issn 2193-4673 • Vol. 16 • Issue 3/2020

3/20

roots

international magazine of endodontics

study
3D accuracy of dynamic navigation in locating calcified canals

case report
The importance of irrigation in challenging cases

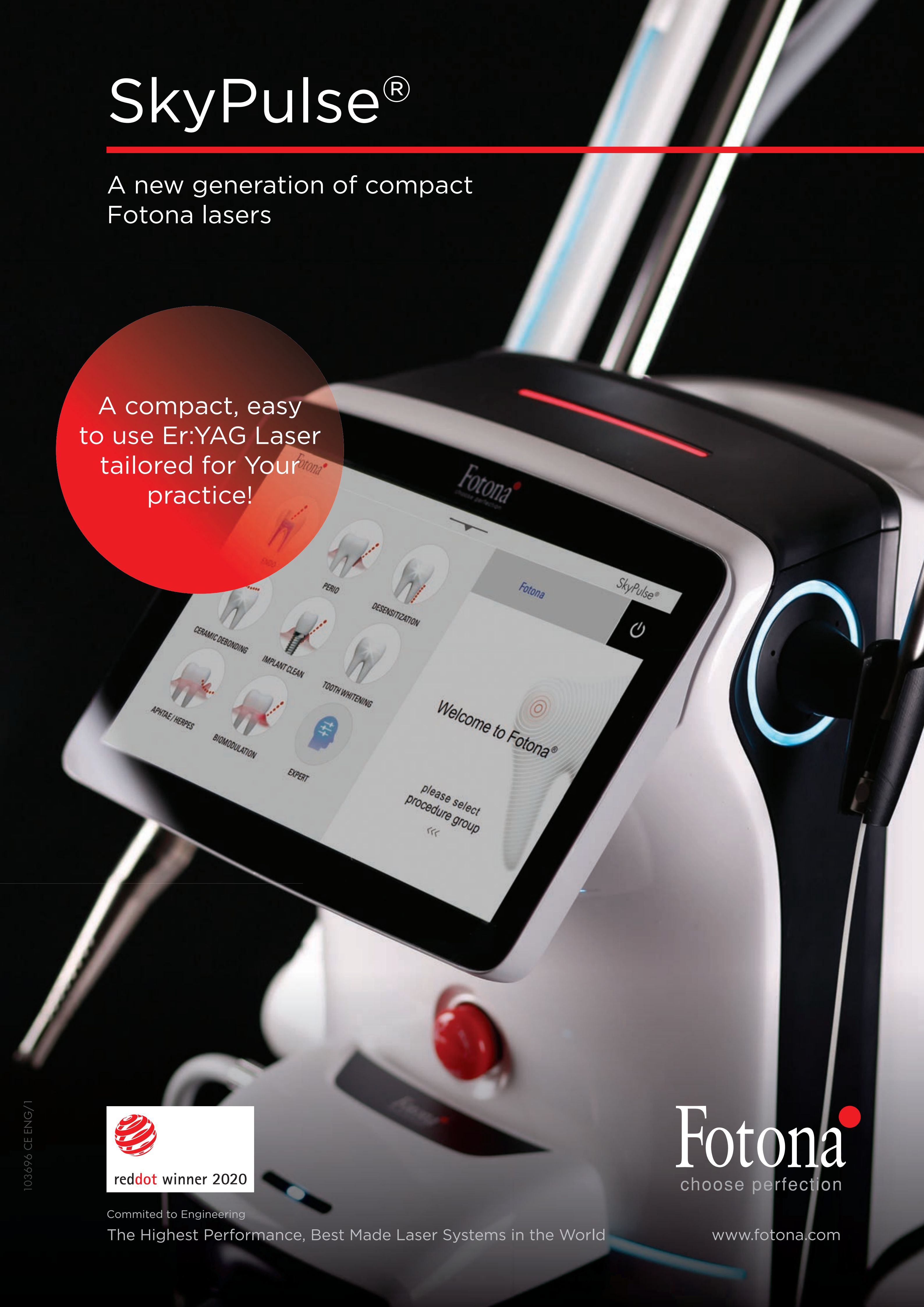
technique
Remover: The ultimate solution for removing gutta-percha

dti] Dental Tribune International

SkyPulse®

A new generation of compact Fotona lasers

A compact, easy to use Er:YAG Laser tailored for Your practice!



reddot winner 2020

Fotona
choose perfection

Commited to Engineering

The Highest Performance, Best Made Laser Systems in the World

www.fotona.com

103696 CE ENG/1

Magda Wojtkiewicz

Managing Editor

New challenges in endodontic treatment

Endodontic treatment during the COVID-19 pandemic seems to be more challenging than ever before. How do dentists ensure both their own safety and the safety of patients during therapy which cannot be performed without drilling?

While the Centers for Disease Control and Prevention recommended restricted use of aerosol-generating procedures in dentistry, such as root canal preparation, and minimised risk by offering less invasive palliative care to emergency patients, many endodontists carried out successful treatment. Does it mean that they were taking unnecessary risk? Definitely not.

The results of Patel et al. have shown that palliative care has been proved successful, but it is important to realise that this level of endodontic emergency management is only a temporary solution and that ultimately aerosol-generating procedures cannot be avoided.[1] Furthermore, some endodontic emergencies, such as cellulitis, can lead to major health problems, including systemic inflammatory response syndrome, osteomyelitis, parapharyngeal abscess, cavernous sinus thrombosis and sepsis, and treatment for such endodontic emergencies should not be postponed by more than several days or even hours.

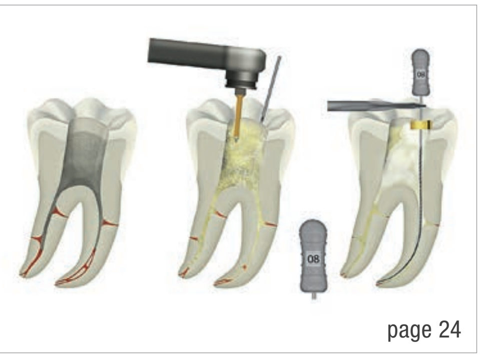
Dental professionals are very aware of the importance of infection control and implement cleaning and disinfection procedures in dental offices daily. Also the use of protective equipment, such as masks, shields and disposable aprons, is a standard procedure in most clinics; therefore, there is nothing new with respect to strict hygiene protocols in dentistry.

In conclusion, avoiding endodontic treatment during the COVID-19 pandemic is not a solution, but all procedures should be conducted according to the protocols and recommendations of the relevant advising organisations. It will probably take a great deal of time before we learn how to live with SARS-CoV-2, but what we know so far has made it clear that respecting the necessary procedures can allow us all to work safely.

Magda Wojtkiewicz
Managing Editor

Reference

1 Patel B, Eskander MA, Ruparel NB. To drill or not to drill: management of endodontic emergencies and in-process patients during the COVID-19 pandemic. J Endod. 2020 Aug 22;46(11):1559–69. doi: 10.1016/j.joen.2020.08.008.


page 24


page 32


page 36

Cover image courtesy of
Sergii Kuchugurnyi/Shutterstock.com


2D & 3D
exams
MAC
Compatible
75µm
High resolution image
X MIND
trium
ACTEON
up to
50%
dose reduction
TRUE LOW DOSE
1 MINUTE
implant planning report
0
compromise with 3D image quality
IT'S TIME FOR
TRUE LOW DOSE CBCT
DE GÖTZEN® | A company of ACTEON® Group
Via Roma, 45 | 21057 Olgiate Olona VA | ITALY
Phone +39 0331 376760 | Fax +39 0331 376763
E-mail : info@acteongroup.com | www.acteongroup.com
ACTEON

COVID-19: Major stress factor among dental staff

By Iveta Ramonaite, Dental Tribune International

Dentists have resumed the provision of patient care, but are experiencing great anxiety arising from extensive changes to the workflow and fear of contracting SARS-CoV-2 in the practice. Besides work-related stress, some dental professionals are burdened with personal stress related to family, finances and the current state of affairs. To help dental staff cope with the anxiety brought about by continually updated safety and cleaning protocols and changes in workplace policies, a number of dental organisations and health authorities have recently offered their guidance on lightening the load of COVID-19 and associated stress factors in the dental office.

As reported by Dental Tribune International, COVID-19 has exerted some devastating psychological effects on dental professionals. Many dentists are finding it wearisome and demanding to work in an environment with ever-changing measures to avoid infection and to cope with personal stress while managing the fear of contracting the virus.

In his paper on the impact of the COVID-19 pandemic on dentistry, Dr J. William Claytor Jr, associate director of the North Carolina Caring Dental Professionals, said that dentists are currently dealing with an unprecedented number of concerns, including unemployment, student loan debts, limited income from emergencies, job losses in other industries, a declining and unstable stock market, increased drug use, addictions, family tensions and halted public education, and stress and burnout.

To offer assurance to dental staff, the California Dental Association (CDA) recommends advising employees of the plans in place to ensure safety in the workplace. Staff should be updated on new infection control procedures and changes related to practice operation and appointment scheduling. After any policies and protocols related to dental practice are reviewed, resulting updates should also be communicated to staff, and they should receive the latest COVID-19-related information that could affect their jobs. CDA recommends retrieving information from the websites of trusted regulatory agencies such as the Centers for Disease Control and Prevention and the World Health Organization.

Keeping employees in the loop communicates that the practice is aware of ongoing changes to recommendations and continues to update its practices accordingly in order to minimise the risk of exposure of both patients and staff.

Protecting mental health of staff

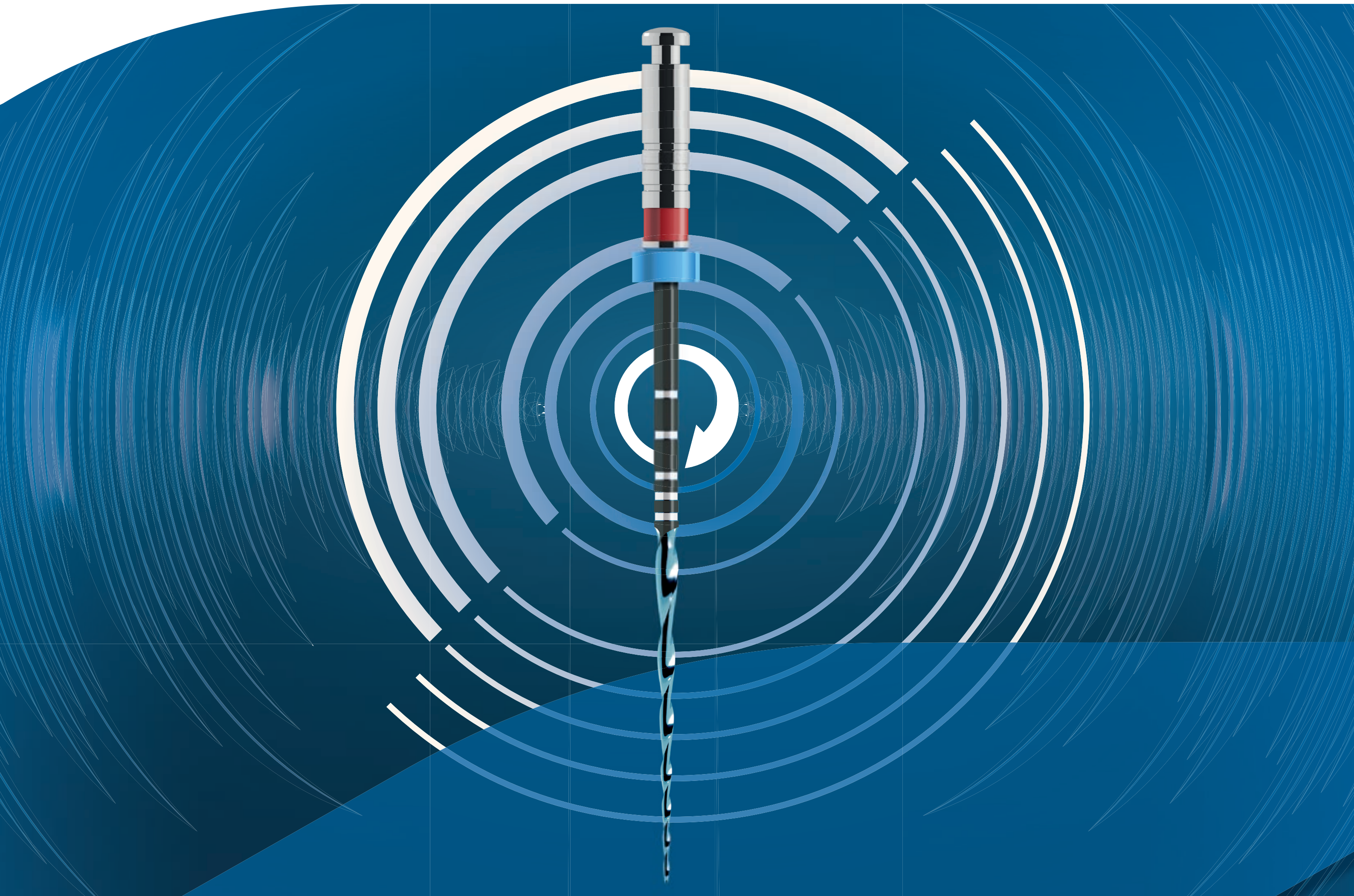
Dental staff are currently extremely susceptible to deteriorating mental health, which is why the well-being of staff should be regarded with the utmost gravity. CDA recommends encouraging employees to share their concerns and, in listening to these, adopting an attitude that is empathic and receptive. This will not only demonstrate engagement, but also help resolve the issue at hand more promptly, CDA noted. Employees who are unwilling or afraid to share their concerns should be offered a channel to express their concerns anonymously.

Other measures to show support and ease tension among employees include relaxing certain pre-pandemic practices and policies, such as reducing the number of employees in the office by implementing alternative workweeks, staggered shifts or telecommuting weeks. CDA believes that open dialogue between dentists and staff will facilitate the establishment of clear responsibilities and expectations and boost employee morale.

Also the British Dental Association published a webinar that addressed stress and mental well-being among dentists. The webinar helps recognise the signs of stress among staff, provides advice on how to prevent it and teaches how to support those whose mental health has been undermined.

Editorial note: Additional guidance for practice management and fostering employees' mental health during the COVID-19 pandemic has been published by the American Dental Association and can be found at https://success.ada.org/en/wellness. Strategies for coping with COVID-19-related stress have been published by the Centers for Disease Control and Prevention and can be accessed on the CEDE website, https://www.cdc.gov.

VDW® Endo Easy Efficient



VDW.ROTATE™ NiTi Root Canal File

The remix taking rotary preparation to the next level

VERSATILITY

VDW.ROTATE™ includes an intuitive 3 file basic sequence plus a wide range of larger files for various clinical cases with matching paper points and obturators.

Be virtuoso!

RESPECT OF THE NATURAL CANAL ANATOMY

The instruments follow the natural canal anatomy smoothly thanks to its specific heat treatment making the file more flexible without compromising its cutting efficiency.*

Get in the swing!

EFFICIENT DEBRIS REMOVAL

The adapted S cross section gives more space for debris removal and provides control of the instrument for a swift, thorough and safe preparation.*, **

Set the beat!

*compared to other VDW continuous rotary instruments
**compared to a centred rotary cross section

vdw-dental.com

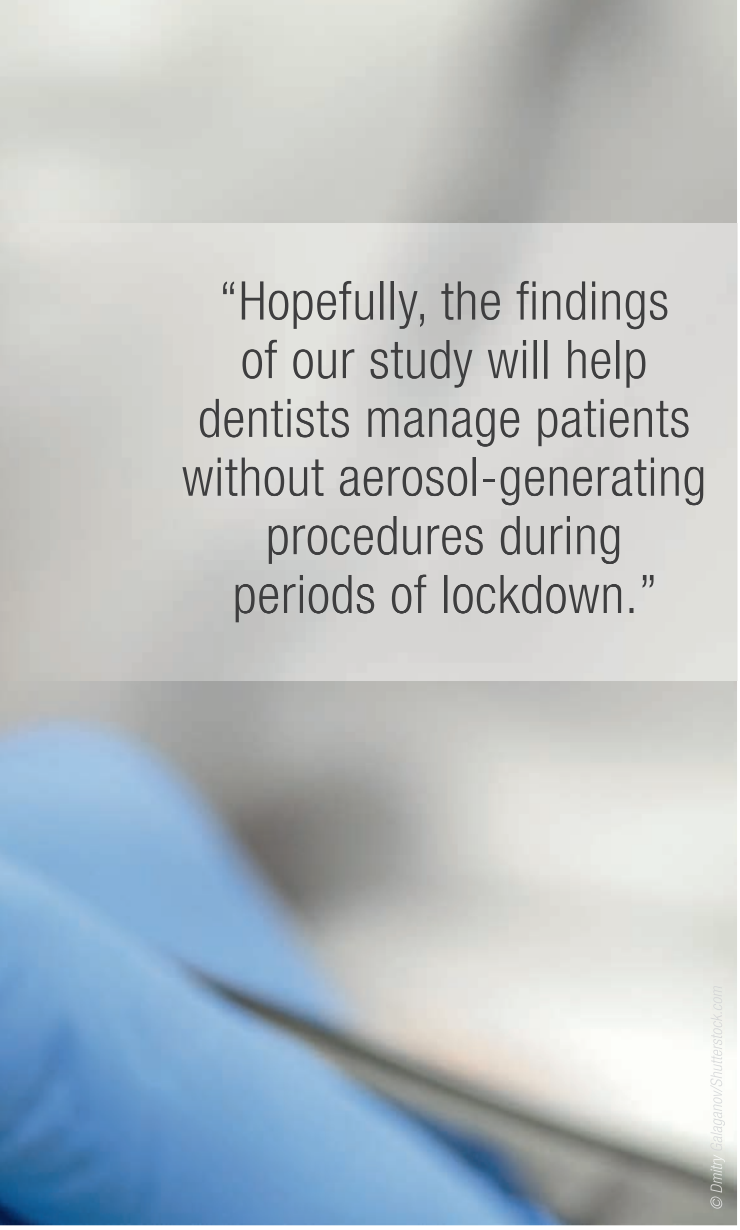
Although palliative care in endodontic emergencies brings immediate relief to patients, it is not a long-term solution, and aerosol-generating procedures cannot be avoided forever should treatment restrictions continue.

Palliative care successful for endodontic emergencies during lockdown

By Dental Tribune International

During the ongoing COVID-19 pandemic, aerosol-generating procedures in dentistry have been restricted in order to comply with a recommendation by the Centers for Disease Control and Prevention (CDC), since dental professionals are at high risk of infection. But how can endodontic emergencies be managed without drilling? A study has investigated the topic and found that palliative care seems to be the answer.

The World Health Organization declared SARS-CoV-2 a pandemic on 11 March 2020. Shortly afterwards, countries began to implement lockdowns, shutting businesses and nonessential services. In the USA, elective dental procedures were suspended and, according to the CDC, aerosol-generating procedures were to be avoided. This led to challenges in the management of patients presenting with emergencies as well as concern



“Hopefully, the findings of our study will help dentists manage patients without aerosol-generating procedures during periods of lockdown.”

among dentists about all in-process pending procedures started before the statewide shutdowns.

To drill or not to drill?

Researchers from the Department of Endodontics at the University of Texas (UT) School of Dentistry conducted a two-part study in order to investigate how endodontists could work around these extreme conditions while managing their patients’ pain. The results of the first part of the study showed that 81 % of the 21 patients who presented with endodontic emergencies in 25 teeth during the statewide shutdown required no further treatment or intervention after palliative care at a follow-up rate of 96 %.

In the second part, 31 teeth had received partial or full root canal debridement before the statewide shutdown. The mean time for completion of treatment was 13 weeks. At a recall rate of 100 %, 77 % of the teeth did not experience any adverse events resulting from delays in treatment completion. The most common adverse event was a fractured provisional restoration (13.0 %), followed by a painful and/or infectious flare-up (6.4 %). These events were managed appropriately and therefore deemed successful. Only one tooth was fractured and nonrestorable (3 %), leading to the failed outcome of tooth extraction. The remaining four outcome failures (13 %) were due to patient unwillingness to undergo school-mandated SARS-CoV-2 testing or patient unwillingness to continue treatment because of perceived risk of SARS-CoV-2 infection.

