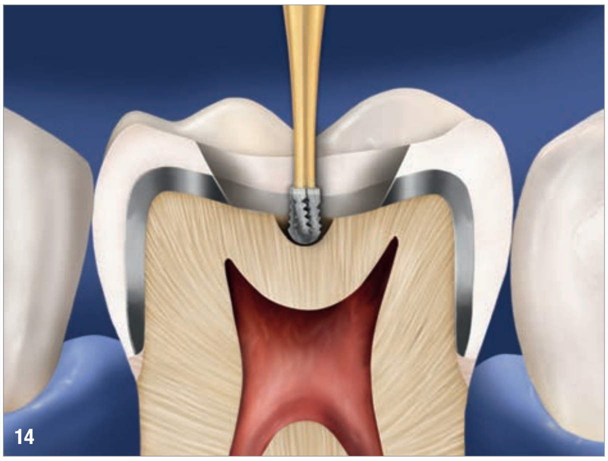


Fig. 13: The slot has been completed through the porcelain-fused-to-metal material and is ready for insertion of the crown remover instrument. **Fig. 14:** Following the outline formed with the round diamond-coated bur to the underlying metal substructure of the crown, the carbide bur is utilised to complete endodontic access to unroof the pulp chamber.

leucite-based and other true ceramics, including those containing zirconia particles, as well as ceramic–resin hybrids, have true adhesion between the crown material and tooth structure.[6–8] These may not split with the two slots created or removal of interproximal crown material. The author has found that this is more frequent in the posterior. When this is encountered, creating an additional slot from the mesial to distal aspect that includes the marginal ridges (creating a plus-shaped slot across the occlusal surface) and placing the crown splitter instrument into the mesial slot and applying rotational torque separates either the mesiobuccal or the mesiolingual cusp portion of the crown from the tooth. This is repeated in the distal slot. If the buccal or lingual crown material remains, the instrument is placed into the remaining slot and that will usually loosen the remaining crown material.

Endodontic access employs similar rotary instruments, a medium-grit round diamond-coated bur being used. The round diamond-coated bur is provided in three sizes, and selection is based on the tooth being treated, determined by the size of the access form needed for endodontic treatment. Mandibular anterior teeth and maxillary lateral incisors will require smaller endodontic access, for which a GWZ 801-014 (SS White Dental; Fig. 1) would be utilised. Maxillary central incisors and canines, as well as both maxillary and mandibular premolars, will require a larger access to unroof the pulp chamber, and a GWZ 801-018 (SS White Dental; Fig. 1) is best suited for these teeth. The round diamond-coated bur, as with the technique for crown removal, is used with light pressure, constant motion and copious water (Fig. 7). The diamond-coated bur is used to outline the access form desired and not pressed into the ceramic crown material, in an attempt to create a hole through the restoration (Fig. 8). Molars require the largest endodontic access owing to the dimensions of the pulp chamber, and widening of the initial access opening through the ceramic crown with the GWZ 801-018 can be followed with a football-shaped GWZ 379-023 (SS White Dental; Fig. 1) to achieve the desired access shape. A carbide bur is utilised to unroof the pulp chamber (Fig. 9). Once the pulp chamber has been penetrated, the outline form may also be refined using the GWZ 856-018 and then endodontic treatment of the canal system can begin (Fig. 10).

All-metal or metal-based restorations

As discussed, metal cannot be effectively cut with a diamond-coated bur and a carbide bur is required. When crown removal is planned, the GWZ 856-018 diamond-coated bur is utilised to create the slots through the ceramic layer until the metal substructure is encountered (Fig. 11). A Great White #1557 metal-cutting carbide bur (SS White Dental) is then applied at the buccal margin and stroked in an occlusal direction with the rotary instrument's tip penetrating to the dentine and continued to the occlusal or incisal surface (Fig. 12). Once the slot has been completed to the dentine, the crown removal instrument is placed into the groove and torqued to complete crown removal. The process is similar with all-metal crowns, eliminating use of the diamond-coated bur and completed with the carbide bur alone (Fig. 13).

Endodontic access is also approached in a similar manner to when dealing with all-ceramic crown materials. When a porcelain-fused-to-metal (PFM) restoration requires access though the restorative material for endodontic treatment, one of the round diamond-coated burs (GWZ 801-014 or GWZ 801-018) is used to create an outline form slightly larger than the needed form through the ceramic to the underlying metal. The Great White #1557 carbide bur is then used to form a hole through the metal into the dentine and then the outline form is widened to the dimensions of the outline created in the ceramic with the carbide bur and through the dentine to unroof the pulp chamber (Fig. 14).

Conclusion

Typically, access in precious and semi-precious metals can be performed with a single carbide bur, but non-precious metals may require multiple carbide burs in order to complete the task. This also is true with removal of PFM crowns. All-metal crowns require more metal to be removed and usually require multiple carbide burs to accomplish the task. Light pressure, allowing the carbide bur to cut the metal, is more efficient and less likely to snap the head off the carbide bur, which may occur when excessive pressure is applied to the restoration with the carbide bur. The carbide bur should be disposed of after a single crown removal or endodontic access or when it stops cutting the metal during the procedure. The diamond-coated burs may be used multiple times and should be discarded when the diamond particles begin to fall off the shaft of the rotary instrument. This can be typically noted by baldness on the tip, as that area takes the most stress when in use.

Crown removal and endodontic access can be accomplished with efficiency and decreased chair time when the diamond-coated burs and carbide bur mentioned are utilised as described. Light pressure with a stroking motion (for crown removal slot preparation) or circular outline formation (endodontic access) with copious irrigation improves efficiency while decreasing stress on the rotary instrument as well as the practitioner.

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

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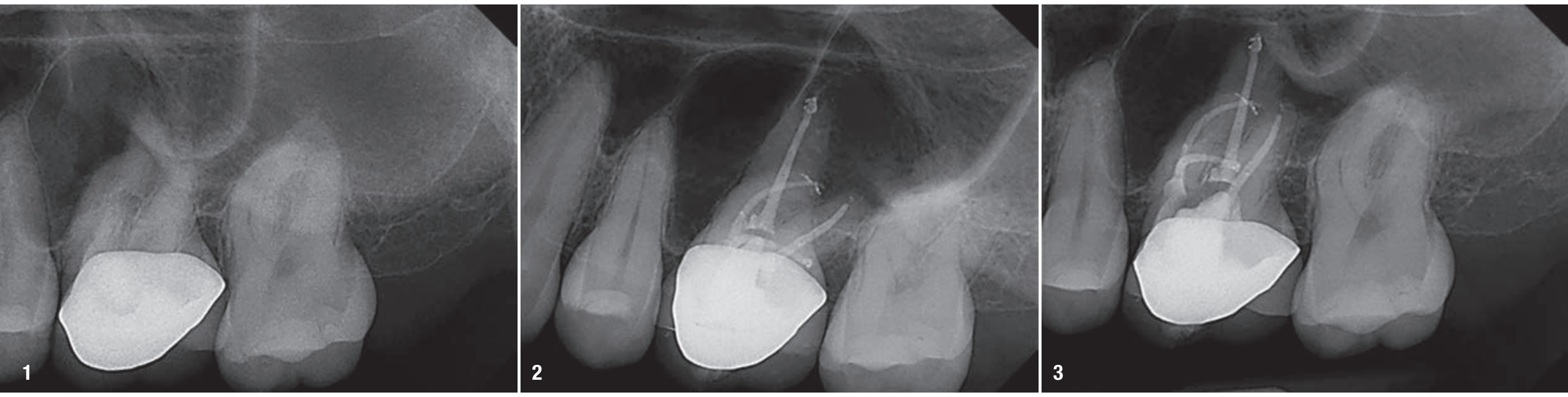
EdgeFile X7: Beastly bifurcation

Dr Yanina Figueroa, USA



In this article, I report a case of a 33-year-old patient with irreversible pulpitis and symptomatic periapical periodontitis affecting tooth #26 (Fig. 1). This case was diagnosed and accessed through the crown using diamond burs and then irrigated with sodium hypochlorite.