In an interview with Dental Tribune International, study co-author Dr. Biraj Patel explained the reasoning behind this study: “The school decided to defer aerosol-generating procedures in accordance with the state guidelines. We managed cases very differently to what we would have routinely done and were interested to see how successful we were. Furthermore, the literature has limited data on the effect of delaying treatment in endodontics and the outcomes of the palliative management of endodontic disease. Our report on the management of endodontic emergencies has important clinical implications for the dental community worldwide and aims to provide an insight into the effect of conservative management of endodontic emergencies without the use of aerosol-generating procedures.”

As results have shown, palliative care proved successful for the UT researchers, but it is important to note that this level of endodontic emergency management is only a temporary solution and aerosol-generating procedures cannot be avoided forever. “The state witnessed a lockdown from 23 March to 20 May 2020, and palliative care was successful in managing patient symptoms during this time. However, if this lockdown had been longer, we may have had to reevaluate patients if they became symptomatic and potentially intervene with aerosol-generating procedures,” said Patel.

What is the long-term solution?

“At present, our school reduces the risk of transmission by testing all patients for SARS-CoV-2 using reverse transcription-polymerase chain reaction (RT-PCR) prior to aerosol-generating procedures,” the endodontist added. “We make sure to follow the state and CDC guidelines, especially with regard to social distancing measures and personal protective equipment. We hope that a better understanding of the transmission of SARS-CoV-2, along with developments in rapid testing, will eventually reduce the risk to healthcare professionals. This will hopefully result in a reduced need for clinics to stay closed. The expectation is that we will see further lockdowns if cases of COVID-19 become uncontrolled. Hopefully, the findings of our study will help dentists manage patients without aerosol-generating procedures during periods of lockdown.”

Editorial note: The study, titled “To drill or not to drill: Management of endodontic emergencies and in-process patients during the COVID-19 pandemic,” was published on 22 August 2020 in the Journal of Endodontics*.*

3D accuracy of dynamic navigation technology in locating calcified canals

Drs Sameer D. Jain, Caroline K. Carrico & Ido Bermanis, USA & Canada

Introduction

Pulp canal obliteration or calcific metamorphosis as a sequela of dental trauma may occur in up to 40 % of cases.[1–3] Endodontic therapy is only indicated in 7–27 % of pulp canal obliteration cases if the tooth presents with symptoms or radiographic pathology consistent with periapical periodontitis.[1,4–7] It may also be indicated if pulp canal obliteration occurs as a sequela of dental caries, tooth surface loss, vital pulp therapy or orthodontic treatment.[8] Severe physiological pulp canal obliteration in geriatric patients may occur from the apposition of secondary or tertiary dentine or from the regular intake of systemic statins.[9,10] Despite the use of high magnification and CBCT imaging, access cavity preparation for such cases is prone to procedural errors that may lead to a substantial loss of dentinal structure, thereby reducing the long-term prognosis.[11] Therefore, the American Association of Endodontists categorised the treatment of teeth with pulp canal obliteration as being of a high level of difficulty.[12]

Recent clinical reports and *in vitro* studies have proposed utilising a static CT-based stereolithographic drill guide system to increase accuracy for surgical and non-surgical cavity preparation.[13–18] Some of its perceived limitations include additional treatment time, cost of CBCT and intraoral scan acquisition, template fabrication, use of larger-diameter slow-speed drills with the possibility of dentinal microcrack formation and a rise in temperature of the periodontium, inability to be used in posterior teeth owing to a lack of interocclusal space, the need for a straight path to the apical target point, lack of real-time visualisation and inability to change the predetermined drill position during the procedure.[14,15,19]

Novel optically driven dynamic guidance systems allow clinicians to visualise the position and angulation of the implant preparation during the osteotomy drilling sequence, which can be adjusted in real time.[20] This technique has the potential to be applied in endodontics for conservative access cavity preparation without the limitations of static guided endodontics. Studies of the newer-generation dynamic navigation systems with slow-speed drills have demonstrated the superior accuracy of dynamic navigation over freehand implant placement.[21] However, no study has been conducted to date to investigate the 3D accuracy of dynamic navigation for access cavity preparation in locating calcified canals using high-speed drills. The aim of this study was to employ a novel dynamic navigation method to attain minimally invasive access cavity preparation and to evaluate its 3D accuracy in locating the simulated calcified canals in maxillary and mandibular teeth.

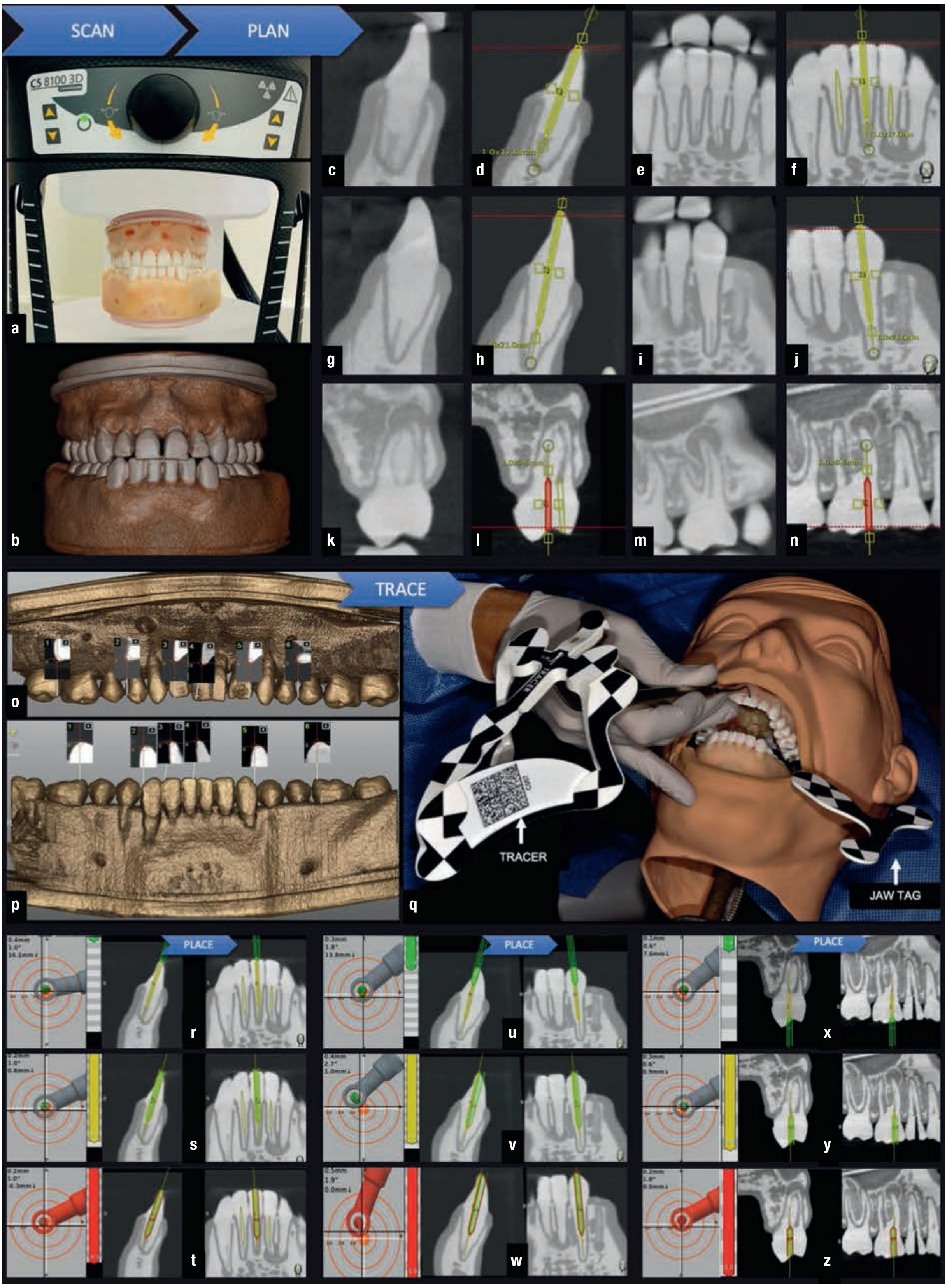
Materials and methods

In this study, stereolithographic images were generated of anatomically precise replicas of human teeth (TrueTooth, DELendo)—anterior teeth, premolars and molars—such that the root canal orifice started at a distance of 5 mm above the apex for anterior teeth and 2 mm below the cemento-enamel junction for premolars and molars. Three identical sets of upper and lower jaw models, totalling 84 teeth (n = 138 canals), were 3D-printed to simulate calcified anatomy on multi-ink simulated training replicas of human jaws (TrueJaw, DELendo).

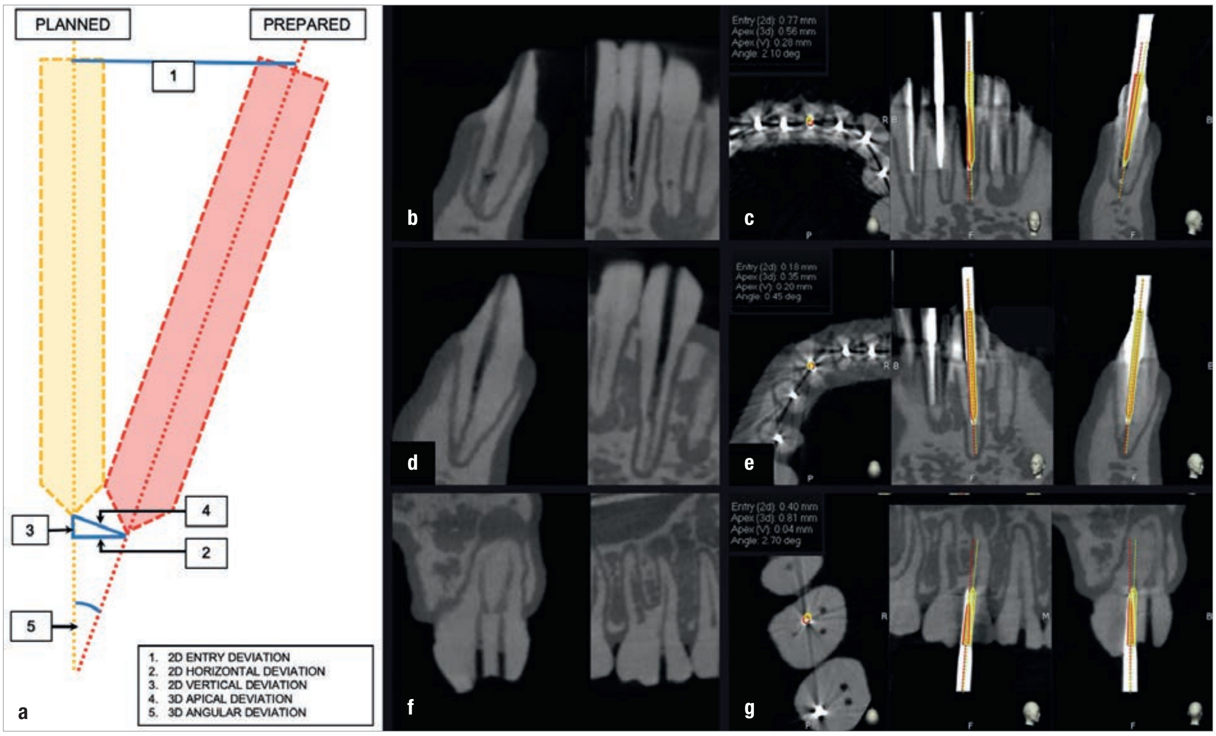
The treatment was performed by a board-certified endodontist after undergoing training sessions on over 20 samples with the dynamic navigation system. The Navident workflow (ClaroNav) in Figure 1 deals with three representative canals with challenging placement (tooth #41), extreme canal orifice depth (tooth #33) and frequently missed anatomy (second mesiobuccal canal of tooth #16).

The Navident protocol was carried out in four steps:

1. Scan: A preoperative CBCT scan (CS 8100 3D, Carestream) with a minimum voxel size of 75 µm was performed separately for each of the jaw models and stored as a DICOM file. These files were imported into the Navident implant/access planning software to map the dentition.
2. Plan: The CBCT image data served as a guide for planning non-surgical virtual 3D access cavities/paths of 1.0 mm diameter and depths ranging between 9.5 mm and 21.0 mm. The entry point started from the incisal edge/occlusal table and ended at the point of negotiation of the canals in 3D. Each canal was entered through its own access opening. For instance, maxillary molars with four canals ended up with four 1 mm openings in their occlusal surfaces.
3. Trace: The CBCT images were matched with the mounted TrueJaw, through the JawTracker installed on it, by registering the CBCT scan to the model. The matching is done through the trace registration tech-



Figs. 1a–z: The Navident workflow. **Scan:** A pre-op CBCT scan of the custom TrueJaw model is acquired **(a & b)**. **Plan:** The CBCT scan is imported into Navident, and the 3D virtual access trajectories are planned. The CBCT coronal and sagittal views of tooth #41 **(c–f)**, tooth #33 **(g–j)** and the second mesiobuccal canal of tooth #16 **(k–n)**, serving as a guide for planning non-surgical virtual 3D access cavities/paths of 1 mm in diameter. **Trace:** Six landmarks (starting points for tracing) selected on the 3D rendered image on each of the maxillary **(o)** and mandibular models **(p)** on the screen. Clinical tracing on the jaw model with a tracer tool in order to register the CBCT scan to the model for the following navigation step **(q)**. **Place (navigated access):** The bur orientation and the drilling guided by target views on the computer screen for tooth #41 **(r–t)**, tooth #33 **(u–w)** and the second mesiobuccal canal of tooth #16 **(x–z)**. The depth of the burs was monitored and indicated by the green bar of the depth gauge; the colour changed from green to yellow when within 1 mm of the desired depth and from yellow to red when the correct depth was reached.



Figs. 2a–g: 3D accuracy measurements. Representation of accuracy measurements on EvaluNav software through superimposition of the planned (yellow) and prepared (red) access cavity positions **(a)**. Post-op CBCT scan of actual prepared cavities and superimpositions of planned and prepared access cavities in axial, coronal and sagittal CBCT views of tooth #41 **(b & c)**, tooth #33 **(d & e)** and the second mesiobuccal canal of tooth #16 **(f & g)** on EvaluNav software.

nique: a calibrated Tracer (like a stylus pen) tracked by the MicronTracker camera is slid along the tooth surface, while the system samples points along its path. The collected cloud of points is then automatically matched in the best possible way with the outer surface of the teeth in the CBCT scan. A full accuracy check was performed in all three directions, antero-posterior, latero-lateral and occlusogingival, to verify registration accuracy along all three axes.

4. Place (navigated access): Each jaw was mounted on to a dental mannequin. A latex face with limited mouth opening simulated limited visibility and pressure due to facial soft tissue. Teeth were isolated using a dental dam. Navigated access cavity preparation for canals within a jaw set was carried out in a randomised order. Precision micro-endodontic high-speed access burs (tip diameter: 0.28 mm; EndoGuide EG3, SS White) were used for initial access, in combination with surgical length tapered diamond carbide burs (tip diameter: 0.21 mm; 859 FGSL, Komet USA) for the remaining depth of the access cavity preparation. After calibration of the handpiece and bur, drilling time was recorded for each attempt.

The high-speed handpiece and the jaws were tracked via the attached optical tracking tags (DrillTag and JawTracker, respectively). The tags are constantly and simultaneously detected by the high-precision optical positioning sensor (the built-in MicronTracker camera), providing optical triangulation tracking. This allows for an accurate real-time representation of the drill tip location and trajectory in relation to the anatomy on the model's CBCT image and the planned virtual access cavity. The navigation was done by the primary investigator. The tip of the bur was directed to be precisely oriented, and the progression was visually controlled by checking the planned cavity in target view. The depth of the bur was monitored and indicated by a green bar on the depth gauge; when within 1 mm of the desired depth, the bar's colour changed from green to yellow and finally red when the correct depth was reached.

Postoperative CBCT scans with access burs in the prepared access cavities were acquired with similar exposure parameters to those of the preoperative CBCT scans. Superimposition of the preoperative scan with planned access templates and the postoperative scan was performed using EvaluNav software (ClaroNav). The planned and prepared access cavities were compared in order to isolate their 2D and 3D discrepancies (Fig. 2).

Statistical methods

Analysis of covariance (ANCOVA) models were used to evaluate the discrepancies between actual and planned access cavities for tooth type (anterior, premolar and molar), jaw (maxilla and mandible), and the interaction between tooth type and jaw while accounting for the canal orifice depth and the discrepancies between the actual and planned access cavities. The discrepancies were measured in the 2D entry, 2D horizontal and vertical deviation from the canal orifice, 3D deviation from the canal orifice and 3D angular deviation. In addition to the discrepancies, a model for the total time was fitted with the same predictors. The significance level was set at $p = 0.05$. Backward elimination was used to reach a parsimonious model. Only terms with $p < 0.05$ were considered for the final model. Post hoc pairwise comparisons were adjusted using Tukey's adjustment. The null hypothesis was that the discrepancies and drilling time were independent of the tooth type, jaw and canal orifice depth.

Results

A total of 138 canals were drilled, 78 in maxillary and 60 in mandibular teeth. Of these, 36 were in anterior teeth, 72 were in molars and 30 were in premolars. The average drilling time was 57.8 seconds, and the average canal orifice depth was 12.4 mm. The overall mean 3D canal orifice deviation was 1.3 mm, the mean 3D angular deviation was 1.7°, and the mean 2D entry deviation, horizontal deviation from the canal orifice and vertical deviation from the canal orifice were 1.1 mm, 0.9 mm and 1.0 mm, respectively. Descriptive summary statistics and the results of the ANCOVA analysis are given in Table 1 and Table 2, respectively.

Drilling time was dependent on the canal orifice depth ($p = 0.0007$), tooth type and jaw, and the differences in tooth type were dependent on the jaw ($p < 0.0001$). For a 1 mm increase in the canal orifice depth, the drilling time increased by 7.6 seconds (95 % confidence interval [CI]: 3.26–11.91). The 2D entry deviations were higher in the maxilla (1.23 vs 0.85; 95 % CI on difference: 1.05–0.65).

The 2D horizontal deviation from the canal orifice was significantly higher for the maxillary teeth compared with the mandibular teeth ($p = 0.0206$). The average deviation for the maxillary teeth was 0.97 mm compared with 0.70 mm for the mandibular teeth, producing an average difference of 0.27 mm (95 % CI on difference: 0.04–0.50).

The 2D vertical deviation from the canal orifice was dependent on the tooth type ($p = 0.0344$). Post hoc pairwise comparisons found that molars had significantly higher average deviation than premolars did (adjusted $p = 0.0270$).

The 3D deviation from the canal orifice was marginally significantly different between the two jaws ($p = 0.0523$). The average deviation was higher in the mandible at 1.4 mm compared with 1.2 mm for the maxilla (95 % CI on difference: 0.00–0.44).

Overall, 3D angular deviation was dependent on the tooth type ($p = 0.0288$). The average deviation for molars was 1.9°, significantly higher than the 1.4° average for premolars (adjusted $p = 0.0403$; 95 % CI on difference: 0.02–1.00). The average for anterior teeth (1.5°) was not significantly different from that for molars (adjusted $p = 0.1633$) or premolars (adjusted $p = 0.7943$).

All 2D and 3D discrepancies were independent of the canal orifice depths ($p > 0.05$).

Discussion

This is the first study to demonstrate and evaluate the potential use of high-speed drills and precision micro-endodontic high-speed burs with dynamic navigation to effectively prepare conservative access cavities in anterior

Table 1: Summary of time, depth and discrepancy measures by jaw and tooth type (mean, SD)

Measures	Overall	Jaw		Tooth Type		
		Maxilla	Mandible	Anterior	Molar	Premolar
Total time (s)	57.8, 61.91	45.6, 41.20	67.2, 72.89	142.1, 63.46	32.2, 21.14	18.2, 8.11
Canal orifice depth (mm)	12.4, 4.04	13.6, 3.71	11.5, 4.08	18.8, 1.83	10.2, 0.89	10.2, 1.84
2D entry deviation (mm)	1.1, 0.80	0.9, 0.65	1.2, 0.87	1.0, 0.80	1.0, 0.80	1.2, 0.82
2D horizontal deviation from canal orifice (mm)	0.9, 0.69	1.0, 0.78	0.7, 0.51	0.8, 0.57	0.9, 0.77	0.8, 0.60
2D vertical deviation from canal orifice (mm)	1.0, 0.64	0.9, 0.68	1.0, 0.60	0.9, 0.63	1.1, 0.66	0.7, 0.52
3D deviation from canal orifice (mm)	1.3, 0.65	1.2, 0.57	1.4, 0.70	1.3, 0.59	1.4, 0.71	1.1, 0.56
3D angular deviation (°)	1.7, 0.98	1.7, 0.90	1.7, 1.04	1.5, 0.78	1.9, 1.14	1.4, 0.62

teeth, premolars and molars with simulated calcified root canals to depths as great as 21 mm. A previous study comparing freehand and static navigation for access cavity preparation in simulated calcified root canals found successful canal location in only 41.7 % using the conventional freehand technique.[22] The failure to locate canals clinically in post-traumatically reduced pulpal lumina varied from 20 % to 71 %.[23,24] Although 3D-printed teeth were used to attain a high level of standardisation that ensured comparability, one must consider that the regional variation in colour or consistency in anatomical landmarks that may guide the clinician during traditional canal location in natural teeth is absent in 3D-printed teeth. Thus, the use of 3D-printed teeth can place the freehand technique at a slight disadvantage. Based on our pilot investigation, the freehand techniques to locate simulated calcified root canals precisely inherently generated errors in all parameters that led to a higher substance loss or perforation. Thus, we eliminated the variable of operator error regarding dependency on anatomical landmarks and focused on evaluating just the accuracy of dynamically navigated access cavities to the virtual planned cavities.

Table 2: Results from the ANCOVA model

	Mean	95 % CI	P-value*
2D entry deviation			
Jaw			0.0054
· Mandible	0.85	0.65, 1.05	a
· Maxilla	1.23	1.05, 1.40	b
2D vertical deviation from canal orifice			
Tooth type			0.0344
· Anterior	0.92	0.71, 1.13	a, b
· Molar	1.06	0.92, 1.21	a
· Premolar	0.71	0.48, 0.93	b
3D deviation from canal orifice			
Jaw			0.0523
· Mandible	1.17	1.00, 1.33	a
· Maxilla	1.39	1.24, 1.53	b
3D angular deviation			
Tooth type			0.0288
· Anterior	1.53	1.21, 1.85	a, b
· Molar	1.89	1.66, 2.11	a
· Premolar	1.38	1.03, 1.72	b
Total time			
Canal depth (1-unit increase)	7.59	2.26, 11.91	0.0007
Jaw*/tooth type†			< 0.0001
Mandible			
· Anterior	51.28	19.94, 82.63	a
· Molar	37.35	25.12, 49.59	a
· Premolar	13.99	–1.97, 29.95	a
Maxilla			
· Anterior	136.69	107.3, 166.08	a
· Molar	57.78	43.25, 72.31	b
· Premolar	48.79	28.61, 68.98	b

* P-value from ANCOVA model; levels with the same letter were not statistically significantly different at Tukey's adjusted 0.05 level. † For interaction term, tooth type was only compared within the jaw. CI = Confidence interval.

Static guided accesses prepared with slow-speed drills were comparable to post space preparation, which can significantly reduce the structural biomechanical properties of the root along with the temperature rise that can negatively affect the periodontium.[11,22,25] A recent pilot investigation used a freehand high-speed drill to create an initial punch to penetrate the enamel, followed by the use of an older-generation dynamically guided slow-speed handpiece for drilling the underlying dentine that led to a stepped access cavity preparation.[26] The second-generation Navident system facilitates calibration of high-speed handpieces and drills, unlike its predecessor which was only geared towards slow-speed drills for implant placement. A high-speed handpiece with precision micro-endodontic burs, as used in our study, was more efficient and effective in penetrating enamel and maintaining an accurate minimally invasive straight-line path in apically extended access cavity preparation. We recommend these burs in order to conserve peri-cervical dentine and mitigate unnecessary removal of dentine around the path of planned access.

Our initial pilot investigations to compare static guides for posterior teeth had to be aborted owing to the lack of interocclusal space to accommodate the additional 10 mm drill or bur length required by the guide ring position over the tooth. Using simulated calcifications in all posterior teeth highlighted an additional advantage of dynamic navigation in patients with restricted mouth opening or canals with an ergonomically challenging entry angle. Our results found no significant difference in 2D or 3D discrepancies with increasing orifice depths using dynamic navigation. Unlike static guidance, the ability to attain real-time verification and validation of positional accuracy enhances clinical transparency and accountability in order for optimizing patient outcomes.[27]

Slow-speed burs through a static guided approach in simulated calcified canals required on average 11 minutes, compared with an average drilling time of 58 seconds in our study.[22] In two extensive meta-analyses on static guidance for implant placement, there was a mean deviation of 1.4 mm at the implant's apex and an angular deviation of 3.5°.[28,29] Studies on *in vitro* models for implant placement indicate that dynamic navigation systems with slow-speed drills have a mean entry deviation approximating 1.2 mm and a mean angular deviation approximating 4°.[30] The 2D horizontal deviation from the canal orifice has greater significance for endodontic applications because increased drilling depths could lead to loss of tactile guidance. In such an event, horizontal deviations can cumulatively increase the risk of perforation or iatrogenic error.[31] The results of our study found a mean 2D horizontal deviation of 0.9 mm from the canal orifice with high-speed drills. This discrepancy could be considered relatively safe for deep endodontic access cavity preparation.

The indirect method of locating the access cavity through the placement of a drill in the cavity for the postoperative CBCT may have introduced possible errors from image acquisition and bur positioning. These errors can be cumulative and interactive, impacting on all the parameters. Future studies using sophisticated segmentation techniques, 3D image processing (micro-CT) and analysis to quantify the difference between the planned and the prepared access cavities are warranted for detecting higher 3D accuracy.[32]

A certain level of technical skill, hand–eye coordination and manual dexterity is necessary in order to drill from the entry point to the target while looking at the computer screen. Clinical success can be dependent on the hand skills of the operator owing to the inaccuracies caused by hand tremor and perception of 0.25 mm and 0.5° involved with bur and handpiece tracking.[33] Simulation of dynamic navigation shortened the learning curve for clinicians performing colonoscopy and improved training of novice endoscopists.[34] Novice operators have demonstrated a significant improvement in implant placement skills with dynamic navigation with as few as three attempts to up to 20 attempts.[21,35] The operator in this study practised on over 20 samples and developed a stable and consistent workflow to minimise the influence of the learning curve and operator-induced error.

The updated second-generation trace registration system can perform registration with pre-existing small field of view CBCT scans, thereby reducing the amount of radiation exposure. This is distinctively different from the first-generation navigation system, which requires additional CBCT scans with thermoplastic stents (NaviStent) and radiographic fiducial markers.[26] The cost and time considerations associated with thermoplastic stent fabrication and errors associated with it can be eliminated, making it clinically feasible for endodontic procedures. Future studies on the application of this technology in the areas of endodontic retreatment and microsurgery may unlock new synergies and minimise iatrogenic error. The recent upgrades in this technology have enhanced chairside clinical feasibility, which may lead to efficient patient care and predictable outcomes.

Conclusion

Optically driven, computer-aided 3D dynamic navigation technology with high-speed drills can achieve minimally invasive access cavities in locating highly difficult simulated calcified canals with a mean 2D horizontal deviation of 0.9 mm from the canal orifice, mean 3D deviation of 1.3 mm from the canal orifice and mean 3D angular deviation of 1.7°.

Acknowledgements

This project was supported by a grant from the Virginia Commonwealth University School of Dentistry. The authors (SDJ and CKC) report no conflicts of interest related to this study. One co-author (IB) is an employee of ClaroNav. The authors acknowledge Dr George Deeb (associate professor in the Department of Oral and Maxillofacial Surgery at the Virginia Commonwealth University School of Dentistry) for allowing access to the Navident system.

Editorial note: A list of references is available from the publisher. This article originally appeared in the Journal of Endodontics *(Volume 46, Number 6, June 2020), and an edited version is provided here with permission from the author.*

about

Dr Sameer D. Jain, BDS, MS, MSD, is an assistant professor in the Department of Endodontics of the Virginia Commonwealth University School of Dentistry in Richmond in the US.

520 North 12th Street
Box 980566
Richmond VA 23298-0566
USA
sdjain@vcu.edu

Dr Caroline K. Carrico, BS, PhD, is an assistant professor in the Department of Dental Public Health and Policy of the Virginia Commonwealth University School of Dentistry.

1101 East Leigh Street
Box 980566
Richmond VA 23298-0566
USA
ckcarrico@vcu.edu

Dr Ido Bermanis, DMD, MSc, is director of clinical affairs at ClaroNav.

1140 Sheppard Avenue West, Unit 10
Toronto ON M3K 2A2
Canada
ido@claronav.com

Endodontic microsurgery of an anatomically challenging zone using dynamic navigation

Prof. Paula Andrea Villa Machado, Dr Felipe Restrepo & Dr Kenneth S. Serota, Colombia & Canada

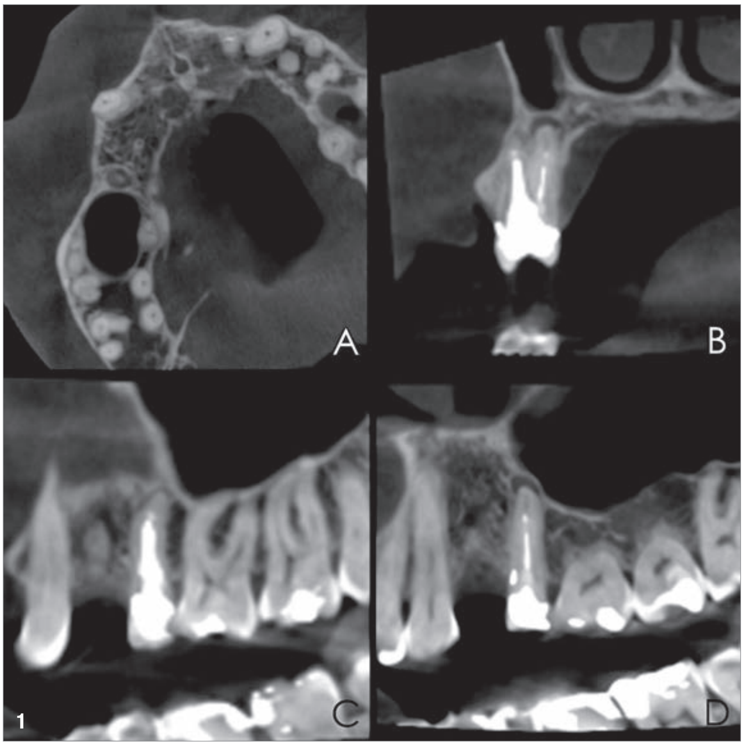


Fig. 1: Pre-surgical CBCT scan: axial view **(A)**; coronal view **(B)**; sagittal view of buccal root **(C)**; sagittal view of palatal root **(D)**.

Introduction

Enhanced magnification and visualisation, innovations in instruments, new sealing materials and the incorporation of soft- and hard-tissue augmentation practices have brought endodontic microsurgery (EMS) from a last resort procedure to an integral part of endodontic retreatment.[1,2] The retreatment of a failing root canal is fraught with potential complications. The removal of cast posts (size and length can potentiate fracture),[3] the distinguishing of bonded fibre posts from the surrounding dentine,[4] the removal of separated instruments,[5] the negotiation of blocked canals,[6] the circumvention of ledging and a myriad of other factors can complicate removal of the residual bio-load and impede resolution of periradicular pathosis.[7,8] Where possible, retreatment alone would be the treatment option of choice; however, where retreatment risk factors are high, EMS is the most viable option, far more so now than prior to the transition to microsurgical protocols.

Contemporary EMS protocols provide for minimal flap size, small osteotomies and resections perpendicular to the long axis of the root. These minimally invasive practices reduce morbidity, promotes more rapid healing, and minimise the size of the retro-preparation and the number of dentinal tubules exposed.[9] Magnification and illumination have lessened the risk of damage to anatomical structures such as the inferior alveolar nerve, maxillary sinus, and greater palatine nerve and artery. Given the inability to visualise the surgical site in 3D, the possibility of procedural error remains, thus impacting on treatment options.[10–13]

Recently, dynamic navigation technology has been used in EMS to guide cutting instruments, including piezosurgery handipece, in real time to perform osteotomies and apicectomies. The matching is achieved by means of the trace registration protocol, in which a calibrated tracer tool attached to a Tracer Tag and tracked by the system's Micron Tracker camera is moved along the tooth surfaces while the system captures a cloud of points along this path to spatially orient the tool tag, therefore mapping the patient's jaw to the CBCT scan. This tracing is finished by a full accuracy check performed by touching all surfaces of the teeth with the tip of the tracer tool. Measurements of ± 0.01 mm allowed verifying the accuracy of the trace in the three orthogonal planes (sagittal, coronal, and axial). Unlike static navigation guides, dynamic navigation procedures are not constrained to a predetermined path, there is no risk of distortion as a complication of the guide fabrication and the inability to work in restricted areas of the mouth owing to the bulk of the guide is obviated.

Dynamic navigation enables adjustment of the osteotomy pathway and the angle of the root section during the EMS procedure. The clinician follows the surgical instrument's movement in 3D on the computer monitor and assesses the surgical site through the microscope oculars. This case report presents the use of dynamic navigation to avoid damage to the Schneiderian membrane of the maxillary sinus while performing EMS on a maxillary premolar in an anatomically challenging space.

Case report

A 50-year-old male patient presented with moderate pain associated with a previously treated maxillary right second premolar (tooth #15). The medical history was non-contributory. The tooth had been endodontically treated and restored with a cast post and core and a complete crown. The patient's CBCT scan revealed two separate roots, an intact buccal plate and an apical lesion associated with the palatal root (Fig. 1). The tooth was moderately sensitive to vertical percussion, and periodontal probing depths and mobility were within normal limits. The diagnosis was symptomatic periapical periodontitis associated with a previously treated tooth. After consultation, the patient chose to have EMS treatment done with dynamic navigation.

The proximity of the palatal root apex to the sinus floor raised the issue of an existing sinus perforation or the risk of iatrogenic creation. Dynamic navigation enabled real-time feedback of the position of the instrument tip on the z-axis as it accessed the palatal root apex.

Lidocaine (2 %) with 1:80,000 adrenaline (New Stetic) was used to achieve profound local anaesthesia, and a full-thickness mucoperiosteal flap with a vertical releasing incision was elevated (Fig. 2A).

Three landmarks (up to six can be used) were marked on teeth displayed in the patient's scan in a non-collinear array. A head tracker (optical marker) was secured to establish jaw position, a tracer tag attached to a tracer tool and a stentless trace registration of the maxilla done by creating a cloud of points around the landmarked teeth, thus accurately mapping the avatar maxilla on the CBCT.

An accuracy check was performed to verify the trace registration, a drill tag (optical marker) was secured to the Piezotome Cube handpiece (ACTEON) with an adapter, the LC2 saw (ACTEON) secured to the handpiece and the saw tip calibrated. The dynamic navigation software algorithms enable the micron tracker (stereoscopic camera) to identify the avatar saw tip as it cuts the periphery and depth of the cortical window (Figs. 2B & C). The position of the saw at the periphery of the palatal root resection can be precisely tracked, thus preventing a sinus communication (Figs. 3A & B). The retro-preparations were done using an E30RD ultrasonic tip (NSK).

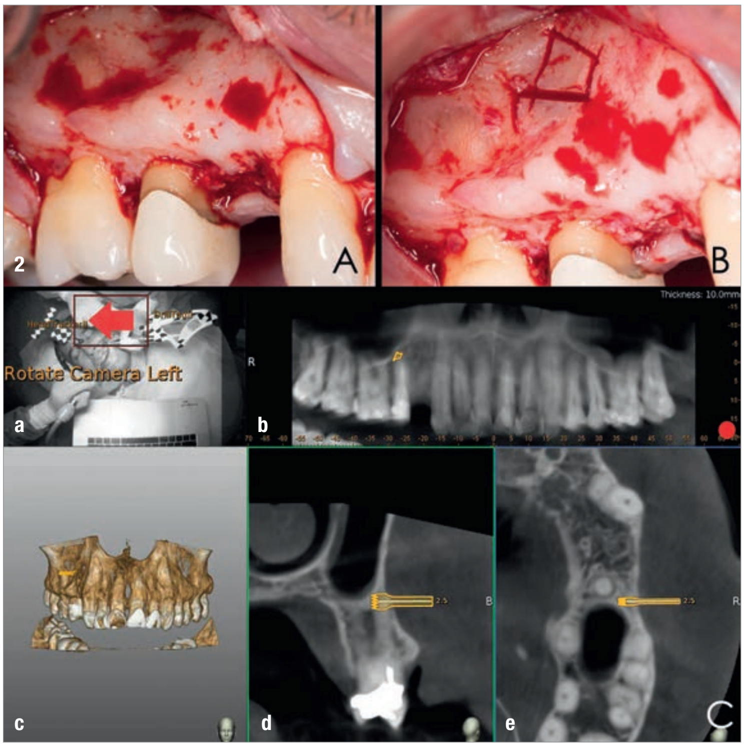


Fig. 2: Surgical procedure. A full-thickness mucoperiosteal flap was raised, exposing the overlying the intact cortical bone of tooth #15 **(A)**. The periphery outline of the cortical window (bone lid) is shown. The efficacy and accuracy of Dynamic Navigation enables minimally invasive resection owing to the real-time feedback capability of the software **(B)**. The calibrated avatar saw tip is visible in the frames of the Navident interface **(C)**; camera view of the patient and optical tags **(a)**; panoramic view **(b)**; rendered view **(c)**; coronal view showing the saw position **(d)**; axial view showing the saw position **(e)**. The coronal and axial views show the movement of the saw, providing real-time feedback of its position during the surgery.

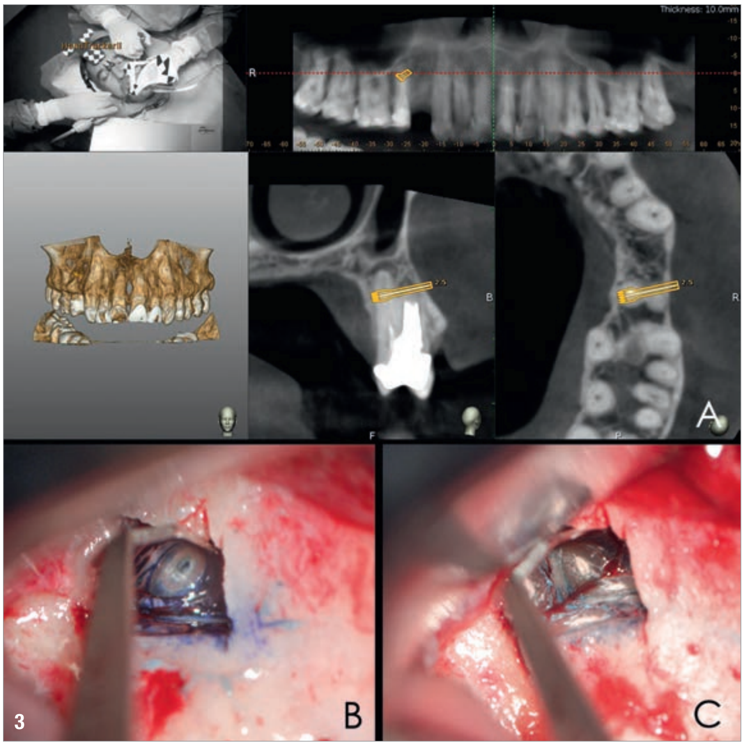


Fig. 3: Preparation of the root end. The progress of the saw is monitored as it moves through the bone and resects the apex of the root **(A)**. The bone lid has been removed, the buccal and palatal roots resected and the apical extent of the root canal space retro-prepared **(B)**. The retro-preparations were retro-sealed **(C)**.