First, I sought to establish patency of the canals, employing size 10 files and working my way up to a 15 file for patency of the distal mesiobuccal canal and distal canal. I instrumented this case using an EdgeTaper SX file (EdgeEndo) to open the orifices, then used copious irrigation with sodium hypochlorite.

I started using the EdgeFile X7 files (EdgeEndo) utilising the crown-down technique. These types of canals that are very curved require some flaring up of the upper portion of the canal, so that the files can slide down easier and bind less on the walls. I started doing the crown-down from a 40 file to a 25 file and progressed to files in the 40s in the mesiobuccal and distal canals and to a 45 file in the palatal canal.

Before fitting the cones, I employed irrigation with ultrasonics using sodium hypochlorite, EDTA and chlorhexidine. I employed Gutta Percha Points and AH Plus sealer (Dentsply Sirona; Fig. 2). The radiograph to check cone fit revealed that a canal had been missed, so I captured a CBCT scan to locate the second mesiobuccal canal. The canal had an unusual buccal inclination to the palate, yielding the forked appearance of a snake's tongue. I closed the cavity with calcium hydroxide and accessed the second mesiobuccal canal on the second visit.

I instrumented the second mesiobuccal canal up to a 35 file following the same sequence, using sodium hypochlorite, first going up to a 15 file and employing the crown-down technique to a 35 file. After that, I irrigated with sodium hypochlorite, EDTA and chlorhexidine, dried the canal with sterile paper points, and took a radiograph to check the cone fit, again employing Gutta Percha Points and AH Plus (Fig. 3).

After confirming my satisfaction on the diagnostic intermediate radiograph, I used vertical condensation, leaving 4 mm of the apical portion of the cone and then backfilling with Gutta Percha Points. After that, as always, I placed an orifice barrier (PermaFlo Purple, Ultradent Products), followed by a cotton pellet.

Any other file of this size in this case would have fractured and may have been impossible to retrieve. The EdgeFiles are the best I have used.

about

Dr Yanina Figueroa obtained a BSc in biology from the University of Puerto Rico—Mayagüez Campus in 2003 and received her DMD from the University of Puerto Rico's School of Dental Medicine in San Juan in 2007. After graduating, she developed a passion for endodontics while working as a general dentist in private practice and pursued her dreams by completing her training in endodontics in 2013 at the University of Pennsylvania in Philadelphia in the US.

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The journey is the reward

Dr Silviu Bondari, France

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Fig. 1: Radiograph of the initial treatment of tooth #36 five years before. **Fig. 2:** Pre-op radiographic image of tooth #36 at the retreatment.

During a revision, the optimal canal shape is not always that obvious at the start. Fortunately, modern assistance systems guide the dentist step by step through the individual root canal anatomy. In the following case, I will present how I used a new digital endodontic co-pilot to support me in navigating to the apex.

When travelling by car, people have long since become accustomed to employing a navigation system or application. The digital co-pilot knows the traffic rules, reports and avoids obstacles and, in case of doubt, even reacts faster than the human driver. The long-cherished dream of reliable autonomous driving is now apparently finally coming true in endodontics too.

Thanks to a new drive concept, modern endodontic motors provide the dentist with quasi active support in both mechanical and chemical preparation. At millisecond intervals, a complex algorithm controls the variable file movements—current intensity and torque and possible fatigue always firmly in view. At the same time, the electronic co-driver signals acoustically when and how often rinsing is required. Such assistance systems are a great help, especially during revisions where the course of the canal ahead is not quite obvious at the beginning. This was also the case in a retreatment in the left mandible reported here.

Periapical periodontitis of tooth #36

The 30-year-old patient was first diagnosed with acute pulpitis in a mandibular molar in 2015. Tooth #36 received root canal therapy and was then obturated using the vertical condensation technique with gutta-percha and a two-component sealer (Fig. 1). Unfortunately, the success of the treatment was not long-lasting. In 2020, the patient again presented himself in our practice with acute pain symptoms. Radiographic diagnostics confirmed the suspicion of periapical periodontitis around both root canals of the treated tooth #36 (Fig. 2). The patient finally agreed to the necessary revision treatment.

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Fig. 3: REMOVER file *in situ. (Image: © COLTENE)* **Fig. 4:** Fully automatic CanalPro Jeni endodontic motor. *(Image: © COLTENE)*

Preparation with remover file

The first and decisive step in retreatment is the complete removal of the inadequate or aged gutta-percha filling. For this purpose, we use special remover files in our practice (Fig. 3). The 30/.07 MicroMega REMOVER file (COLTENE) adapts flexibly to the individual canal shape. In this case, we loosened the existing obturation material in this way without using additional solvents. At a speed of 1,000 rpm with continuous rotation, the filigree file was inserted into two-thirds of the canal. Thanks to the non-cutting instrument tip, the surrounding dentine was spared as much as possible. This additional safety component has proved to be very valuable in daily work.

Subsequently, the use of suitable nickel-titanium (NiTi) files is recommended for further shaping of the canal. The remaining distal root was treated with the HyFlex EDM OneFile in the contra-angle handpiece at 500 rpm. The 20/.05 HyFlex EDM file was used in the mesial canals. The speed was also 500 rpm. With the remover files, the existing gutta-percha could be eliminated surprisingly quickly and easily. Within seconds, a clean access to the apical third was achieved.

To the root in autopilot

Even more exciting for us was the test drive with a new type of digital endodontic assistance system. The CanalPro Jeni endodontic motor (COLTENE) was used for the first time to perform the mechanical and chemical preparation in the case described (Fig. 4). The motor is named after its developer, Dr Eugenio Pedullà. For a long time, the Italian endodontist was occupied with the question of how the concept of autonomous driving could be employed in endodontics for safe and less error-prone root canal therapy. The result is a fully automatic endodontic motor that independently finds its way through the root canal.

The application was comparatively simple: just work steadily with light pressure from the coronal to the apical aspect. Meanwhile, the motor decides independently on the appropriate motion sequence. For this purpose, the software of the assistance system uses complex algorithms that make the whole thing possible in the first place. Every millisecond, the device controls the variable file movements and continuously adjusts the rotational movement, speed and torque. Unnecessary file stress is also continuously corrected by Jeni.