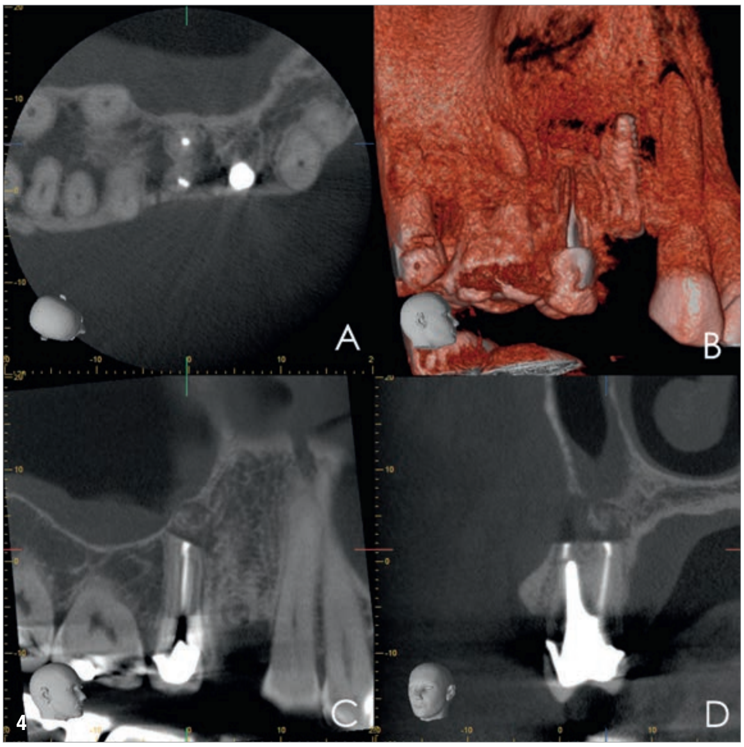


Fig. 4: Post-surgical CBCT: axial view showing the retro-seals in place **(A)**; 3D reconstruction of the surgical area **(B)**; sagittal view of the palatal root showing the angle of the resection and the retro-seal in place **(C)**; coronal view of the buccal and palatal roots, showing the angle of the resection and the retro-seals **(D)**.

EndoSequence BC RRM-Fast Set Putty (Brasseler) was used as the retro-filling material (Fig. 3C). Radiographs were taken to confirm the density and position of the retro-seals. The post-surgical CBCT confirmed the precision of the saw cuts, resulting in accurate resection of both roots without complications ensuant on an iatrogenic tear of the sinus membrane (Fig. 4).

Discussion

Dynamic navigation has been shown to be more accurate than freehand and static navigation in surgical implant placement.[14] Its effectiveness has been demonstrated for the removal of foreign objects from the maxilla and mandible, repositioning of the inferior alveolar nerve and removal of pathology with minimal hard- and soft-tissue damage.[15–18]

Piezo-surgery is a relatively new surgical technique. Its major advantages include precision, ease of curvilinear osteotomy, less trauma to soft tissue, preservation of neurological and vascular structures, reduced haemorrhage, minimal thermal damage to the bone and improved healing. Piezoelectric bone surgery has been demonstrated to mitigate critical and important complications during maxillary osteotomy procedures, such as oroantral communication.[19–23] Vercellotti et al. introduced the piezoelectric bony window osteotomy as a simplified technique for sinus elevation.[24] Owing to the cessation of the surgical action of the piezoelectric scalpel when it comes into contact with non-mineralised tissue, there is a reduced risk of iatrogenic damage.[25] In conjunction with dynamic navigation, piezo-surgery allows the creation of a cortical window size accurately approximating the pathology about the root apices.

Conclusion

Dynamic navigation is an exciting and promising adjunct for enhancing positive EMS outcomes in contrast to the efficacy of static navigation guides. The real-time feedback feature of dynamic navigation technology mitigates risk in areas close to anatomical structures. Selective and controlled osseous dissection is enhanced. The ability to alter the surgical pathway provides for an improved margin of accuracy and degree of safety. Its use in other aspects of EMS is being evaluated.

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

Prof. Paula Andrea Villa Machado is an endodontist from Universidad CES in Medellin. She is cofounder of the graduated endodontic programme in Universidad de Antioquia, where she is Titular Professor. She is a former president of the Colombian Association of Endodontists. Currently she runs a private practice specialised in endodontics and endodontic microsurgery in Medellín, Colombia. She can be contacted at paula.villa@udea.edu.co or paulavillam@gmail.com.

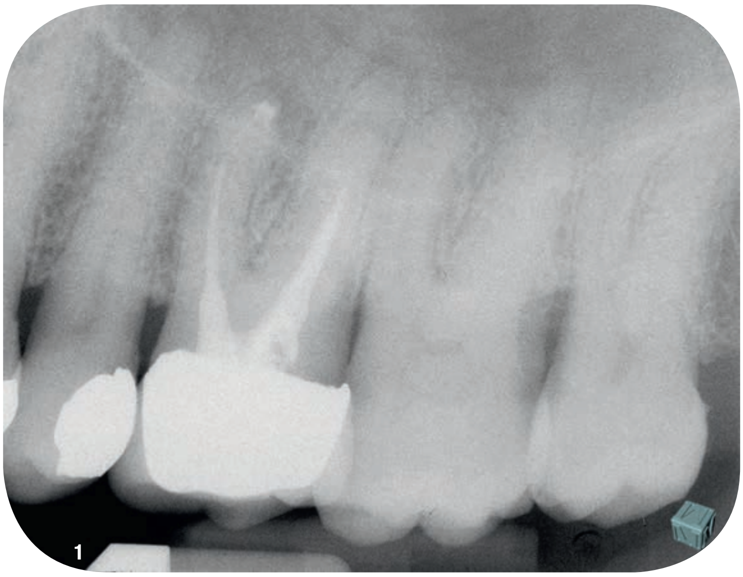
Dr Kenneth S. Serota has been active in online education since 1998. He is the founder of the ROOTS endodontic forum and the NEXUS interdisciplinary Facebook forum. Dr Serota is a clinical instructor in the University of Toronto postdoctoral endodontics department in Canada. He is the social media and marketing director for Navident dynamic navigation.

Dr Felipe Restrepo is an associate professor at Universidad de Antioquia, lecturing postgraduate students in endodontics, and director of the dental emergencies diploma. Dr Restrepo has authored scientific articles in peer-reviewed journals. He can be reached at felipe.restrepo@udea.edu.co.


RETREATMENT
Remover
for HyFlex and MicroMega file systems
→ One file to remove the root filling material
→ Respects the root canal anatomy
→ Efficient without any solvent
→ Safe thanks to non-cutting tip
Get your
FREE SAMPLE!
remover.coltene.com/sample
The essential piece for your retreatment
remover.coltene.com
COLTENE
005777 07.20

The importance of irrigation in challenging cases

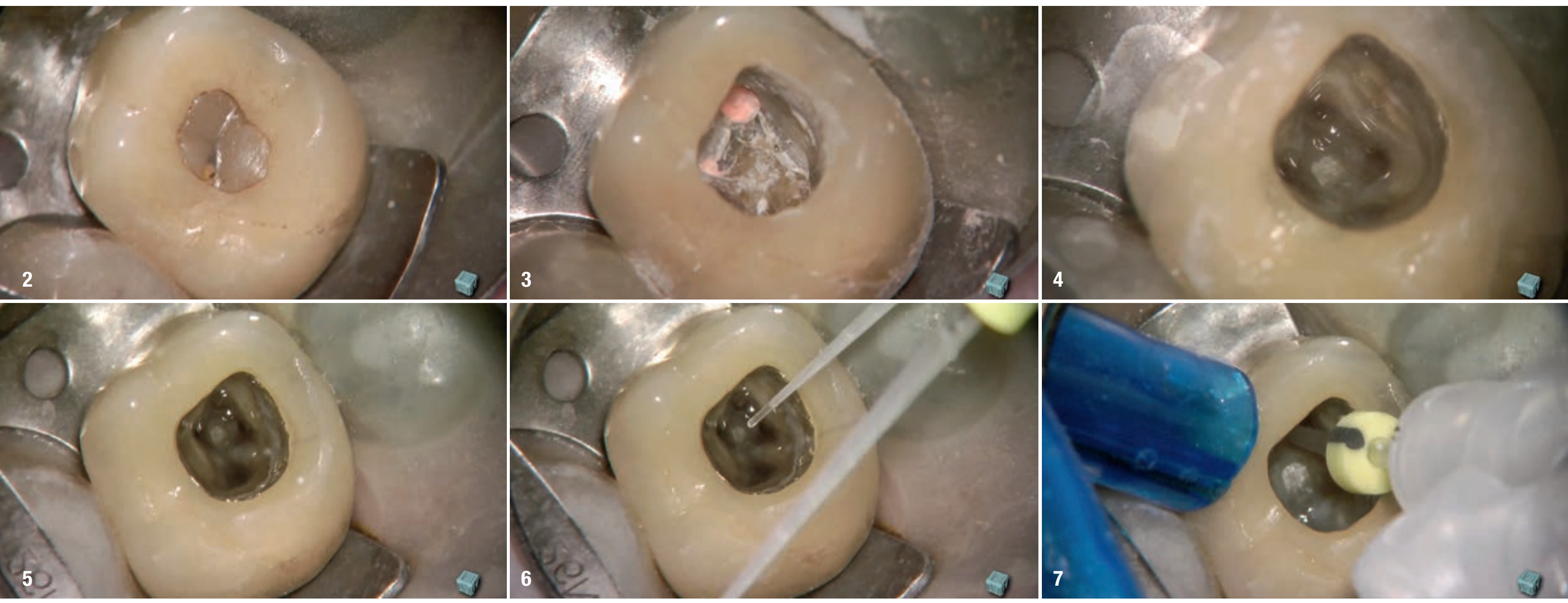
Dr Marco Martignoni, Italy



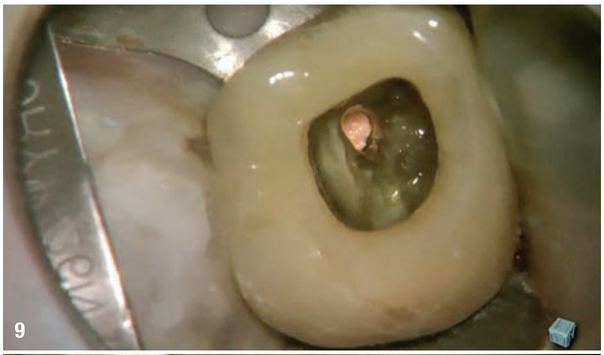
Introduction

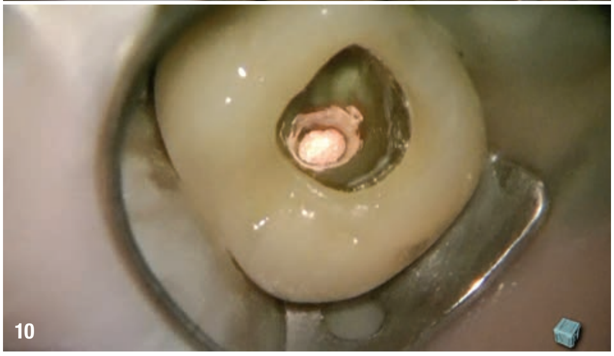
Irrigation of root canals is key to improving the removal of bacteria, pulp tissue, the smear layer and debris from the root canal system,[1] reducing the risk of post-treatment disease. In fact, it is well known that mechanical instrumentation leaves untreated canal areas ranging from 10 to 50 % in individual canals.[2–6] In these areas, there is the possibility for bacteria to replicate, leading to the failure of the treatment.[7] A recent article showed that the bacterial persistence at the time of filling has a significant influence on the outcome of the treatment, regardless of the irrigating solution and the medication used,[8] thus stressing the importance of eradicating as many microorganisms as possible from the root canal system. The synergy between mechanical preparation and irrigation is influenced by several factors, such as the fluid properties and the volume of the irrigant, the irrigant delivery system and its depth of placement, and the anatomy of the root canal system.[9]

Conventional needle irrigation is unable to provide good disinfection[10] because of the risk of the vapour lock effect[11] and because needles can have difficulty penetrating into narrow spaces;[12] as a consequence, the difficulty in reaching the most apical region of the canal with large volumes of fresh irrigant may result in insufficient replacement and fluid exchange beyond the tip of the needle.[13] In order to increase the efficiency of the irrigation, the literature suggests the use of preheated solutions[14]




8


9


10


11

or activation of irrigants[1] by means of ultrasonic/sonic devices[15] or negative pressure devices.[16]

The closer the needle is to the working length, the greater the irrigation is. For this reason, using products that follow the anatomy of the prepared root canal can help in this clinical step. However, the flux must not be violent, in order to decrease the risk of extruding debris into the periapical tissue.[17]

Several articles have described the use of a novel polypropylene needle (IrriFlex, Produits Dentaires) characterised by a back-to-back side vent design that helps the clinician irrigate the root canal space efficiently and safely. This product, with its 30-gauge tip, has the advantages of reaching the working length effortlessly and of bringing a high volume of irrigant close to the apex. The product has been shown to be effective in curved canals, but what about challenging cases? The following case reports demonstrate the use of IrriFlex in two different scenarios: a retreatment and a primary treatment of a calcified canal.

Case 1

A 62-year-old patient was referred to our clinic for endodontic retreatment. The patient reported swelling of the maxillary left gingiva. The radiographic examination revealed the results of a previous endodontic therapy and the presence of periapical radiolucencies (Fig. 1). Since the results of the previous therapy could be improved, we decided to retreat the tooth, passing through the existing crown.

After positioning of the dental dam (Fig. 2), the existing composite filling in the centre of the crown was removed using a diamond-coated bur driven by a high-speed handpiece. In this way, the access cavity was created and refined in order to see the pulp chamber (Fig. 3). The existing root canal filling was removed using rotary instruments specifically designed for retreatment, and then ultrasonic tips were used to remove the remnants on the pulp chamber floor. The chamber was filled with 5 % sodium hypochlorite (Fig. 4), and the second mesiobuccal canal, which had not been shaped, cleaned or filled during the initial treatment, was located and shaped according to the standard protocol.


12


13


14

Considering the presence of an endodontic lesion and swelling, a great deal of time was dedicated to decontamination of the root canal system (Fig. 5).[18] The device chosen to deliver the irrigating solution to the working length was IrriFlex (Fig. 6 & 7) because, thanks to its flexibility, it would be able to deliver the irrigant to the apical third of each root, without any effort, without stopping in case of curvatures. The irrigant was then activated by means of ultrasonic inserts[19] according to the indications given by Tonini and Cerutti.[12]

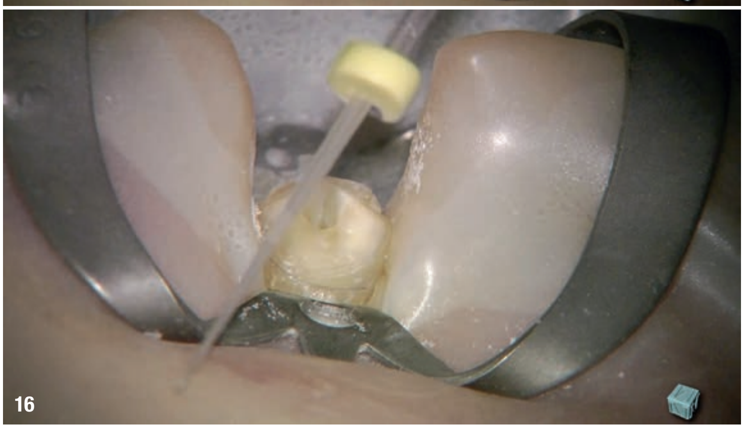
After ensuring that the root canals were dry, they were filled according to the warm gutta-percha compaction technique (Figs. 8–10). After that, the access cavity was filled by means of a direct composite restoration (Fig. 11) and a postoperative radiograph was taken in order to check the final result (Fig. 12).

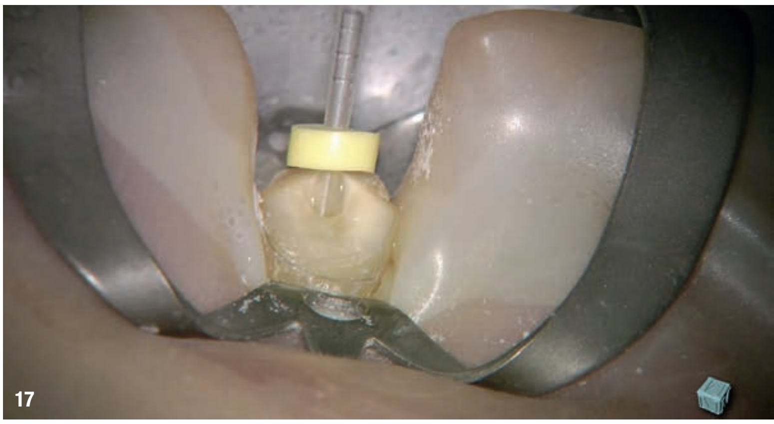
Case 2

A 50-year-old patient came to our office because of an emergency: while eating, he had broken tooth #22 and he was not able to find the fragment (Fig. 13). The fracture had exposed the pulp and the patient reported spontaneous and acute pain. The preoperative radiograph showed that the tooth had a very thin canal lumen (Fig. 14) and sufficient bone support. It was thus decided to do an endodontic treatment followed by restoration with a prosthetic crown.

As a first step of the therapy, a dental dam was positioned directly around the remaining tooth structure and the root canal therapy was started. The access cavity was created, and the root canal opening was located and


15


16


17


18


19

enlarged using ultrasonic tips. Then nickel–titanium rotary instruments were used to complete the shaping of this narrow root canal space (Fig. 15). Multiple irrigation sequences were repeated using IrriFlex and ultrasonic activation of the sodium hypochlorite, both in order to have the endodontic instruments work in the presence of an irrigating solution and to decrease the bacterial load.[20] The great advantage of using a polypropylene irrigation cannula was that, once the last shaping instrument had reached the working length, the cannula reached the working length smoothly too (Figs. 16 & 17), allowing the dentist to bring the irrigant as close as possible to the apical constriction.[1]

When the root canal walls looked sufficiently clean and shiny, obturation with warm gutta-percha was performed. As a last step of the endodontic treatment, a build-up was done with composite (Fig. 18) and a periapical radiograph was taken (Fig. 19).

Conclusion

The same experienced practitioner performed the two root canal therapies reported in this article. The cases were extremely different, an initial treatment of a single-rooted tooth and a retreatment of a multi-rooted tooth, but both of them were challenging. The instruments and the sequences used for shaping the root canal system differed between the cases, since the root canal taper was different and the apical size of the lateral incisor was discernibly smaller than that of the molar.

The thing that did not change in the approach to these cases was the attention paid to the irrigation step. In the retreatment, the eradication of bacteria was the key to success in a tooth that had already received an endodontic treatment that had failed, whereas in the lateral incisor, the presence of a narrow canal made it more difficult to clean the complexity of the root canal system.[21]

In both cases, the use of a flexible irrigation cannula that follows the path created by the endodontic instruments precisely made the treatment easier and reduced operating times, because it was possible to deliver a large volume of irrigating solution where it was needed the most. The presence of length marks on the cannula helped the clinician establish the needle penetration inside the root canal; the yellow stop was put on the cannula to emphasise the correspondence between working length and IrriFlex depth of penetration inside the prepared canal. Obturation with warm gutta-percha was performed in order to seal the root canal space in 3D, and the choice to restore both teeth in the same appointment as that of the root canal therapy was meant to prevent coronal leakage often associated with provisional restorations.

about

Dr Marco Martignoni graduated from the Gabriele d'Annunzio University of Chieti–Pescara in Italy in 1988. From 1989 through 1991, he completed continuing education courses at the Boston University Henry M. Goldman School of Dental Medicine in the US, presented by Dr Herbert Schilder. In 1992, he completed a continuing education programme presented by Dr Cliff Ruddle in Santa Barbara in the US. He runs a private clinic in Rome in Italy, and the practice is dedicated mainly to endodontics, pre-prosthetic core build-ups and prosthodontics. He has conducted and published research on post-endodontic core build-ups. He is a well-known speaker and has given numerous lectures and practical workshops in Italy and worldwide on endodontics, on core build-ups and on the use of the operating microscope in dentistry. He is founder of the Accademia Italiana di Odontoiatria Microscopica (Italian academy of microscopic dentistry) and an honorary member of the Société Française d'Endodontie (French society of endodontics).

Innovative endodontics using SWEEPS technology

Tips and tricks

Drs Giovanni Olivi[1,2], Linhlan Nguyen[1], Matteo Olivi[2] & Jason Pang[1], Italy & Australia

[1] Catholic University of Sacred Heart, Rome—Master Laser Dentistry; [2] Private practice InLaser, Rome

Conventional endodontic treatment is based on different phases, resulting in the elimination of acute or chronic inflammation of the pulp and periapical area (Table 1).[1–3] The different phases of the therapy are:
- initial cleansing of the endodontic space,
- shaping the root canals to a size sufficient for delivery of irrigants,
- final cleansing and 3D disinfection of the endodontic space, and
- 3D sealing of the endodontic space and restoration of the post-endodontic space and the crown to conclude the therapy.