The selection of the appropriate NiTi sequence on the touch screen was quick and easy. However, it took a bit of getting used to the consequent preliminary work in the canal from coronal to apical, since I was used to advancing carefully in a small pecking motion downwards relying on tactile feedback. With Jeni, the dentist just holds the contra-angle handpiece; the motor does the rest and adjusts the rotation to the root canal anatomy. This "teamwork" also makes root canal therapy much more efficient and less prone to errors. After my initial reluctance, I grew more confident and trusted Jeni to indicate in good time when things could get tricky in the canal. The digital co-pilot also indicates when it is time to change files and when to rinse. In turbulent weeks with many treatments and emergencies, you will be quite grateful to have an additional safeguard in addition to the assistance at the chair to subtly remind you of the next step in the treatment process.

Figs. 5 & 6: Post-op radiographic images.

For the final shaping of the canal, the 25/~ HyFlex EDM OneFile was used in the mesial canals. A 40/.04 EDM file was used in the distal canal. The result on the radiograph after obturation was extremely pleasing. Hopefully, it will be more durable than the first treatment approach five years ago (Figs. 5 & 6).

Conclusion

During revisions, flexible remover files can be used to efficiently loosen and remove insufficient gutta-percha fillings. Digital endodontic assistance systems navigate the dentist step by step through the mechanical and chemical preparation by adjusting the variable file movement. Thanks to the continuous preprocessing from coronal to apical, canal shaping is much more efficient and less prone to errors than before.

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Calcified canals: A new approach to an old problem

Dr Randolph Todd, USA

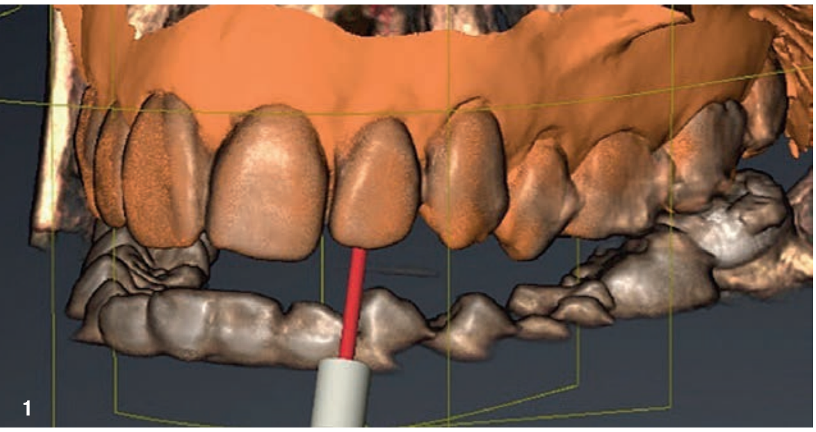

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Fig. 1: The superimposed digital impression over the CBCT image with a planned pathway.

We, as dentists, have developed outstanding new technology in order to fashion beautiful smiles. The option to retain the natural dentition or replace it with implants opens limitless possibilities. As an endodontist, however, my mission is to preserve functioning teeth when possible. In the process, I focus on integrating the patient's needs with technology. Today, advances in dentistry provide us with new choices when confronting the challenges of the past. Calcified canals are considered by many to be one of those challenges.

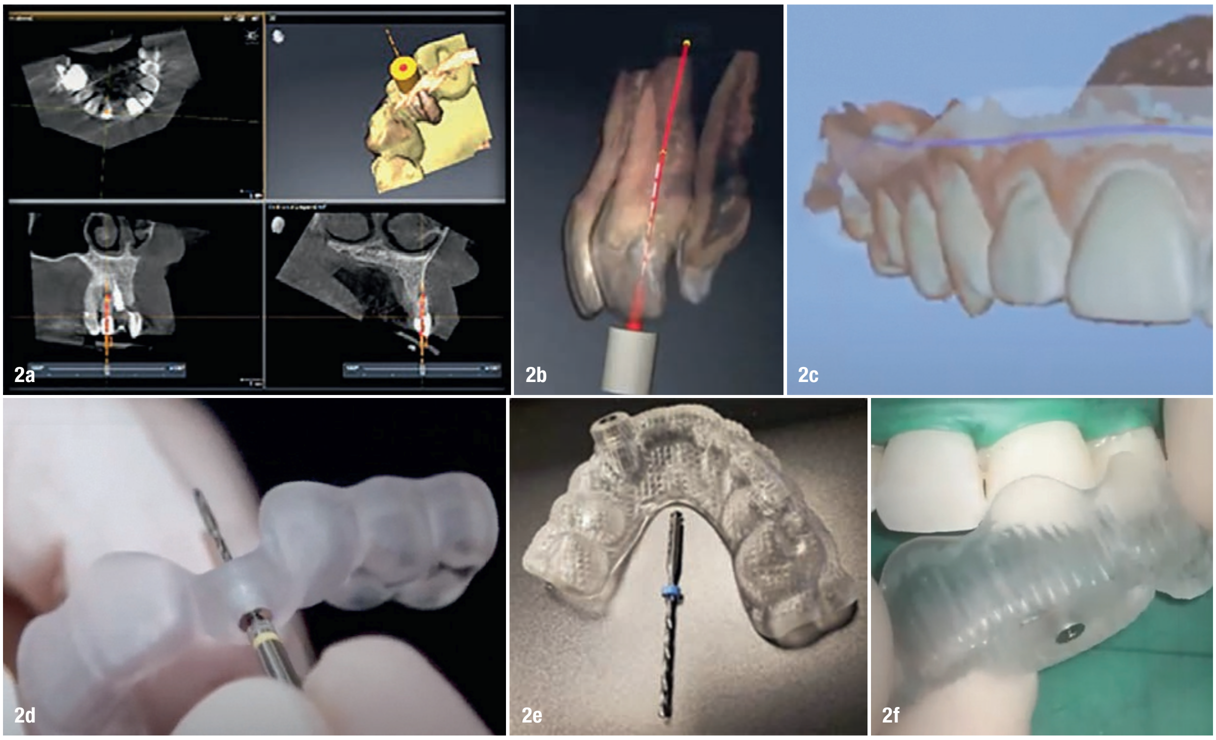
In fact, this condition frequently limits our ability to treat affected teeth. As we all know, leaving behind untreated, infected canals is a recipe for failure that may lead to extraction. Treating and saving nonvital roots with severe calcification challenges even the most talented practitioner. Various methods of bypassing calcification have been tried, but they frequently result in over-preparation or perforation. Let us take a look at a fresh approach to this old problem.

All treatment begins with a review of the chief complaint, a comprehensive examination, a review of the medical and dental history, diagnosis and treatment planning. It is important to note that not all calcified canals need root canal therapy. The foundation for endodontic treatment is based on the research performed by Kakehashi et al. Their findings established that endodontic care is indicated when there is bacterial contamination, leading to irreversible pulpitis or pulpal necrosis. Not every problem requires reinventing the proverbial wheel. New use of existing technology may be the answer. For example, surgical templates assist implant placement. Their use for guidance through a calcified root is just a new application.

The process begins with taking a CBCT image to identify and visualise the root canals. CBCT, 3D imaging, frequently reveals canals not observable on 2D conventional periapical films. Examples include those elusive second mesiobuccal canals often missed in maxillary molars or second canals observed in mandibular incisors and premolars. When calcification of canals develops, it commonly starts in the chamber and travels apically. When a tooth undergoes calcific metamorphosis, the canals frequently are obscured from view in the coronal and middle thirds of the root but visible in the root's apical third. When these canals are examined on the CBCT image, although not visible, a straight path may be imagined from the chamber to the canal in the root's apical third. Computer software is now available to reproduce this path through the calcification to the remaining canal. SICAT Endo offers a service that streamlines the process.

After capturing the CBCT image, scan a digital impression of the same arch. Superimpose the data set of the digital impression over the data set of the CBCT image. Select four common points on both arches to align the information. Once matched and joined, the previously imagined pathway can be accurately measured from a cusp tip to the residual canal on the software. This digital information is ready to use to create a guide. The next step is to use software to design a rigid template that fits over the occlusal or incisive surface. The template needs to extend beyond the treated tooth in both directions. This added dimension offers stability when seating the template. A space is designed in the template, over the tooth, to hold a 5 mm metal sleeve. On the computer, align the sleeve with the proposed pathway. Fabricate the template with a 3D printer. After it is created, insert the sleeve into the template. Drills that fit the sleeve's internal diameter are selected based on the length needed to reach the residual canal. The guide is now complete and ready to use. The measurement from the top of the sleeve to the viewable canal is determined on the computer. Access is gained through the guide with a low-speed handpiece. Once the residual canal is reached, treatment is completed following standard endodontic practices.

This approach reduces over-preparation of the canal and perforations. The dentist can apply a guide at any point during endodontic care. Each canal would require its own guide. The



Figs. 2a–f: Planning the guide path with CBCT software **(a)**. A planned path on the CBCT image **(b)**. An image of a digital impression in digital dentistry software **(c)**. An endodontic guide with a low-speed drill **(d)**. A template guide and drill **(e)**. Placing the guide over a tooth **(f)**.

additional cost to the patient for fabricating the guide is much less than replacing the tooth. It enables predictable treatment of canals that otherwise would not be treatable. Very few patients have turned down the opportunity to save a tooth.

This example of the reapplication of technology may be useful in other areas of dentistry. The only limitation is our imagination. To provide a look into the future, I have listed other challenges we could pursue. I hope you read this with no expectations but rather an open mind for what could be:

- *Current technology:* Patients have multiple electronic medical files containing history and current medications. In the future, DNA may also be available on a file.
- *Future potential applications:* Fingerprint access or retinal scans could securely protect a single medical file that would efficiently transfer medical information to dentists. This information would enable personalised prescription of medications and more accurate use of the patient's medical history. It may prevent accidental allergic reactions, adverse interactions and overprescribing.
- *Current technology:* Microscopes can view computer screens through their optics.
- *Future potential applications:* Radiographs, CBCT and digitalised impressions should be viewable through the microscope. The dentist could use tracked files (viewable on CBCT) in conjunction with preoperative or intraoperative images, to directly or indirectly guide the instrument, in an image-guided procedure.
- *Current technology:* Ultrasonic light-activated nanoparticle-infused irrigation liquids need to be further adapted for irrigation of the canal system.
- *Potential dental application:* Enhanced ultrasonic irrigation that would eliminate bacteria, viruses and prions.
- *Current technology:* Laser fusion of dentine should be explored for obturation of root canals.
- *Potential dental application:* The endodontic obturation process should seal the dentine and match the root's physical properties to reestablish its strength. The process should be able to be reversed if retreatment is required.
- *Current technology:* CBCT can identify canals and be used to measure their length accurately.
- *Potential dental application:* This process should be automated.

The future may include significant advances in technology, but the application of existing technology will continue to open the doors for new treatment. Imagination is the key to unlocking those doors.

about

Dr Randolph Todd is a technology-inspired diplomate of the American Board of Endodontics who began his academic dental career at Tufts University School of Dental Medicine, Boston, US. Upon completing a general practice residency at North Shore University Hospital and Long Island Jewish Medical Center (NSUH/LIJ), New York, US, he pursued his endodontic specialty training at New York University College of Dentistry (NYU Dentistry). Over the past forty years, Todd has maintained an exclusive microsurgical endodontic private practice in New York.

"At Slow Dentistry, we believe that time is a universal vector of excellence"

An interview with Dr Miguel Stanley about the importance of practising Slow Dentistry

By Iveta Ramonaite, Dental Tribune International

According to Dr Miguel Stanley, dental practices should strive for clinical excellence over profit, and patients ought to fight for more quality chair time in order to be sure that appropriate safety protocols are in place. *(Image: © Slow Dentistry)*

Many dental professionals equate business success to practice profitability. Unfortunately, this can sometimes lead to rushed dental appointments and poor-quality treatments. In his webinar on 4 December, Dr Miguel Stanley, the clinical director of the White Clinic based in Lisbon in Portugal and a passionate advocate for high-quality dental care, talked about how Slow Dentistry should be a fundamental human right. He also explained why it is now more important than ever to follow the best disinfection practices in a dental clinic.

What do dental professionals need to know about Slow Dentistry, and how did the concept come about?

We live in a dental world in which so many things have been accelerated through technology, software and new workflows. Dentists have enjoyed a booming industry over the years, and those who have invested in their practices have benefited from all of the new ways of practising dentistry. However, dentistry is mostly privately owned or managed. We are seeing a growing trend in dental service organisations or dental management companies that are investing heavily in purchasing small private practices.

There is a growing understanding within the dental community that many of these privately owned and managed practices focus too much on profit over clinical excellence. We completely understand the need to make a fair living through your craft, but it cannot be at the expense of public safety and ignorance. There are various ways to save money when managing a dental practice. However, since dentistry is an aggressively competitive market, it is usually done at the expense of quality materials or salaries and the duration of appointments.

Needless to say, salaries vary from country to country, and controlling the quality of materials is an impossible task. However, at Slow Dentistry, we believe that time is a universal vector of excellence and that it is often overlooked and undervalued. There is a growing belief

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.

in clinics around the world that, in order to boost profits, one needs to try and pack as many appointments into a daily schedule as possible. There is also the belief of an unsuspecting public that a short consultation is something positive, when in fact we know that dentists have never been trained to work fast; they have been trained to provide quality service to reach the best results.

The whole reason behind Slow Dentistry is the communication of four basic cornerstones that cannot be contested by any dentist in the world. These cornerstones do not rely on any technology or require special education. They are ubiquitous and globally accepted as true. When applied, they guarantee that patients will be treated in a disinfected dental unit, that they will receive an explanation in terms of what will be done to them from a medical perspective, that their experience will be pain-free and that a dental dam will be used in all root canal procedures as well as in most restorative dental work. We find these to be universal rights that must always be present on a trip to the dentist.