The cleansing and shaping phases include two different types of cleansing: a chemical cleansing, carried out by different irrigating solutions, and a mechanical cleansing, carried out by endodontic instruments that shape the root canals. However, many studies have demonstrated the incomplete action of the tested instrumentation, which left 35 % or more of the canal surface area unchanged.[4–6] Accordingly, it is the efficient irrigation of the endodontic space that determines the success of the therapy. During the shaping phase, hand irrigation is performed using a syringe with an end- or side-vented needle, alternating with instrumentation using files of different sizes. Besides reducing the bacterial load, irrigants act as a lubricant during filing prior to the final activated irrigation protocol. The purpose of this article is to present an innovative rationale for endodontic therapy using the newest cutting-edge laser technology SWEEPS (shock wave enhanced emission photoacoustic streaming).

Not previously treated	Previously treated
Asymptomatic irreversible pulpitis	
Symptomatic irreversible pulpitis	
Asymptomatic apical periodontitis	Asymptomatic apical periodontitis
Symptomatic apical periodontitis	Symptomatic apical periodontitis

Table 1: Diagnostic classification of endodontic pathology.[1–3]

Irrigating solutions in endodontics

In endodontics, different irrigating solutions are used to kill microorganisms, dissolve the organic components (pulp remnants and collagen), and chelate and remove the inorganic components (calcification and debris).[7] The smear layer is composed of both organic and inorganic components. However, there is no irrigating solution that has all the ideal characteristics.[7] An effective irrigation approach is based on a specific alternating sequence of use of different irrigating solutions, before, during and at the end of the therapy. After creation of an access cavity, root canal therapy is started by cleaning the pulp chamber and canals using an irrigant with antibacterial and pulp-dissolving action.

Sodium hypochlorite

Sodium hypochlorite (NaOCl, 1–6 %) is the main irrigant used in endodontics owing to its high bactericidal activity and pulp tissue dissolution action.[7] Higher NaOCl concentrations achieve faster bacterial load reduction; however, the more concentrated the solution of NaOCl, the thicker it is, resulting in reduced wetting ability. NaOCl is still recognised today as the gold standard solution in endodontics because of its use from the initial to final phases of the therapy.[7] NaOCl has significant biological toxicity risk for periapical tissue when pushed under pressure through the root canal orifice.[8] The outcome is significantly worse for higher concentrations.

EDTA

Irrigation with chelating solutions such as ethylenediaminetetraacetic acid (EDTA, 15–17%) is often utilised during root canal therapy. When alternated with NaOCl, such as in cases of calcified canals and at the end of the treatment, EDTA cleans the canal walls of debris and the smear layer produced during instrumentation, just before the final decontamination. EDTA is slightly irritating but not toxic to periapical tissue.

Chemomechanical systems	Positive pressure systems	Negative pressure systems
XP-endo Finisher	Hand dynamic	EndoVac
	Sonic	
Self-Adjusting File	Multi-sonic	
	Ultrasonic	
	Laser-activated irrigation (PIPS* and SWEEPS**)	

* PIPS = photon-induced photoacoustic streaming. ** SWEEPS = shock wave enhanced emission photoacoustic streaming.

Table 2: Irrigant agitation techniques.

Chlorhexidine

Chlorhexidine (2 %) has good antibacterial properties, but it is not able to dissolve pulp tissue. This suggests its use only in an additional final decontamination step because of its unique substantivity property, which could allow persistent residual antimicrobial action. It is important to prevent interaction between NaOCl and chlorhexidine, by rinsing the canals with distilled water in between solutions to avoid the formation of precipitates that may discolour the tooth and that may contain potentially mutagenic compounds.[9,10] Its inability to dissolve organic tissue also explains the absence of toxicity to periapical tissue.[11,12]

Other solutions

Other chemical solutions have been investigated and used in endodontics. Among these, hydrogen peroxide, iodine, citric acid, ozone (gas) and ozonated water are available, but none of them have demonstrated superior properties and results to the previously cited NaOCl and EDTA solutions. EDTA plus Cetavlon and a mixture of doxycycline, citric acid and a detergent are new solutions that combine different components, surface-active agents and antibiotics which can be very effective and have broader action. The experimental use of nanoparticles is also very promising.

Irrigant activation techniques

The initial irrigation phase and the irrigation during shaping are performed using a syringe with an end- or side-vented needle that can only negotiate the canal up to the middle third. Therefore, it must be considered that the efficacy of hand irrigation is quite limited; thus, supplementary, active and dynamic irrigation (Table 2) is proposed at the end of the treatment to ensure the cleaning of the dentinal walls and the deep decontamination of the endodontic system.[13] Among the various activation methods, we can find systems that heat the irrigating solutions or that activate the solutions by agitation, with positive or negative apical pressure.

Heating

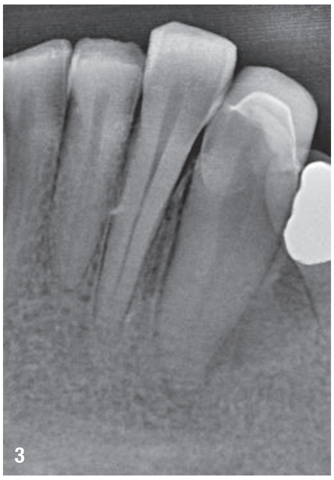
Scanning electron microscope studies on intra-canal heating of NaOCl at 180 °C have proved this method to be more effective for cleaning the canal walls than extra-canal heating at 50 °C, which left a higher quantity of debris and the smear layer widely distributed.[14] Other studies have reported that NaOCl at a concentration of 1 % heated to 60 °C was significantly more effective than 5.25 % at 20 °C. The advantage of using lower concentrations of NaOCl, heated to higher temperatures, could be related to a twofold effect: the same effectiveness and less systemic toxicity than that of non-heated, high-concentration NaOCl.[15]

Agitation techniques

However, the effect of agitation on tissue dissolution was proved greater than that of temperature and with continuous agitation resulted in the fastest tissue dissolution.[16] Comparing the efficacy of various agitation systems, De Gregorio et al. found a limited penetration of the irrigant into lateral canals using an apical negative pressure irrigation system, whereas passive ultrasonic irrigation demonstrated significantly more penetration of irrigant into lateral canals.[17] Nevertheless, it could be reasonable to combine the two techniques, using heated NaOCl and agitating it with the preferred method.

Laser-activated irrigation using SWEEPS

The physical concepts behind laser-activated irrigation and SWEEPS technology have already been explained in a previous issue (4/2019) of this magazine.[18] One of the great advantages of SWEEPS over all of the other activation techniques is its profound effectiveness. Unlike all the other techniques, SWEEPS action is not limited to the vicinity of the tip, as is the case with ultrasonic irrigation, but it is also effective at distant regions of the root canal system.[19,20] For this reason, SWEEPS only requires positioning of the tip in the access cavity to stream the irrigant into all of the endodontic space at the same time. This is different to other techniques, which require needle or tip/



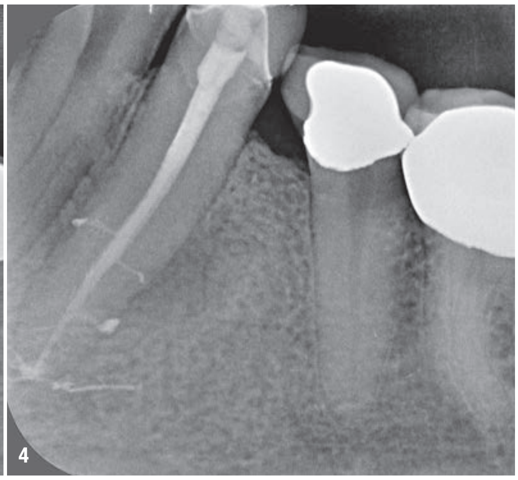


Fig. 1: Tooth #12—the radiograph showed a large periapical lesion. The asymptomatic tooth was prepared with an ISO 25/.06 TF Adaptive file (Kerr Dental). **Fig. 2:** Tooth #12—root canal filling was performed with mineral trioxide aggregate (ENDOSEAL MTA, Maruchi). Note the sealing of the apical ramification, possible because of the effective cleansing and decontamination of the apical terminus. There was almost complete healing after 12 months. **Fig. 3:** Tooth #33—the patient showed a buccal sinus tract that radiographically corresponded to the area between tooth #32 and tooth #33. The CBCT and radiograph showed a large periradicular lesion, especially on the distal side. Preparation was performed with a 20/.07v ProTaper Gold (F1; Dentsply Sirona). **Fig. 4:** Tooth #33—root canal obturation was performed with a sealer and carrier-based gutta-percha (AH Plus and Thermafil, Dentsply Sirona). The radiographic control six months post-op showed that several lateral canals had been filled and the healing process was in progress.

file or probe insertion up to the apical third of each canal or so for irrigation after the root canals have been prepared. Thus, SWEEPS can be used from the initial phase up to the final phase of the therapy, permitting a progressive decrease in the bacterial load before any file is used. The efficacy and effectiveness of SWEEPS rely on both chemical activation of the endodontic solutions by agitation,[21,22] improving the ability of irrigants to kill bacteria and to dissolve tissue, and mechanical flushing action to clean the root canal wall.[23,24]

Researchers have found the SWEEPS dual modality to be more effective than the single-pulse modality SSP (super-short pulse; PIPS, photon-induced photoacoustic streaming).[25–28] Using the SWEEPS dual-pulse modality, the sudden expansion of the second bubble, generated by the second laser pulse, exerts additional pressure on the first bubble, leading to its violent collapse, during which shock waves are emitted also in very small canals. Furthermore, shock waves are emitted from the collapsing secondary cavitation bubbles that form naturally throughout the entire length of the canal during laser-activated irrigation.[25–29] The secondary cavitation bubbles are in close proximity to the canal walls during their collapse, generating shear stress and vortical flows that are able to remove debris, the smear layer and biofilm from the root canal surface, as well as from undetected and uninstrumented anatomical areas, such as isthmuses, lateral canals, loops and ramifications, thereby increasing the cleaning and decontamination mechanism even further (Figs. 1–4). The enhanced pressure generation along the root canal consequently also increases the depth of penetration of irrigants into dentinal tubules.[25–28]

Fig. 5: Proper isolation for SWEEPS is important. A liquid dam was interlocked beneath the dam clamp. Traditional access cavity preparation of the maxillary first molar was performed using a cylindrical or round diamond bur under magnification (4.5–6.0x).

Clinical protocols

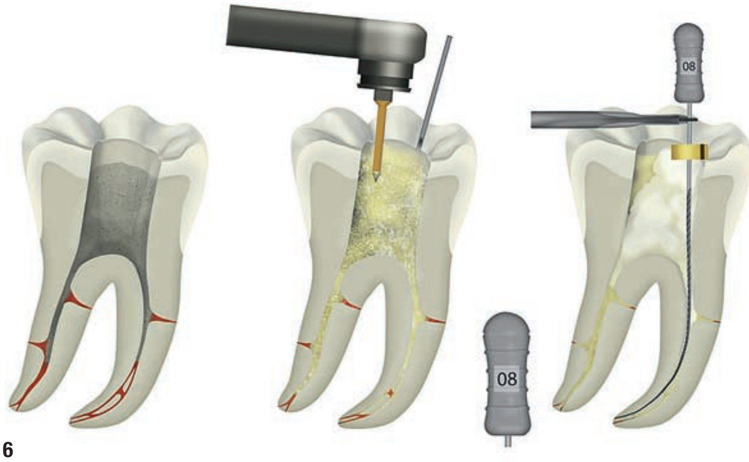
Proper patient draping with a waterproof bib to protect clothing is highly recommended. Local anaesthesia is performed in all cases (asymptomatic and symptomatic) to avoid any unpleasant sensation of internal pressure during the treatment. A dental dam is then applied, and a liquid dam is interlocked beneath the clamp to ensure complete isolation (Fig. 5). In case of occlusal or proximal decay or a defective filling, complete removal of the carious tissue and filling must be performed, followed by composite reconstruction of the entire tooth crown; this preliminary step is mandatory to minimise leakage and reinfection. Furthermore, good marginal sealing prevents any irrigant extrusion during laser-activated irrigation.

Access cavity preparation

At this point, the access cavity is opened using a small carbide, or cylindrical or round diamond bur under magnification (4.5–6.0x). Traditional access cavity preparation, following the laws of centrality and concentricity, is advisable (Fig. 5).[30] Several studies have demonstrated the lack of usefulness of ultra-conservative "ninja" access cavity preparation in terms of fracture strength and preservation of the original canal anatomy during shaping compared with traditional access cavity preparation, particularly at the apical level. Furthermore, standardised access cavity preparation is advisable when the X-SWEEPS modality is chosen for laser-activated irrigation. Future publications will explain this topic in depth in order to establish the correct laser settings to be used with standardised access cavity preparation volumes. Whatever the pathology is, the concept is to minimise the root canal shaping, optimising the cleansing and decontamination of the endodontic space by exploiting the chemomechanical flushing of SWEEPS. The main difference between asymptomatic and symptomatic pulpitis and apical periodontitis therapy is in the longer or shorter initial NaOCl SWEEPS-activated irrigation phase. Retreatment also involves a few differences in the energy applied during the initial phase when filling material has to be removed.

Asymptomatic and symptomatic irreversible pulpitis

In the case of irreversible pulpitis, the pulp is irreversibly inflamed, with or without acute symptoms. The patient's age and preoperative radiograph give information on a possible immature apex; this condition contra-indicates a full-power SWEEPS irrigation and suggests a more careful intervention and lowering of the energy used (more to follow). Once the pulp chamber has been opened, excessive bleeding may be present, indicating the presence of inflamed pulp tissue inside the chamber and root canals. In this case, one-visit therapy is advisable. The treatment starts with NaOCl irrigation by syringe (3–5ml) and simultaneous activation by Er:YAG laser (2,940nm; LightWalker AT, Fotona), using the dual-pulse (25µs duration) Auto-SWEEPS modality for 30–40 seconds. The resting time after irrigation can be extended to 1–2 minutes to allow more NaOCl pulp dissolution. A flat- or radial-ended SWEEPS tip (400µ) is used. The pulp tissue may show different grades (levels) of inflammation, up to initial necrotic degeneration. It is important to consider at this stage whether the pulp tissue itself is preventing any extrusion of the irrigant so that full-power Auto-SWEEPS activation (20mJ at 15Hz and 0.6W) can be performed up to almost complete pulp dissolution, which is indicated by a progressive decrease in bleeding. According to the tooth type and condition, this initial phase can be



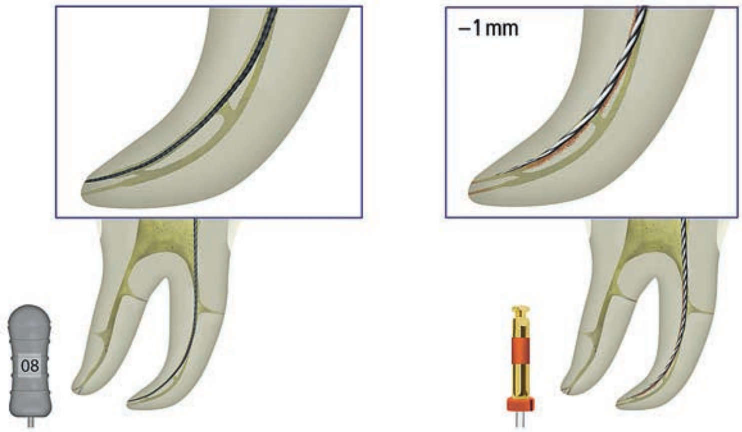
6

Fig. 6: After the cavity access has been prepared, laser-activated irrigation of NaOCl using SWEEPS is performed in the access cavity. Then lubricant gel containing urea peroxide is placed on the file (or in the cavity) to lubricate and avoid tissue plugging when sliding the file to the apical constriction. *(Courtesy of Dr Giovanni Olivi)*

repeated for two to three cycles for single-rooted teeth and up to three or four cycles for premolars and molars.

The initial irrigation phase also decreases the bacterial load. The access cavity can now be observed under magnification (6–10x) in order to locate all canal orifices. If the orifices are not all visible, the use of ultrasonic tips can easily discover orifices hidden under calcification in the pulp chamber. These are usually located at the angles, at the floor–wall junction and at the terminus of the root developmental fusion lines. Then pre-flaring of the orifices and enlarging of the coronal thirds of the canals allow easy and direct access to the canals. Subsequently, a direct glide path to the apical third is established by hand or dedicated rotary instruments, up to 3–4mm from the apex. This manual or rotary instrument step produces debris and dentine chips that must be removed by Auto-SWEEPS NaOCl irrigation, again for 30–40 seconds, followed by 30 seconds of resting time. At this point, use of a small stainless-steel hand file (ISO 06 to 10) is recommended with a cream containing urea peroxide or EDTA to lubricate and avoid tissue plugging when sliding the file to the anatomical opening to scout the canal and determine the anatomical length (Fig. 6). It must be emphasised that by now most of the pulp tissue will have already been dissolved by NaOCl and the possibility of dislodging pulp remnants or debris inside unreachable anatomical areas is very difficult if the previous phases have been correctly followed. Also, the bacterial load is highly decreased so that apical transportation of bacteria is minimal or absent. Use of an electronic apex locator and radiographic confirmation provide verification of the anatomical length of the tooth.

Different approaches to the apical constriction can be used: working to the anatomical length or 1mm shorter,



7

8

Fig. 7: In order to prevent possible over-instrumentation of the apex with enlarging of the apical opening, the authors suggest working to 1 mm shorter than the anatomical length. **Fig. 8:** Recapitulation with the smaller first instrument (ISO 06 or 08) is performed to the apical anatomical constriction (working length + 1 mm) to ensure apical patency and remove any possible dentinal plugs produced during instrumentation. The last millimetre is just cleansed and disinfected by SWEEPS. *(Courtesy of Dr Giovanni Olivi)*

in order to prevent possible over-instrumentation of the apex with enlarging of the apical opening. This is one reason for possible extrusion at the end of treatment (Fig. 7). At this point, the canals can be minimally prepared. Because SWEEPS technology does not require the tip to be placed in the canal, it is not necessary to prepare the canals to a large size. This results in a more conservative and biomimetic result: 20/.06 and 25/.06 are sufficient to warrant a hermetic apical obturation. These two or three mechanical preparation steps are always alternated with Auto-SWEEPS NaOCl irrigation and recapitulation with the smaller first instrument (ISO 06 or 08) used at the apical anatomical constriction to ensure apical patency and remove any possible dentinal plugs produced during instrumentation (Fig. 8).

Asymptomatic and symptomatic apical periodontitis

Chronic pathology can last for years without symptoms and without temperature hypersensitivity, and diagnosis can be done occasionally during check-ups with radiographic control. It ranges from minimal lamina dura dilatation to larger periapical radiolucent lesions. If symptomatic, the tooth presents with a painful dull ache, intermittent pain, gingivae that can be sore to the touch, up to excruciating pain in cases of flare-ups, possible buccal swelling and a possible visible buccal sinus tract, and the tooth is tender to percussion. More frequently, such a tooth has undergone previous dental treatments, such as a full-crown or deep restoration with or without recurrent caries, and may have untreated deep decay (cavity) extending to the pulp chamber. In this case, carious removal and cavity filling reconstruction are preliminarily performed as previously mentioned.