The concept came about many years ago because I was seeing a lot of examples of failed dentistry, mostly poorly performed root canals, and could not understand why so many dental professionals were doing such a poor job. I later realised that it was mostly due to the time that the patient spent in the chair and not necessarily the fact that dentists were not good at their jobs; the clinics were simply managed in this way. Having approximately 16 appointments a day, dentists had limited time to fix all the problems.

> “The general public currently has no idea of their rights at a dental appointment.”

Dental practices that work with insurance companies or sign subsidised deals with financial organisations do not usually get rated on the quality of their work or the time they take to complete a procedure, but rather on the technicality of their work. I feel that this is unacceptable to the general public.

The goal of Slow Dentistry is to improve the standard of care globally through public awareness. People have to argue for more quality chair time. We understand that this will create higher costs for the practice, but that is something that is not negotiable. These basic cornerstones have to become globally accepted and implemented. Everybody learns them at dental school, but too many people forget them when running a business.

In your opinion, why should dental professionals practise Slow Dentistry?

In my opinion, and this might sound a bit aggressive, dental practices that do not practise Slow Dentistry should not be allowed to operate. It is a basic human right of any patient to be treated in a dental chair that has been properly disinfected according to gold standard protocols. How can you do this when your turnaround time is under 20 minutes? I have had multiple conversations with many dentists in the UK who told me that in National Health Service clinics, the average turnaround time is 15 minutes. With that in mind, how could you properly invest the appropriate amount of time to disinfect the chair in between appointments and still provide quality, humane and ethical care? How can you accept that the dental dam is not used in all root canal procedures?

> “The goal of Slow Dentistry is to improve the standard of care globally through public awareness.”

This paradigm must change. However, the change will not come from the industry itself as it directly affects profitability. That is why we market these simple and easily identifiable cornerstones to the general public, hoping that they will apply pressure to their dentists.

I challenge you to find one specialist who says it is impossible to practice these four simple cornerstones. The only impediment is chair time, and that should not be taken away from the patient; rather, dentists should be invested in patient care.

Slow Dentistry should not be necessary, but, unfortunately, the whole industry has almost no regulations. It has failed to regulate itself, and so it is up to the general public to impose these rules. If they wish not to be treated according to these rules, that is a different subject. However, the general public currently has no idea of their rights at a dental appointment. According to some of the leading dentists in the world, these four cornerstones are globally accepted as being profoundly important in order to establish trust, hygiene and safety during a dental consultation. Only clinics that wish to save time in order to boost profits would not be practising in this way, and we believe the public has the right to know which clinics these are.

What can the participants expect from your very first DT Study Club webinar on the topic?

I am very excited about talking on this platform. I am representing all of our honorary global ambassadors and member clinicians around the world who themselves share the same values for achieving excellence in dentistry. Excellence does not only imply high-quality work; it needs to guarantee high-quality safety. Through this pandemic, we have learnt that patient safety is something that cannot be negotiated. We are on the cusp of 2021, and we are still having to argue that a patient should always receive a dental dam for a root canal treatment and for most direct restorative work, even though we have known for years that this augments the safety and the quality of work.

During the webinar, I present the entire process, showing how easy it is to sign up and explaining how Slow Dentistry transitioned into a non-profit organisation run by a Swiss foundation that aims to focus on the betterment of dentistry globally. I explain to our attendees that their yearly subscriptions are, in fact, donations that will help the foundation gain capital and will help share our values with patients around the world. The more member clinics we have, the more financial capital the foundation will have to carry out its work and reach a bigger audience. Hopefully including mainstream media.

I also introduce a new website coming in 2021 with considerably more functionality. The website is for member clinics and clinicians as well as for companies that wish to support this movement. We have already received some generous donations from leading technology companies that wish to support our cause.

Moreover, I talk about some new badges that can be unlocked in 2021, such as the digital badge and the small business owner badge. Each of these badges is based on the four basic cornerstones and can be acquired by our members after meeting certain criteria. This will allow the general public to distinguish those clinicians and practices that go the extra mile to maintain a high-quality, well-managed and safe dental practice.

Editorial note: The webinar, titled “Slow Dentistry”, was presented live on 4 December 2020 and is still available on the DT Study Club website, registration is free of charge.

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dti Dental Tribune International

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Andrea Stix, Germany

In order to avoid stress and disharmony in the daily work routine and to appear professionally as a team to the outside world, clear communication with one another is important. Reciprocal feedback is therefore of vital importance in order for communication in the dental practice to be as simple, appreciative and smooth as possible. What needs to be taken into account in this regard will be highlighted in this article.

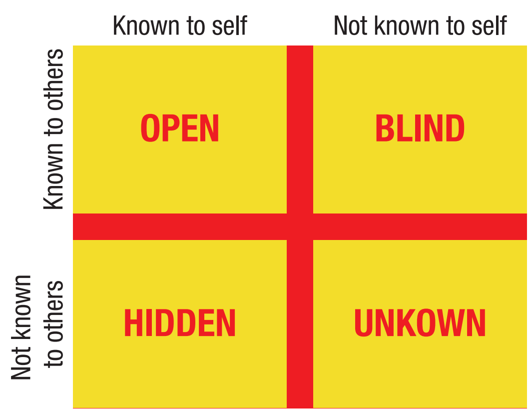
Feedback is important

Why we need feedback is explained by American social psychologists Joseph Luft and Harry Ingham in a model that sets out conscious and unconscious personality and behavioural traits. Their Johari Window, a combination of the psychologists' first names, is divided into quadrants and shows the differences in self-perception and perception by others. The open quadrant relates to what one reveals about oneself and what is known or visible to others. This includes external characteristics such as appearance, manners or even physical reactions, as well as internal attitudes and behaviour. The hidden quadrant is what a person knows about himself or herself, that is, things that he or she is aware of, but either unknowingly does not make available to others or consciously hides from them. The blind quadrant is everything that a person conveys and is perceived by the recipient without the sender being aware of it. Others thus recognise behaviours and characteristics that one does not perceive in oneself. Only through constructive feedback can information be moved from the blind quadrant to the open quadrant. It also allows reflection on things that we unconsciously keep from others. Feedback is an effective instrument to support colleagues or employees in their personal development. Unfortunately, the potential of this powerful tool often remains unexploited in many companies.

What is feedback?

The term "feedback" refers to a response to or assessment of a person's behaviour. It is a central process by which a reaction is conveyed. With feedback, we inform someone about how we perceived and experienced his or her behaviour. In this way, we invite the other person to employ metacommunication, that is, to talk about his or her behaviour. The most common feedback error is criticism of personality traits—and that is exactly what turns feedback into ridicule. Discussion in this manner of one's personality—which cannot be changed—is insulting and abusive, and no good or fruitful outcome can come from it. Authentic feedback, however, always aims at a positive change in behaviour; it is constructive and supportive. Feedback complements self-perception through external assessment and external perception. Feedback can

Johari Window (Joseph Luft & Harry Ingham, 1995)
Conscious and unconscious personality and behavioural traits



make visible how one's own behaviour has an effect on or is received by the other person, how a situation or performance is assessed or what potential for improvement exists. Correctly used, feedback can therefore be extremely valuable. In everyday professional life, it is almost indispensable for the further development of one's behaviour.