When creating the access cavity, the chamber and the canals are usually empty, with no pulp tissue. Sometimes, especially in molars, the pulp condition can differ from one canal to another. Some may present with minimal bleeding. In case of swelling and a periapical abscess, pus may flow out of the tooth from the opening into the canal orifices. Treatment starts with two to three cycles of saline irrigation (3–5 ml by syringe) and simultaneous activation by Er:YAG laser (2,940 nm; LightWalker AT), using the dual-pulse (25 µs duration) Auto-SWEEPS modality for 30–40 seconds, at 20 mJ and 15 Hz. This preliminary irrigation with saline, besides its initial cleansing and antibacterial action,[33] helps to test the patency of the apical constriction to the pressure applied. Frequently, chronic periapical inflammation can lead to an enlargement of the apical constriction so that irrigant extrusion can occur, especially in cases of apical contraction larger than ISO 40–50. Then NaOCl irrigation is activated by Auto-SWEEPS, using a low energy, 10 mJ, at 15 Hz for 30 seconds to start the decontamination and lubrication of the canals prior to using the ISO 10 hand file to explore the canal and verify patency and anatomical length. Once apical patency and working length are established, new NaOCl irrigation activated by Auto-SWEEPS is performed. The possibility of decreasing the energy output from 20 mJ to 15 or 10 mJ allows reduction of the streaming pressure to the apex. However, the dual-pulse Auto-SWEEPS modality promoted an almost constant flow rate for different pulse energies of between 10 mJ and 20 mJ, compared with the single-pulse modality SSP, indicating superior safety of Auto-SWEEPS regardless of the pulse energy.[29]

Furthermore, the pressure efficacy is higher for a smaller fibre tip diameter (400 vs 600 µ), and radial-ended fibre tips are slightly less effective for generating pressure in comparison with cylindrical tips.[28] To simplify, in case of a larger apical size, it is suggested to use the Auto-SWEEPS modality with a larger size tip (600 µ), preferably with the radial-ended tip (X-Pulse). This management of energy and tip choice allow beginner users to work carefully in case of altered apical anatomies. When the apical opening is more than ISO 40–50, a simple operation that permits control of any unwanted irrigant extrusion is the use of a particularly smooth needle file of different calibres (from ISO 40 to ISO 100). The apical end closes the apical opening of the canal while laterally all the irrigant flows throughout the canal.

Calcified canals

Sometimes canal restrictions and calcifications, due to tertiary dentine formation, may be found, hindering the negotiation of the canal (Figs. 9 & 10). In case of a multi-rooted tooth, another canal may be accessible and the usual protocol can be applied up to completion of root canal filling (Figs. 11–13). In a separate session, the calcified canal is irrigated by EDTA solution, activated and forced by full-power Auto-SWEEPS, at 40 mJ and 15 Hz (Figs. 14 & 15). The single-pulse USP mode (25 µs) can also be more effective for pressure generation. Note that, if the canal is obstructed by calcification while the other canals have already been prepared with files, this procedure at higher energy is very safe. EDTA in this case is used to chelate and soften the dentine, but sometimes the use of a thin, rigid ultrasonic tip is necessary to remove the calcification in the coronal third. Stainless-steel hand files with EDTA gel can be used to help bypass the blockage in the middle and apical thirds.

Final irrigation protocol

At the end of the preparation and before the final irrigation protocol, the root canal system has already been cleansed and disinfected by the SWEEPS protocol used from the beginning of the therapy. Further research is required to confirm the reported efficacy and effectiveness of SWEEPS's cleansing ability and pressure generation regarding decontamination. Several researchers have reported the superior decontamination results of the SSP modality using PIPS.[34–36] Therefore, this evidence-based protocol is used for the final NaOCl disinfection (Fig. 16).

Continue using the tip size and shape (flat- or radial-ended) chosen:

- Two cycles of 30-second EDTA (15–17 %) irrigation by syringe is performed, delivered in the access cavity and activated by Auto-SWEEPS at 20 mJ and 15 Hz. In case of an open apex, the energy can be reduced to 15 or 10 mJ. Each cycle is followed by 30 seconds of resting time, to allow the solution to react on the dentinal walls. At this point, gutta-percha points can be tested after calibrating length and apical size. Apical friction and retention should be checked and adjustments made if necessary. This simple operation contributes, with its hand dynamic action, to irrigation efficacy.
- One cycle of 30-second irrigation with distilled water (or water directly from the 0/1 laser spray) is performed to rinse the canals before the final decontamination.

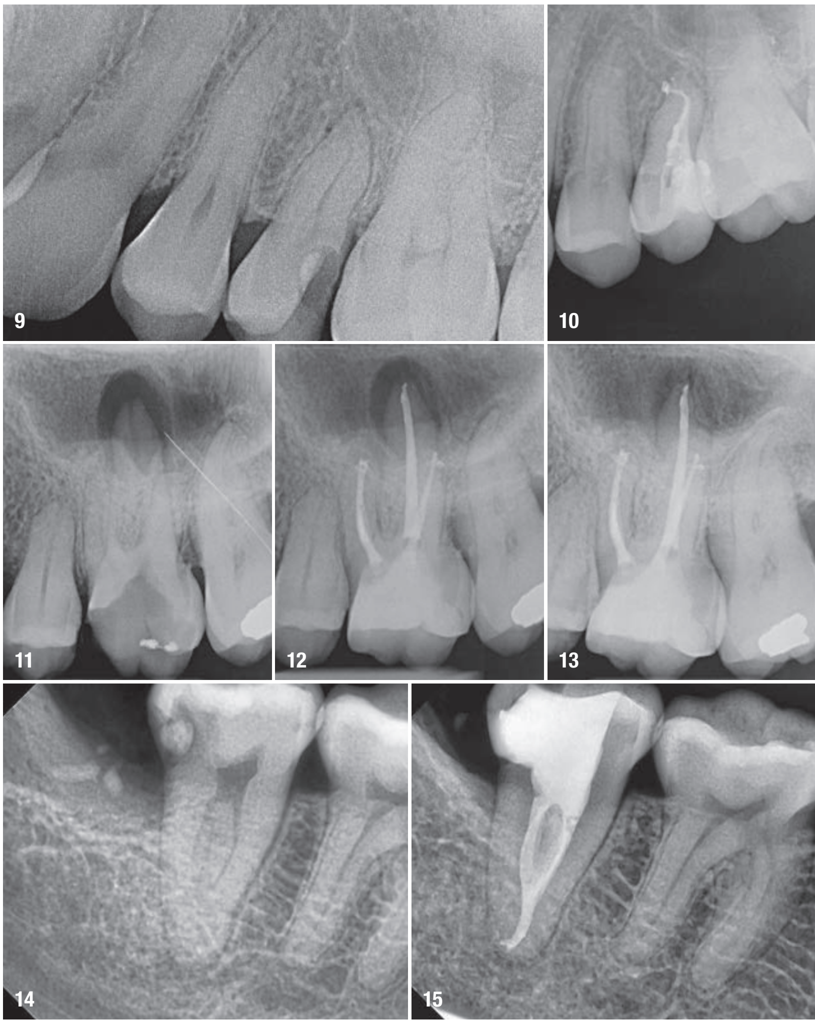
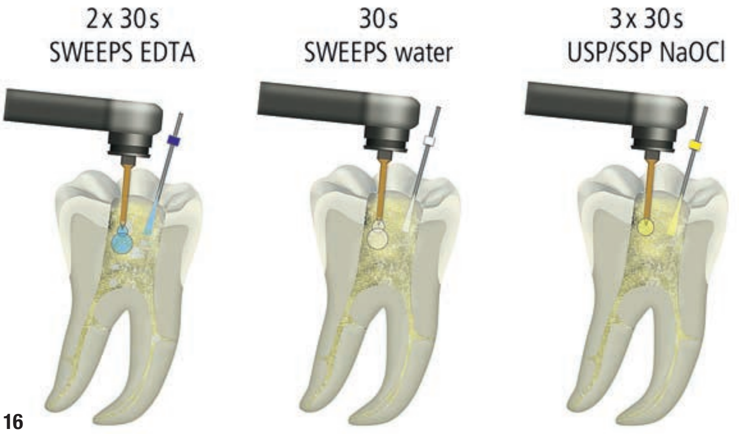


Fig. 9: The symptomatic maxillary second premolar showed a periapical lesion on radiographic examination. The preparation of the buccal and palatal canals was performed with a 25/.08v ProTaper Gold (F2) to 4 mm short of the radiographic apex. A size 10 hand instrument was used up to 2 mm short of the apex. **Fig. 10:** The calcified canals hindered the negotiation of the apical constriction. Full-power Auto-SWEEPS (40 mJ, 15 Hz) activation of 15 % EDTA solution was able to force through the blockage to cleanse and disinfect the last 2 mm of the confluent curved canals. Obturation was performed with Thermafil and AH Plus sealer. **Fig. 11:** A symptomatic maxillary first molar with large mesioocclusal decay and a large periapical lesion. **Fig. 12:** Root canal preparation was performed with a 25/.06 ProTaper Next X2 (Dentsply Sirona) in the buccal canals and 40/.06 X4 in the palatal canal, which demonstrated pre-existing apical resorption. Obturation was performed with EndoSequence BC Sealer (Brasseler) and gutta-percha. The first and second mesiobuccal canals merged into one unique larger canal in the apical third. **Fig. 13:** The three-month post-op radiographic examination showed that healing was progressing rapidly. **Fig. 14:** Radiograph showing deep distal caries with a large periapical lesion on symptomatic tooth #47. The mandibular molar presented with a typical C-shaped canal, and it was prepared with an ISO 25/.06 TF Adaptive file. **Fig. 15:** Auto-SWEEPS (20 mJ, 15 Hz) activation of 4 % NaOCl and 15 % EDTA solution was able to dissolve the tissue and debris from the complex radicular anatomy, allowing a sealer (EndoREZ, Ultradent) to fill the full endodontic space (five-month post-op radiograph).



16

Fig. 16: SWEEPS final irrigation protocol: at the end of therapy, the final irrigation protocol entails two cycles of 17 % EDTA activated by Auto-SWEEPS for 30 seconds each and 30 seconds of resting time, followed by rinsing with distilled water activated by SWEEPS for 30 seconds, then three cycles of 5 % NaOCl activated by USP/SSP for 30 seconds each and a resting time of at least 30 seconds. A final distilled water rinse completes the protocol.

- Three cycles of 30-second NaOCl (5 % minimum) irrigation using a syringe is performed, delivered in the access cavity and activated by SSP at 20 mJ and 15 Hz. The resting time after each cycle can be easily extended from 30 seconds up to 120 seconds, if needed (acute infection). The energy can be reduced to 15 or 10 mJ in order to prevent any risk of extrusion. If the apical size is larger than ISO 40–50, a thin, smooth file of the same apical master size is chosen to occlude the apical terminus before the disinfection cycles start.
- Before obturation, the canals must be rinsed with distilled water agitated by laser and dried using sterile paper points.

Root canal filling

The final obturation can be performed as usual. However, the use of flowable sealer is recommended to better fill the previously inaccessible endodontic areas, the cleansing and decontamination of which were made possible by SWEEPS. Additionally, the proven combination of carrier-based gutta-percha and warm vertical condensation is recommended for complete 3D obturation.

Conclusion

Er:YAG laser, *in vivo* at very low energy, combined with the innovative dual-pulse SWEEPS technology, allows further optimisation of the already effective SSP procedure (PIPS) during root canal therapy in everyday practice. The ability to effectively activate the irrigants directly at start of the root canal therapy plays an important role in the advantage of laser-activated cleansing and decontamination over the conventional chemomechanical preparation. SWEEPS promotes shock wave energy to clean and disinfect the root canal system with fewer files than needed during standard root canal therapy. SWEEPS promotes fluid streaming throughout the entire root canal system, even in the microscopic areas that conventional treatments cannot reach. The chemomechanical flushing action of SWEEPS produces superior cleansing and decontaminating action over conventional irrigation methods, reducing the need for canal shaping and allowing new flowable sealer and gutta-percha to obturate the endodontic space three-dimensionally. In this way, the root canal preparation size can be minimised, preserving more dental structure without losing the efficacious action of the irrigants.

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

about

Dr Giovanni Olivi graduated cum laude in Medicine and Surgery (MD) from the Università Cattolica del Sacro Cuore in Rome in Italy and in Dentistry (DDS) from the University of Rome Tor Vergata. He is a contracted professor and scientific coordinator of the laser dentistry proficiency course and Master of Science in Laser Dentistry at the Università Cattolica del Sacro Cuore in Rome. He is the President of the International Academy of Innovative Dentistry and an active member of the Italian Society of Endodontics.

Dr Linhlan Nguyen completed her BDS at the University of Sydney in Australia in 1996, a Master in Laser Dentistry at the Laser and Health Academy in 2017 and is currently completing a Master of Science in Laser Dentistry at the Università Cattolica del Sacro Cuore. She has been a fellow of the International Congress of Oral Implantologists since 2015 and the International Academy for Dental-Facial Esthetics since 2016.

Dr Matteo Olivi graduated in Dental Medicine from the Victor Babeş University of Medicine and Pharmacy in Timişoara in Romania. He obtained the European Master Degree in Oral Laser Applications from La Sapienza University of Rome. Dr Olivi is co-author of several peer-reviewed articles and books on laser dentistry topics and a member of the Italian Society of Endodontics.

Dr Jason Pang completed his BSc in Biomedical Science in 1994 at the University of Technology Sydney in Australia, receiving a university medal. He completed his BDS at the University of Sydney in 2002, a Master in Laser Dentistry at the Laser and Health Academy in 2017 and is currently completing a Master of Science in Laser Dentistry at the Università Cattolica del Sacro Cuore. Dr Pang is chairman of the Australian study club of the Academy of Laser Dentistry.

contact

Dr Giovanni Olivi
InLaser Dental Practice
Piazza Francesco Cucchi 3
00152 Rome, Italy
Phone: +39 06 5809315
olivi@inlaser.it

Remover: The ultimate solution for removing gutta-percha

Prof. Walid Nehme, Drs Jean-Philippe Mallet, Bérenger Soulages,
Mathilde Michel & Franck Diemer, Lebanon & France

Introduction

Endodontic retreatment is generally considered the first-choice option when failure of an initial treatment occurs. The presence of bacteria and their by-products embedded in the failing obturation material and in canal intricacies is often linked to the loss of integrity of the hermetic seal of the initial filling, leading to the spread of post-treatment disease. It is therefore of utmost importance to remove all the root canal filling material effectively prior to negotiating the canals to their full extent.

Several techniques and instruments have been proposed to remove gutta-percha, including hand files or mechanical instruments or a combination of both. Nowadays, manual files are generally regarded as time-consuming and the current trend is towards more efficient tools, such as rotary instruments. Since the beginning of the 2000s, specific endodontic files have been designed to improve the removal of gutta-percha. R-ENDO (COLTENE MicroMega) was the first sequence available, followed rapidly by ProTaper Universal Retreatment (Dentsply Sirona). These two sequences have three files and are used with the crown-down technique. Later, many systems were developed by several companies, such as D-Race from FKG Dentaire, Mtwo R from VDW and Endo ReStart from Komet, and these presented different profiles, cross sections and recommended techniques.

Moreover, several developments have marked the last two decades and changed the way we practise endodontics, among them the single-file concept and the heat treatment process. The response to the increasing demand by dental clinicians for a simplified process led to new shaping systems with a single file. The aim was to replace multiple-file systems in the initial canal treatment, but it was later recommended for retreatment too.

The advent of new manufacturing processes, such as surface finishing or heat treatment, aiming to upgrade the

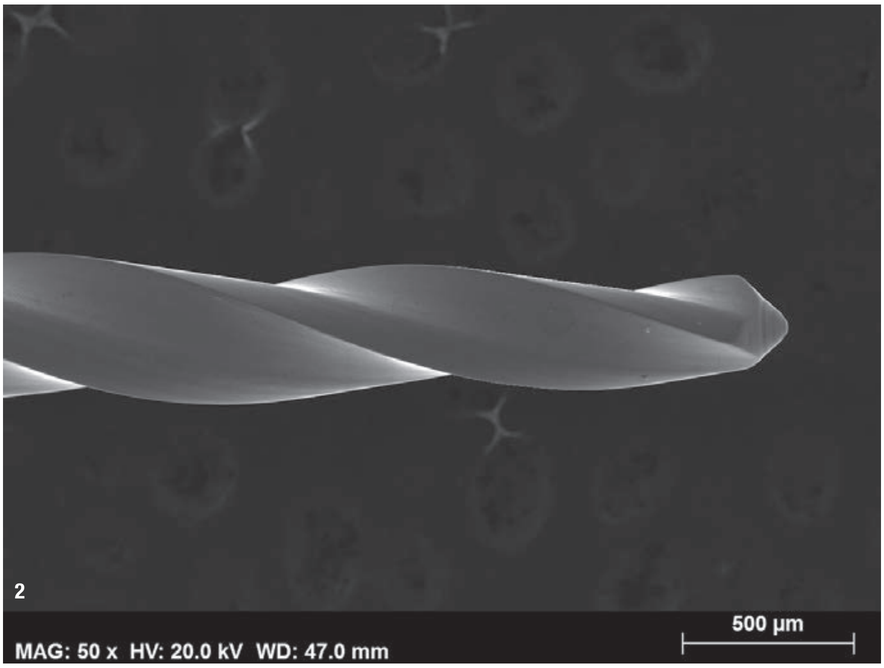


Fig. 1: Remover for the HyFlex and MicroMega file systems. *(Image: © Coltène/Whaledent)* **Fig. 2:** Scanning electron microscope image of the tip of the Remover. *(Image: © Franck Diemer)*

Figs. 3a–h: Retreatment of a tooth #46 pre-op radiograph **(a)**; the Remover is positioned at the entrance to the mesiolingual canal **(b)** and is progressively advancing into the gutta-percha **(c)**; pathway created by the Remover after its first central advance into the gutta-percha **(d)**; mesial canals after shaping and mechanical irrigation (2Shape TS2 and F35 finishing files, COLTENE MicroMega) **(e)**; pre-op radiograph to check the master cones **(f)**; post-op radiograph centred **(g)**; post-op radiograph offset **(h)**. *(Images 3–4: © Jean-Philippe Mallet)*

mechanical performance of nickel–titanium (NiTi) files led to new file systems that are more flexible and more resistant to cyclic fatigue. The Remover (COLTENE) has benefited from all these technological advances and concepts for removal of obturation material.

Removal of different sealers

A retreatment file is supposed to go through the deficient obturation material and remove it from the canal. This material generally includes a core material (gutta-percha) sealed to the canal walls with a fine film of endodontic sealer. Different types of sealers have been used over the years. Historically, zinc oxide eugenol sealers were the first, but many others have been proposed to improve different properties of the sealer. These include resin-based sealers to improve the hermetic seal and adhesion to the canal walls; silicone-based sealers, which are well tolerated by tissue and have low water resorption; epoxy resin-based sealers for the possibility of adhesion to dentine and lower rates of water solubility; sealers based on mineral trioxide aggregate which have a predilection towards mineralisation; calcium silicate sealers, commonly referred to as “bioceramics” owing their excellent biological properties; and calcium phosphate and calcium-enriched mixture sealers with

Fig. 4: Photograph of the shavings created by the Remover.

the potential to promote bone regeneration and induce cementogenesis.

The purpose of such an instrument would therefore be to remove the initial obturation material, paving the way for access to the non-instrumented area with conventional NiTi instruments and thus proper reshaping of the canal space. The Remover has benefitted from state-of-the-art technology in material processing and long experience in file design and has been developed by COLTENE in response to the dental community's increasing demand for a means of safe, simple and swift removal of gutta-percha in retreatment procedures.