Differentiation from praise

Praise is usually not very specific, such as "you did a good job", "I am very pleased with you" or "keep up the good work". Praise is therefore positive feedback which, owing to a lack of specificity, does not bring about any lasting change. Praise might be very important in daily interaction—but giving feedback is essential.

Giving feedback

Giving constructive feedback has to be learned because, if applied incorrectly, it can have the opposite effect to that intended. Ideally, feedback should follow a methodical framework—feedback rules. The feedback should help the recipient to reflect on his or her behaviour in order to better assess its effect on others and to modify his or her behaviour if necessary. Feedback must be conveyed in a particular form in order to be fully effective.

Feedback rules

In order for feedback to have a motivating effect and to encourage one to develop oneself further as a consequence, it is important to follow the ten golden rules of feedback. The context especially is of vital importance: feedback is particularly effective if it is given promptly. Feedback should never take place according to fixed times. It makes much more sense to give constructive feedback as relevant things—whether positive or negative—arise.

Receiving feedback

Receiving feedback is also something that has to be learned. Most people initially react defensively to feedback and this is just what must be avoided. Constructive feedback is valuable because it reduces our blind spot. Explaining or justifying oneself immediately after receiving feedback would be counter-productive. Furthermore, feedback is not debatable. Even if one perceives the situation differently to the feedback received, it shows in a very appreciative way how one's behaviour affects others. The giver of the feedback must always intend to trigger a positive outcome—regardless of whether it concerns something negative that needs to be improved or something positive that needs to be reinforced. If one is not receptive to feedback, one is unlikely to receive authentic feedback. Hence: LISTEN. TAKE IT IN. SAY THANK YOU.

Rules for constructive feedback:

1. Give feedback only in an emotionally relaxed state. This will help you to stay objective and avoid strong emotional reactions.
2. Is your counterpart receptive to feedback? Is feedback desired? Ask for feedback!
3. Separate statements about behaviour from statements about personality traits! In this way, you can avoid affronting the person and increase the probability that your feedback will be well received. IMPORTANT: Behaviour must be clearly separated from identity. There must be no moral judgement, generalisation or interpretation.
4. If you have negative things to communicate, also express your positive experiences, perceptions and feelings.
5. Give very specific feedback. Use concrete examples of the behaviour to which your feedback relates.
6. Observation: Describe only what is visible and objectifiable for all.
7. Perception/effect: Make sensory statements and name your own (emotional) reaction to the recipient of feedback. Say what and how something has affected you: "It affects me …".
8. Express yourself exclusively using "I": "I have seen …", "I have noticed …", "I feel …".
9. Recommendation/wish: Address specific criteria for desirable behaviour so that your feedback is useful for future situations. "I recommend …", "I would like …", "I would like it if …".
10. Be brief and only convey as much as your counterpart can take in.

In teams, feedback should always be given directly to the intended recipient.

Editorial note: This article was first published in laser—magazine of laser dentistry*, Vol. 12, Issue 1/2020.*

about

Germany-based **Andrea Stix** is a consultant for communication strategies. She is a coach in practice marketing and is specialised in personality diagnostics. She currently works as strategic consultant for CAMLOG.

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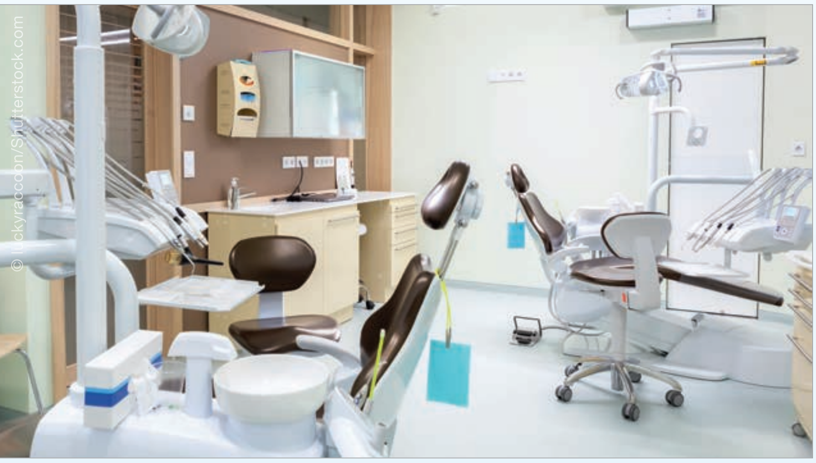
ADA supports point-of-care COVID-19 testing by dentists

According to a new policy from the American Dental Association, point-of-care testing to screen patients for chronic diseases and other medical conditions, including COVID-19, that could complicate dental care or put the patient and dental staff at risk is within a dentist's scope of practice. "Yet currently, rapid and reliable COVID-19 tests are not available to dentists for in-office use, which makes no sense," states ADA President Dr. Daniel Klemmedson.



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According to the American Dental Association, it makes sense for COVID-19 point-of-care testing to be offered by dentists.

Klemmedson, who holds degrees in both dentistry and medicine, points out that dentists are doctors of oral health. "It is well within dentists' scope of practice to screen not just for COVID-19 infection but also other medical conditions that may affect dental care such as glucose levels, which help screen for diabetes, and blood pressure, which help screen for hypertension. Patients with abnormal test results would be referred to a physician, other qualified medical professional or medical facility for diagnosis and follow-up care."

"With strengthened infection prevention protocols and personal protective equipment (PPE), dental offices have re-opened safely around the country," Klemmedson said. "Millions of patients have returned for oral health care, which is an essential health service. Dentists should be given access to FDA-authorised point-of-care testing for COVID-19 infection to add to their ability to screen patients and help to identify those infected with the virus."

Klemmedson pointed out that dentists' areas of care include not only their patients' teeth, gums and supporting bone but also the muscles of the head, neck and jaw, the tongue, salivary glands, the nervous system of the head and neck and other areas. When appropriate, dentists perform procedures such as biopsies, and screen for chronic or infectious diseases, salivary gland function and oral cancer.

In addition, according to 2013 to 2016 data from the U.S. Centers for Disease Control and Prevention, 7.7% of people (10.2 million) reported having seen a dentist in the previous 12 months but no other medical professional.

"It makes practical sense for COVID-19 point-of-care testing to be included in screening procedures dentists perform," Klemmedson said.

The U.S. Food and Drug Administration includes dentists among those professionals who can test for COVID-19. In addition, the CDC recommends dental facilities consider implementing pre-procedure testing for COVID-19, particularly during PPE shortages.

The ADA and state dental societies are actively advocating state and federal regulatory authorities to: Publicly recognise that point-of-care testing for COVID-19 is within dentists' existing scope of practice, and make COVID-19 tests available for use in dental practices.

"With dental practices reopened across the country, dentists are already screening patients for signs and symptoms of COVID-19, and referring patients for appropriate medical follow-up when indicated," Klemmedson said. "Unfortunately, such screening alone will not identify all individuals who are infected. Identifying infected patients is key to being able to protect both patients and dental team members from exposure to the virus."

Given that patients receiving dental treatment may be pre-symptomatic (infected but will develop symptoms in the next 14 days) or asymptomatic (infected but will never exhibit signs or symptoms of disease), Klemmedson said it is critical to identify those individuals carrying the virus so that it is possible to minimise their contacting and potentially infecting others.

Source: American Dental Association

Decellularised matrix hydrogel may promote dental pulp regeneration

By Monique Mehler, Dental Tribune International

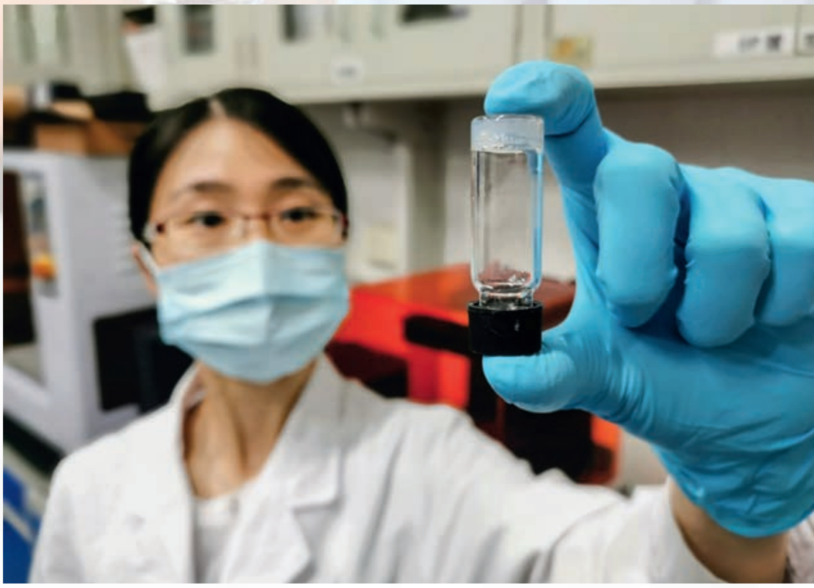
Dental pulp regeneration has been a great challenge to researchers in the field of endodontics for decades. It has been widely regocnised that tissue-engineered biomaterials might be beneficial for endodontic regeneration; however, single-component materials or shape-fixed scaffolds are not able to meet the requirements for multifunctional dental pulp regrowth. Inspired by the clinical use of multiple acellular tissue grafts, researchers in China have become interested in decellularised dental pulp matrix.

In a recent study, scientists from Dr Zhengmei Lin's group at the Affiliated Stomatological Hospital of Sun Yat-sen University, and their collaborators from School of Materials Science and Engineering in Guangzhou developed a decellularised matrix hydrogel (hDDPM-G), derived from human dental pulp, which might be able to serve as a growth-permissive microenvironment for dental pulp regeneration.

In an interview with Dental Tribune International, Dr Ying Bai, who is part of the team that carried out the research, said that the most important requirements were that the biomaterial had to be gel-based, fit into the root canals, form *in situ* and exhibit bioactivity.

After complete decellularisation was implemented, protein contents found in the human decellularised dental pulp matrix were found to contribute to promoting cell proliferation, migration and regulation of stem-cell differentiation. The results showed that hDDPM-G-coated surfaces promoted hDPSC adhesion, migration and proliferation. Furthermore, hDDPM-G coatings facilitated odontoblast-like, neural-like and angiogenic differentiation of the seeded hDPSCs after being cultured in induction media for 14 days.

"The whole study has been quite challenging, since it pioneers the exploration of endodontic regeneration at the intersection of materials science, biology and medical science," Bai explained. "Among all the challenges we faced, the preparation of decellularised dental pulp hydrogel was probably the most difficult. The availability of healthy dental pulp is extremely limited—a small amount of hydrogel might be obtained from hundreds of routinely extracted third molars. Moreover, the physical properties of the hydrogel could undergo batch-to-batch variations. Therefore, it is difficult to standardise the fabrication process of such tissue-derived biomaterial; we are still working on it," he continued.



This recent research into regenerative endodontics is only the beginning, according to researchers. The ultimate goal is to develop a novel therapeutic solution for dental pulp regeneration. Here, Dr Qiting Huang, who participated in the study, is showcasing tissue-derived decellularised matrix hydrogel. *(Image: © Sun Yat-sen University)*

Looking to the future, Bai and his colleagues are investigating the possibility of developing a novel therapeutic solution for dental pulp regeneration for clinical use in patients. He added: "The reported work was just the beginning of our journey in exploring the biological functions of the decellularised dental pulp matrix hydrogel. Through this work, it is clear that the hDDPM-G could promote multifunctional differentiation of dental pulp stem cells, but we do not yet know why or how. The underlying mechanisms are still to be discovered. However, further work on clinical applications, proper treatments and animal models will be conducted. There might be a long way to go from laboratory to dental clinic, but we hope that this complex but viable biomaterial will be able to inspire more multidisciplinary research in the field of endodontic regeneration."

The study, titled "A decellularized matrix hydrogel derived from human dental pulp promotes dental pulp stem cell proliferation, migration, and induced multidirectional differentiation *in vitro*", was published on 1 October 2020 in the *Journal of Endodontics*.

New range of products

FKG Dentaire expands its legacy with RACE EVO and R-Motion

Swiss company FKG Dentaire has a legacy founded on years of trusted performance and expertise. It is well known for its flagship XP-endo line, and it is now introducing two innovative treatment solutions, RACE EVO and R-Motion. The company offers a comprehensive range of products, providing a complete solution to the market's instrumentation needs.

RACE EVO—the RaCe legacy

The latest rotary system introduced by FKG, RACE EVO, has evolved from two decades of high-speed precision performance design and original RaCe product features. A proprietary heat treatment process meets a groundbreaking protocol using higher rotation speed in order to deliver greater soft control, increased efficiency and improved patient safety with every instrument. Boasting 40 % more flexibility, 50 % higher cutting efficiency and 2.8 times more resistance to fatigue than its predecessors, RACE EVO is engineered for high performance and smooth progression.

Your approach, your choice

RACE EVO offers two core sequences with the highest optimal-use range—RACE EVO 4 % and RACE EVO 6 %—complete with one glide path and two shaping instruments. In addition, the flexibility offered by the choice of two larger instruments ensures that each treatment can be adapted to the patient. The versatility offered by the RACE EVO system allows clinicians to treat the vast majority of cases. The highest-quality Swiss manufacturing standards, coupled with FKG's proud reputation for reliability and clinical excellence, provide the user with maximum confidence in the system.

R-Motion—reciprocation redefined

R-Motion is the first truly complete solution in reciprocation endodontics to combine enhanced instrument flexibility and fatigue resistance with a unique minimally invasive approach. Engineered for optimal ease and efficiency, R-Motion is up to 3.3 times more flexible than standard NiTi reciprocating systems and offers up to 3.6 times the fatigue resistance. The R-Motion range comprises five reciprocating files—one for glide path creation (R-Motion Glider) and four shaping instruments to choose from: R-Motion 25, R-Motion 30, R-Motion 40 and R-Motion 50.