This unique instrument (Fig. 1) boasts numerous specifications and technical characteristics, including:

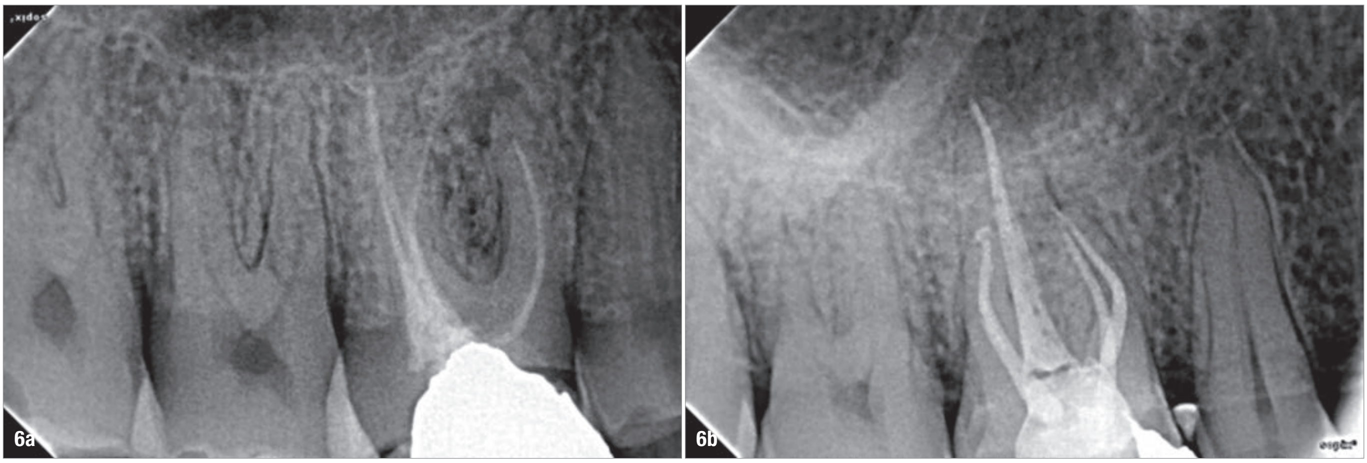
Figs. 5a & b: Teeth #21 and #22 requiring retreatment: pre-op radiograph **(a)**; post-op radiograph **(b)**. *(Images 5–6: © Walid Nehme)*

– a non-cutting tip of 30/100 mm, allowing safe use in curved canals (Fig. 2);
– a variable triple-helix cross section, symmetrical in the first 3 mm then asymmetrical towards the shaft;
– a 7 % taper limited to the first 10 mm and followed by a 0 % taper towards the shaft in order to preserve periradicular dentine; and
– a proprietary thermomechanical process called C-wire, entailing electropolishing and heat treatment and increasing flexibility and cyclic fatigue resistance.

Preparation—technique for use

Once the access cavity has been reopened canal entrances located and gutta-percha confirmed to be the canal filling material, an orifice modifier (HyFlex EDM, COLTENE; or One Flare, COLTENE MicroMega) can be introduced into the gutta-percha for 2–3 mm on continuous rotation at a speed of 400–800 rpm. This instrument is used to create a pilot hole, guide the engagement of the Remover inside the gutta-percha and achieve a straighter access. The Remover should be used in continuous rotation at 400–800 rpm and 3.0–3.5 Ncm with very light apical guidance. The 19 mm Remover is introduced into the opening created by the opener and moved in an apical direction over a distance of 2–3 mm until slight resistance to inward movement is felt, and then it should be pulled out while leaning on selective canal walls to dislodge all the gutta-percha. In general, all the filling material can be removed with a series of three to four in and out motions in a downwards apical direction (Figs. 3a–h). The removed material usually comes out in small shavings (Fig. 4), but also as a mass of gutta-percha. The removal of the filling material must be followed by copious irrigation in order to wash away all the debris and sealer residue. Once all the filling material has been removed, scouting and glide path creation can be carried out using manual or NiTi files. Standard reshaping instruments such as 2Shape, One Curve (COLTENE MicroMega), or HyFlex CM or EDM (COLTENE) can now be used to clean and shape the non-filled canal space and to ensure the smooth transition between previously filled and unfilled portions. Clinicians must keep in mind that a continuously tapered preparation is essential for 3D obturation.

When clinical and radiographic diagnoses indicate retreatment of a case showing obturation material reaching the apical area, the clinician is advised to limit the use of the Remover to 2 mm short of the estimated working length. The objective is to prevent potential overextension of filling material into the periapical area. The filling material in the last 2 mm can be carefully and securely removed with manual files. Once all previous material has been removed, the cleaning and shaping can be undertaken using standard NiTi shaping instruments (Figs. 5a & b).



Figs. 6a & b: Pre-op radiograph of a maxillary first molar presenting with periapical periodontitis with a forgotten canal in the mesiovestibular root **(a)**. Post-op radiograph after filling removal with the Remover, cleaning and shaping with the 2Shape and apical finishing with the F40 (0.40 tip and 4 % taper) in palatal and distobuccal canals **(b)**.

Flexible retreatment

The Remover is available in two lengths: 19 and 23 mm. A large number of cases can be addressed with 19 mm files. If the 19 mm Remover does not reach the full extent of the filling material, the 23 mm file can be used to make up for the missing millimetres.

This new instrument, specifically designed for endodontic retreatments, embodies the current concepts in endodontics and uses the most recent advances in technology (asymmetry, electropolishing and heat treatment). The diameter of the wire of the Remover is only 1 mm, which makes it smaller than that of the majority of reshaping or retreatment instruments. Moreover, it allows for minimally invasive removal of filling material while ensuring increased blade flexibility.

It is a single-use instrument; however, removing the filling material from two teeth in the same patient is possible. In this case, the instrument should be carefully inspected after use and discarded when unwinding occurs.

Conclusion

This instrument allows the removal of gutta-percha canal filling swiftly, thoroughly and safely, transforming this difficult procedure into a more predictable and easier task. Finishing the preparation size and taper varies according to the anatomy of each clinical case. Clinicians should keep in mind that the size and taper of the selected final shaping file should allow a total elimination of the filling material and the cleaning and shaping of the apical third. This step should obviously be accompanied by abundant irrigation and activation of the irrigants using specifically designed ultrasonic generators and tips such as EndoUltra (COLTENE MicroMega). Thorough cleaning and shaping complete the retreatment procedure, facilitate the 3D obturation and promote a successful root canal therapy outcome.

about

Prof. Walid Nehme is a clinical professor in the department of endodontics of Saint Joseph University of Beirut in Lebanon, where he received his DDS in 1988 and MSc in 1994. His academic activities lie in undergraduate and postgraduate education in endodontics and focus on clinical training and practice and supervision of research projects. He runs postgraduate endodontic courses and hands-on courses in the Middle East, Africa, Europe and Canada. Prof. Nehme works in a referral-based practice limited to endodontics in Beirut and Abu Dhabi in the UAE. He is an analyst and opinion leader for clinical trials for endodontic manufacturers and has contributed to the development of new files and devices in endodontics. He has published scientific and clinical articles in peer-reviewed journals nationally and internationally on such subjects as root canal anatomy, instrumentation techniques, NiTi files, irrigation procedures, obturation and retreatment. He is a fellow of the International College of Dentists, an international member of the American Association of Endodontists, a council member of the Asian Pacific Endodontic Confederation, a founder member and a past president of the Arab Endodontic Society, and a past president of the Lebanese Society of Endodontology.

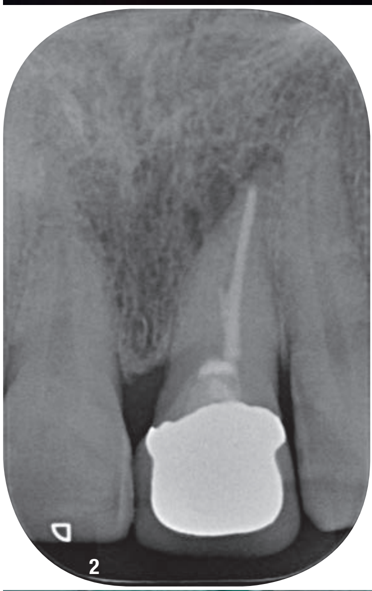
contact

Prof. Walid Nehme
Space 2 Center
New Jdeiden Street
Beirut
Lebanon
walidnehmeendo@gmail.com

One-step post and core build-up of an endodontically treated tooth

Dr Giancarlo Pongione, Italy

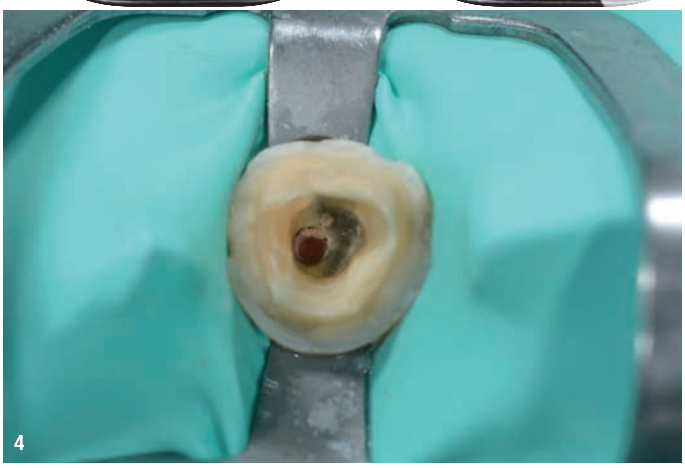
Figs. 1a & b: Initial situation: intra-oral view **(a)**; extra-oral view **(b)**.



Case presentation

A 48-year-old patient came to our dental clinic because she wanted a more beautiful smile. Her central incisors had a tooth size discrepancy because of incisal wear. Tooth #21 had suffered trauma in the past and had been treated with a porcelain-fused-to-metal crown that did not match the adjacent teeth (Fig. 1).

Radiographic examination of that tooth showed that the root canal was slightly underfilled and a persistent apical radiolucency was present (Fig. 2). The decision



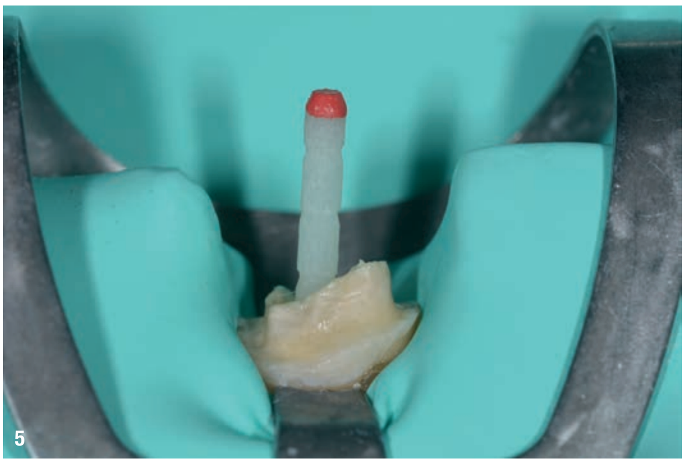


Fig. 2: Radiograph of the initial situation: a persistent apical radiolucency and slightly underfilled root canal can be seen at tooth #21. **Fig. 3:** Radiograph after endodontic retreatment of tooth #21. **Fig. 4:** Coronal view before post insertion. **Fig. 5:** Fit of the glass fibre post.

Fig. 6: After the core build-up. **Fig. 7:** After preparation of teeth #11 and 21 for a veneer and crown, respectively. **Fig. 8:** Lithium disilicate restorations. **Figs. 9a–c:** Result after treatment: intra-oral view **(a)**; extra-oral view **(b & c)**.

was made to do an endodontic retreatment and restore tooth #21 with a glass fibre post, core build-up and crown. A veneer on tooth #11 was planned as well in order to correct the shape and create symmetry.

For the post and core build-up, GRADIA CORE (GC) was chosen. The reason why GRADIA CORE was chosen is that it is a dual-cure composite that can be used as a luting cement and for a core build-up. Because of the thixotropy of the material, it easily retains its shape during the build-up. However, during insertion of the glass fibre post (Fig. 5), shear thinning occurs, which makes the material more fluid and easily adapted to the shape of the root canal. When the post space was prepared, an apical seal of 5 mm was left (Figs. 3 & 4).[1] The universal adhesive G-Premio BOND (GC) was used in conjunction with GRADIA CORE. Inside the root canal, it was mixed with the dual-cure activator (G-Premio BOND DCA, GC) to ensure proper polymerisation over the entire depth.

After the build-up, both central incisors were prepared (Figs. 6 & 7) for treatment with lithium disilicate restorations (Fig. 8). The end result was aesthetically pleasing: the restorations were fully integrated into the surroundings, and the patient was very satisfied with the appearance of her new smile (Figs. 9a–c).

Conclusion

A post and core build-up often entails a multitude of treatment steps. With GRADIA CORE, the luting and build-up material are contained in one product, simplifying the procedure considerably and minimising treatment errors, as all steps and components are optimally adjusted to each other.

Acknowledgement

The author would like to thank master dental technician Roberto Della Neve for his diligent work.

References

1 Abramovitz L, Lev R, Fuss Z, Metzger Z. The unpredictability of seal after post space preparation: a fluid transport study. J Endod. 2001 Apr; 27(4):292–5. doi: 10.1097/00004770-200104000-00016.

about

Dr Giancarlo Pongione obtained his DDM from the University of Rome Tor Vergata in Italy in 1991 and his PhD on the biocompatibility of dental materials from the University of Siena in Italy. Currently, he has private practices in Naples in Italy and Rome, specialising in aesthetic adhesive restorations and endodontics. In the past, he was a visiting professor at the Sapienza University of Rome. He has authored more than 90 articles on endodontics and aesthetic dentistry and has lectured at numerous national and international congresses. Dr Pongione is an active member of the Bio-Emulation Group, Italian Society of Endodontics and Società Italiana di Odontoiatria Conservatrice (Italian society of conservative dentistry), and a certified member of the European Society of Endodontology.

Turn back time

Remover facilitates endodontic retreatment

Whereas in the past an implant was the last resort, today, thanks to modern endodontics, many damaged teeth can be preserved. Together with the total number of cases, the number of retreatments in endodontic practices is growing, either because the clinical picture is different from what the referring dentist imagined it would be, or because the initial materials used have proved to be less durable. The uncomplicated removal of previous endodontic restorations has thus become part of the standard programme of reliable root canal therapy.

Remover file for safe preparation

COLTENE, a leading international developer and manufacturer of dental equipment and materials, is currently expanding its range of highly flexible nickel–titanium (NiTi) files to include special revision files. The new HyFlex REMOVER and MicroMega REMOVER 30/.07 perfectly match established file systems and remove insufficient gutta-percha fillings and similar outdated endodontic restorations in an instant. Thanks to their filigree shape, they adapt to the natural anatomy of the canal and efficiently loosen the existing dental material—without the need for additional solvents. At the same time, the remover files are gentle on the surrounding tooth structure; their non-cutting tip offers additional safety during preparation.

For a quick and thorough treatment, the subsequent use of the appropriate NiTi files is recommended for the optimal shaping of the root canal. Files with a .07 taper are now available in the lengths 19 mm and 23 mm in well-stocked dental depots. They fit seamlessly into the range of individually designed special files from COLTENE, such as the HyFlex CM and EDM or the MicroMega 2Shape and One Curve files.

Full support for the practice

On the COLTENE website, or on one of the innovation leader's social media channels, interested dentists can find out about the latest trends and ideas in the dental world. In addition, COLTENE offers a wide range of training courses and practical workshops in order to ensure the optimal use of technical and digital aids. In this way, even endodontic beginners will be able to achieve competent and efficient preparation quickly.

www.coltene.com

Septodont

Biodentine and ART: Minimising droplets and aerosol generation

In the current difficult times, healthcare professionals are on the front line and doing their best to continue to provide dental care to patients. At Septodont, we are committed to doing everything we can to support dental practitioners worldwide. To protect the health of dental practitioners around the globe, procedures that avoid the spread of viral particles, via aerosol generation, should be preferred. Some conditions can be managed with minimal intervention procedures and without, or at least little, aerosol generation. A minimal intervention dentistry procedure is aimed at maintaining the vitality of the pulp, as supported by the European Society of Endodontology.

Atraumatic restorative treatment (ART) is relevant in this regard: the objective is to remove dental caries by using only hand instruments without a drill and turbine while preserving the tooth structure as far as possible and generating little to no aerosol.

Why choose Biodentine with the ART procedure?

Clinical data has demonstrated similar success rates during pulp capping procedures with Biodentine with manual removal of the soft dentine and round carbide burs on a slow-speed handpiece. In addition, Biodentine provides several benefits when used with the ART procedure: · limitation of bacterial propagation (pH = 12); · biocompatibility; · bioactivity; · resistance/compressive strength; · good adhesion; · a short setting time; · a bio-bulk fill approach; and · no staining.

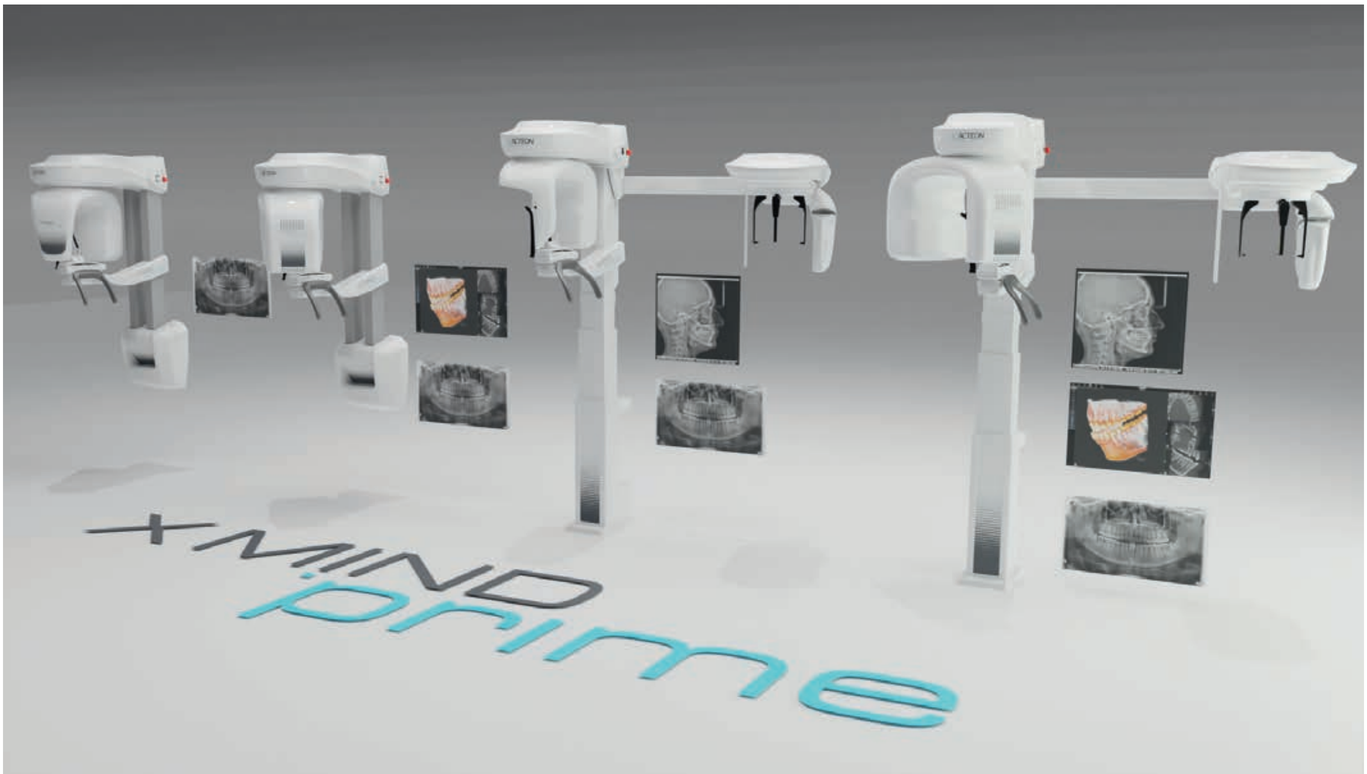
Thanks to its biological and bioactive properties, Biodentine can be placed directly on to the pulp and used for filling any areas of deep caries. For this procedure, it is recommended that the final enamel restoration be placed in the same session in order to avoid a second appointment and the use of the drill during that second appointment. Launched nearly ten years ago, Biodentine has proved itself a reliable product for vital pulp therapy. Acknowledged by more than 700 publications worldwide, Biodentine has allowed dentists to save millions of teeth around the globe.

www.septodont.com

Dedicated configuration for any clinic

ACTEON X-Mind prime family expands

The ACTEON X-Mind prime range has been extended with two new cephalometric configurations, the X-Mind prime 2D-CEPH and the X-Mind prime 3D-CEPH, expanding the fields of application of the device to orthodontic analysis and improving diagnosis and treatment planning. The line can now offer a dedicated configuration for any clinical need, from the most basic panoramic image only to the most complete panoramic/CBCT/cephalometric one, guaranteeing a state-of-the-art implementation of the internal technology and presented in the stylish and compact design which characterises the whole range.



Premiered in September 2020, the new CEPH configurations now complete the ACTEON X-Mind prime family and retain the same key concepts of the other members. X-Mind prime devices are designed to fit any environment with their minimalistic and compact design, which, combined with their outstanding ease of operation, provides the operator and patient with the best examination experience available.

The unique innovative and effortlessly mounted solution, combined with a lightweight framework and a compact footprint, make X-Mind prime CEPH one of the easiest and most complete extra-oral solutions for any dental practice.