Safety and respect of anatomy—reciprocation improved

The all-new sleek core design of R-Motion and elite heat treatment equip these instruments with unrivalled flexibility, high resistance to fatigue, superior cutting efficiency and a reduced screwing effect. Demonstrating 60 % less transportation than standard reciprocating NiTi systems, R-Motion offers improved centring ability and respect of the canal anatomy, and an up to 40 % reduction of dentinal stress compared with the instruments of other leading endodontic providers. The result is a smoother progression in the canal, putting control back into the hands of clinicians, improving patient safety and increasing treatment efficiency for a wide range of canal anatomies and, as ever, a minimally invasive approach—the trademark of all FKG instrument systems.

New Rooter Universal endodontic motor—one size fits all

Rooter Universal is the latest cordless endodontic motor from FKG. Having preset and fully programmable settings and an integrated apex locator function, the cost-effective device drives all endodontic files with high precision and reliability. Preset programs dedicated to R-Motion, RACE EVO and XP-endo make Rooter Universal the ideal complement to FKG's leading instrument systems.

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Co-pilot upgrade

COLTENE extends options for fully automated endodontic motor

Congestion reports in real time or information about new road layouts—regular updates of your navigation system help you and save your nerves when driving. The same concept underlies guided endodontics. With a range of new options, the latest endodontic motors extend their capabilities for fully automated navigation through the root canal. As a result, these clever assistance systems offer even more flexibility during treatment.

Extended file sequence

With the latest update, the international dental specialist COLTENE has extended the options of the fully automated CanalPro Jeni endodontic motor. The motor automatically finds its path through the root canal, working in unison with the mechanical and chemical preparation every step of the way. The user can choose from a number of popular sequences for the flexible nickel-titanium files. The highlight of the latest update is the addition of remover files, which make a significant difference to an endodontic revision treatment. The novel 30/.07 HyFlex and MicroMega remover files fit perfectly into the established file systems and quickly and reliably remove inadequate gutta-percha fillings as well as similar ageing endodontic restorations. Owing to their intricate shape, they adapt to the natural contour of the canal and efficiently loosen the existing obturation material. In addition, the reaction time of the motor and the touch screen has been further reduced. Graphic optimisation and enhanced system performance make the Jeni even more attractive. The result of these improvements is that treatment becomes even safer and more comfortable.

Exclusive service page

Innovation leader COLTENE has developed a special service page for dental practices which provides regular access to the latest updates and information. Dentists can simply register with the serial number of their CanalPro Jeni at https://canalpro.coltene.com/register-jeni.

With these new options and improvements, this clever navigation aid makes it easier than ever to get started in endodontics. The user works forwards continuously from the coronal to apical aspect, applying only slight pressure, while the motor decides independently on the progress of movement. Employing complex algorithms, the software can control the variable file movements at millisecond intervals by constantly regulating rotational movement, speed, torque and file stress.

Descriptive short video

The mode of operation of the endodontic motor is demonstrated in detail in a new short video. The informative, explanatory video is now available to view at https://youtu.be/Qw3uc3hSTkg on the COLTENE YouTube channel (see qr code). At https://canalpro.coltene.com/jeni, you can find more information about the CanalPro Jeni and register for your personal demonstration appointment.

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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.

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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.

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Questions?

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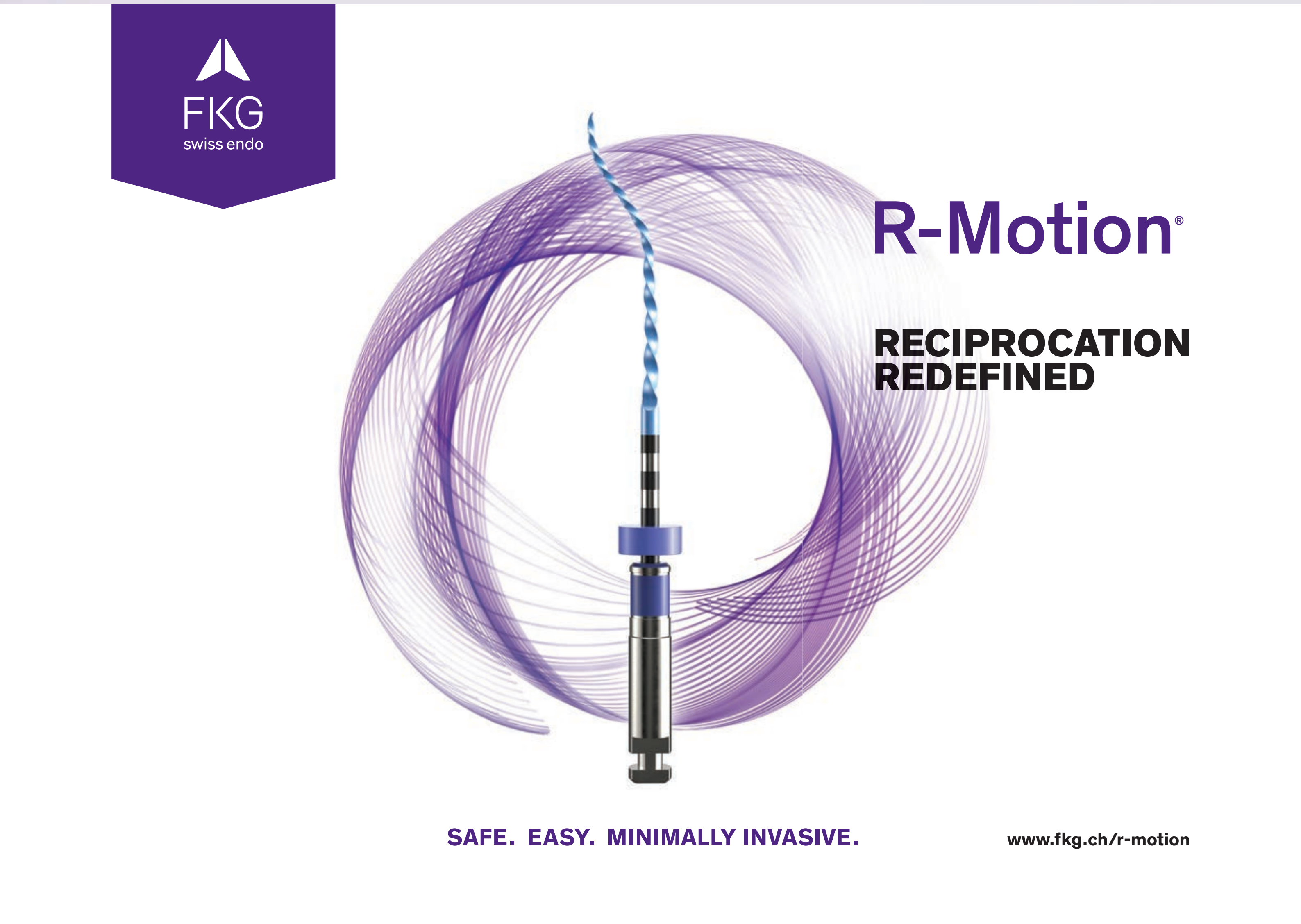
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