The new cephalostat, specifically designed for optimising patients' comfort and stability, and the smart Frankfurt plane reference integrated in the ear rod ensure quick and precise patient positioning.

Its patented collimation system allows up to 17 different cephalometric program selections, including new reduced size modes, which ensure a perfect assessment of the region of interest at the lowest radiation dose.

X-Mind prime CEPH continues the tradition of the unmatched ease of use of the X-Mind prime product line, thanks to the user-friendly interface of its virtual control panel, which leads the user through all of its functions in just a few simple steps.

The use of a state-of-the-art digital sensor, combined with the high performance of ACTEON Imaging Suite software, ensures superior image quality.

ACTEON

www.acteongroup.com

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.

www.fkg.ch

Cell type atlas

New research may expedite regenerative dentistry

Understanding of cell types and the mechanisms of dental growth is essential for the reconstruction and engineering of teeth. Therefore, researchers from Karolinska Institutet in Stockholm have investigated the cellular composition of growing and non-growing mouse and human teeth. They believe that the new data on the cellular make-up and growth of teeth could accelerate developments in regenerative dentistry and in the treatment of tooth sensitivity.

Even though major tooth cell types have long been identified, the spectrum of various tooth cells and stem cells, their differentiation, and the interactions that enable tooth growth remain poorly understood. Teeth develop through a complex process in which soft tissue, with connective tissue, nerves and blood vessels, is bonded with three different types of hard tissue into a functional body part.

In contrast to humans, whose teeth are completed before adulthood, mice and many other species have teeth which continue to grow throughout life. The incisor stem cell population in mice continuously self-renews and replenishes tissue that is lost owing to gnawing, making this model attractive for studies of stem cell generation, cell differentiation and injury-induced regeneration.

Using a single-cell RNA sequencing method and genetic tracing, the researchers examined the characteristics of growing mice incisors, compared them with non-growing mice molars and evaluated the extent to which the mouse model reflects the growth of human teeth. In this manner, the researchers at Karolinska Institutet, in collaboration with the Medical University of Vienna in Austria and Harvard University in the US, identified and characterised all cell populations in mouse teeth, in young growing human teeth and in adult human teeth.

In addition, the findings might explain complex aspects of the immune system in teeth and help in understanding the formation of tooth enamel.

Editorial note: The study, titled "Dental cell type atlas reveals stem and differentiated cell types in mouse and human teeth", was published online on 23 September 2020 in Nature Communications.

Low-risk dentistry vs high-risk dentistry

Dr Miguel Stanley, Portugal

Patients usually do not think of dentistry as being of low risk or high risk from a medical perspective. When visiting the dentist, a patient would expect that the dentist knows exactly what he or she is doing and that it is relatively safe to undergo the treatment proposed. Most dentists graduate with an understanding of the basic concepts of general dentistry and are fully capable of performing a wide array of treatments. In my humble opinion, the problem of risk lies in the nature of dentistry itself, and I have spent a great deal of time thinking about this.

Let us consider the profession. Dentists come in many different forms: cosmetic dentists, prosthodontists, periodontists, orthodontists, endodontists, general practitioners, oral surgeons, implantologists, paediatric dentists and others. It is difficult for the public to differentiate one from the other, and moreover, a general practitioner (GP) can perform most dental procedures if well trained. Let us look at it this way: when a patient goes to the hospital, he or she is directed to a specialist in the part of the body that has the problem. That specialist is usually highly trained and has the resources in his or her department to treat that part of the body. You will never see a medical GP operating on a patient's heart or an orthopaedic surgeon operating on a patient's brain.

Like the body, the oral cavity should be seen as consisting of parts: hard tissue, soft tissue, nerves, bone, teeth, mechanics and muscles. A myriad of problems can occur in the oral cavity. You can have biological issues such as infections, mechanical issues such as fractures or abrasions, and of course, your teeth create one of the most important things connected to our emotions: the smile. So why should we expect a GP to solve all these problems?

To make matters more complicated, any dentist is legally allowed to perform hundreds of different procedures. From a simple cleaning all the way up to extracting every single tooth in a patient's mouth and replacing them with dental implants and new laboratory-made teeth. This is actually quite a crazy concept when you think about it. It is like having a driver's licence that will allow you to drive a motorbike, a car, a truck, an 18-wheeler, an aeroplane and a jet. It is very unlikely that anyone could be good at all these things.

This is a global phenomenon, and it is no different in the US, despite having very specialised dentists in each discipline. Recent studies show double-digit growth of the GP market in terms of implantology, orthodontics and cosmetic dentistry that are now powered by digital technologies such as digital smile design, clear aligners and guided implant surgery. In a recent analysis published by the American Dental Association's Health Policy Institute, of the 198,517 practising dentists in the US in 2017, 156,992 (the majority at 79 %) are GPs, 7,546 oral and maxillofacial surgeons, 5,664 endodontists, 10,658 orthodontists, 7,778 paediatric dentists, 5,790 periodontists and 3,708 prosthodontists, and 426 work in oral and maxillofacial pathology, 827 in public health dentistry, and 144 in oral and maxillofacial radiology.[1] This calculation counts a dentist toward each practice area for which he or she holds a degree. For example, a dentist possessing degrees in orthodontics and paediatric dentistry is counted in both categories. According to these figures, there were 1,007 dentists with multiple specialty degrees. Nevertheless, although dentists tend to obtain a specialty degree, if we compare the number of general dentists to the number specialists in 2001 and 2017 in the US, there is evident growth in the number of GPs: from 130,775 in 2001 to 156,992 in 2017.[1] The most popular specialty in the US is orthodontics, and in 2001, there were 9,265 orthodontists, compared with 10,658 in 2017.[1]

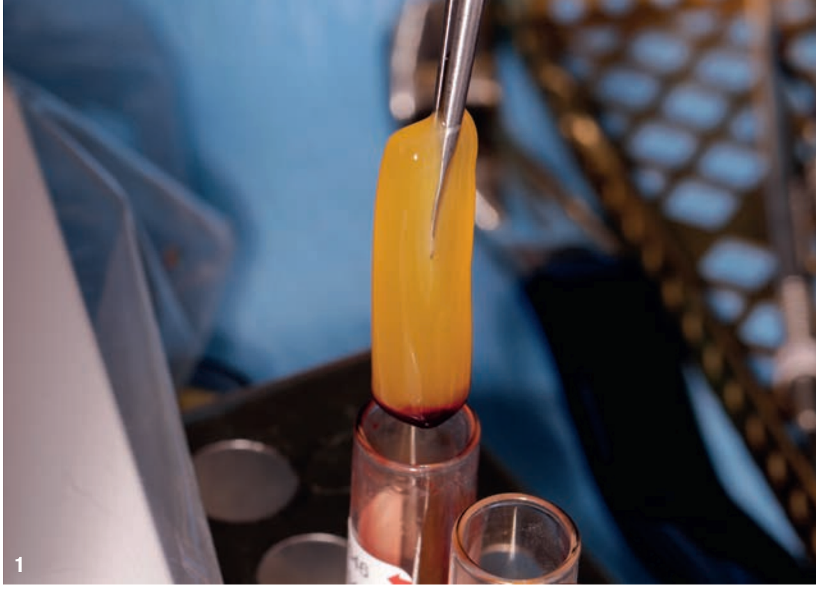
Since there is no true quality control oversight in dentistry except for our personal ethics, if the patient demands a procedure that the dentist is legally licensed to perform, but technically inexperienced in doing so, yet there is a financial reward for conducting it, the risk of things going wrong is quite high. This begins to explain the fine line between high-risk and low-risk dentistry.

The American Academy of Oral Medicine (AAOM) developed a risk assessment that affirms that the patient evaluation process requires inclusion of determination of risk associated with dental treatment, as it is essential for the delivery of safe and appropriate dental care as well as the overall health of the patient. AAOM classifies high-risk treatments according to the patient's age and the potential for infections and complications, among others.[2] Nevertheless, it does not consider the experience of the treating dentist, the technologies that the clinician is using or even the time the dentist has in which to perform the treatment.

In dentistry, it is my understanding that the higher the degree of complexity of treatments you carry out, the more technology and materials you need, and the more experienced and trained your team must be. For this reason, most clinics that offer high-end dentistry usually have a large team and invest significantly in technology and materials.

Once you move into the realm of dental aesthetics, you are entering into an emotional relationship with your patient; unless you are able to deliver what the patient desires, you will encounter complications down the road. It requires an expert cosmetic dentist and a great dental technician to ensure that the patient is happy. I consider most complex aesthetic dental work in the anterior area to be high risk in nature.

Implant dentistry has been growing in double digits for years, around the globe. It is not something that should

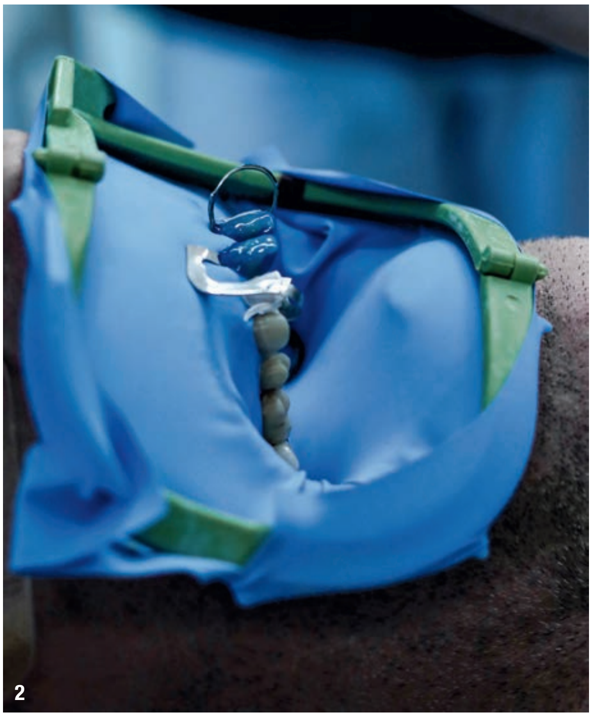


1

Fig. 1: Use of platelet-rich fibrin to accelerate wound healing after extraction and to avoid alveolitis.

be taken on lightly and requires a great deal of training and technology. No matter how simple a procedure might be, I consider this field to be high risk. There are so many things that can go wrong, and the fact that in many cases the surgeon is not the one doing the restorative work can lead to complications. All it takes is poor positioning of the implant to really create a huge headache for the restorative team. When things go wrong, who is to blame? Restorative work too is high risk, but thankfully, digital technologies are here to provide better solutions to this problem with guides and immediate preoperatively milled temporary restorations.

Complex root canal therapy usually requires a microscope, expensive rotary instruments and a highly trained professional, and it can sometimes take many hours to ensure



2

Fig. 2: Use of dental dam isolation and ozone therapy to guarantee elimination of any bacteria.

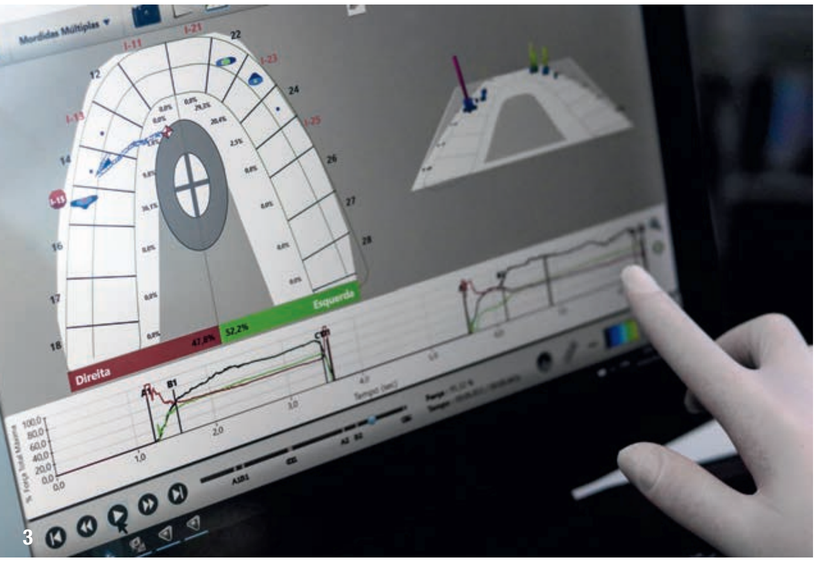


Fig. 3: Use of Tekscan technology to obtain a more precise adjustment of the occlusion in oral rehabilitation.

the correct quality of an endodontic treatment. Consider root canal therapy of a second molar with five canals and a complex anatomy. This cannot be seen as a simple procedure, and so I consider this to be a high-risk dental treatment. There are obviously, by this measure, many more interventions that can be considered high risk in nature; the ones I have given are a just a few classic examples.

Low-risk dentistry refers to all the procedures that a relatively inexperienced dentist, as long as he or she is given the necessary amount of time for treatment and the right instruments and technology, can perform with relative safety for the patient and with an optimal outcome from a clinical standpoint. This of course only happens when following a gold standard protocol.

Some examples are:
- Simple direct restorations: when using dental dam isolation and respecting the right bonding steps, manipulation and photopolymerisation of the composite, and occlusal adjustments
- Simple extractions: when employing an atraumatic technique, performing the right curettage, eliminating infection if present, and giving the right postoperative recommendations for optimal healing and thus avoiding complications such as alveolitis
- Oral hygiene: when employing the right diagnostics, performing the correct steps to ensure all calculus and biofilm are removed, and motivating the patient to maintain a good oral health—these things take time, as stated in the Slow Dentistry philosophy
- Bleaching in office and with take-home trays: when using the right concentration of the bleaching product and following the recommendations of the manufacturer
- Emergency root canal therapy: when using dental dam isolation and performing proper cleaning and instrumentation of the canal
- Crowns and bridges: when following the right guidelines and procedures of preparation, impression taking, cementation and occlusal adjustments, not to mention fit.

Figs. 4 & 5: Technologies such as intra-oral scanners and microscopes are important tools that facilitate our work as dentists, helping us perform more precise work. Nevertheless, both require time to learn to use them properly.

5

Of course, also included are any other procedures that have little impact for the patient or the dentist if things go wrong and for which arising problems can be easily remedied. I see so many simple restorations create such huge headaches due to rushed treatment and a poor protocol.

Nevertheless, although complex risky procedures should be performed by highly trained dentists, nowadays, with the development of new technologies in the dental field, it is easier to perform high-quality complex dentistry even if you are a GP without a specialty degree.

One the one hand, it is important to understand that it requires time to learn how to use technologies in the dental practice and manage costs, and dentists should not consider a quick training session from a sales person to be the same as a proper accredited course.

On the other hand, the dentist’s experience and knowledge as well as the application of high-quality materials at the right time can be influencing factors in the performance of dental treatments, making them more or less risky. One example is the placement of a crown or bridge, even if it is out of the aesthetic zone. This is a common procedure that has all the risk factors. If the dentist knows how to employ a minimally invasive approach, such as Pascal Magne’s,[3] using high-quality materials, has the requisite time for treatment and works with a great laboratory, what would otherwise have been considered a high-risk treatment would then be a low-risk one.

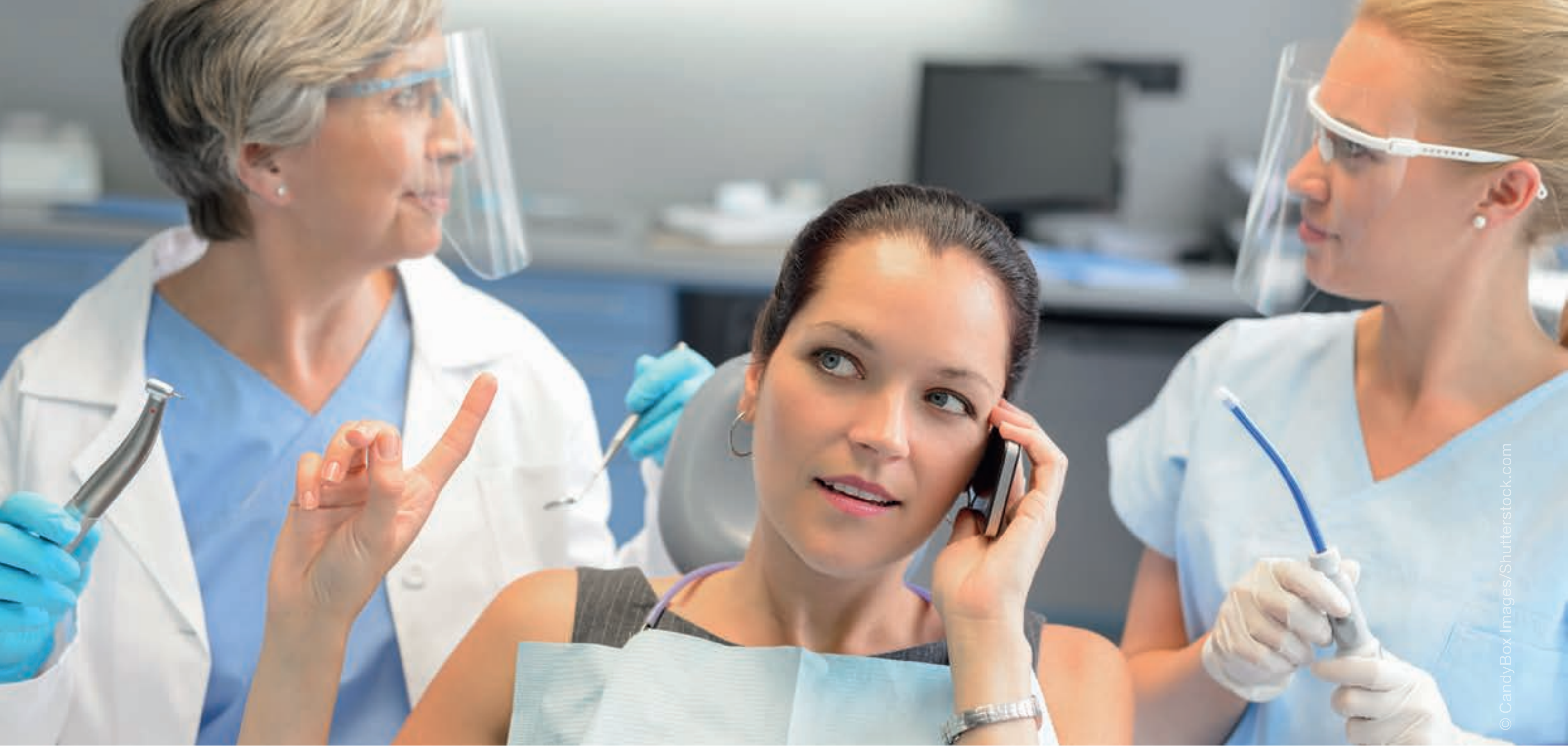
To sum it all up, I believe that the development of technologies will help and assist GPs and less skilled dentists to perform high-quality dentistry. Things are rapidly progressing, and artificial intelligence is coming to help us better diagnose and plan. Yet, for those like myself who are managing teams and trying to get the best out of each clinician, from the planning of a treatment sequence, which is key to achieving perfect results, we can now rely on the cloud to help us work with teams in other parts of the world, and delegate responsibilities by ensuring that the quality of the treatment plan is perfect.

I believe that, if dentists work in teams, surrounded by good materials and technology, they can work more safely and practise higher-quality dentistry as a standard. It is up to universities to ensure that the ethical boundaries of business practice and dental practice are never blurred. Science and dentistry must always win over pure profit, and a well-managed team can do both.

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

contact

Dr Miguel Stanley
Rua Dr. António Loureiro Borges,
ed. 5, 1º Andar
Arquiparque
Miraflores
1495-131 Algés
Portugal
info@whiteclinic.pt



Successful communication in your daily practice

Part XIII: How to deal with rude patients

Dr Anna Maria Yiannikos, Germany & Cyprus

Hi! My name is Dr Anna Maria Yiannikos. Today, I present you the thirteenth part of this popular series, packed with communication protocols for your clinic or practice. This series covers the most common and challenging scenarios that might arise in your dental practice and presents successful ways to manage them in order for you to enjoy greater peace of mind and to reach another level regarding your experiences with patients. Each article of this series teaches you a new, easy-to-use protocol which can easily be applied and implemented into your own dental clinic's workflows and procedures right from the outset.

Have you ever wondered what the essential ingredients are for solving problems that you might encounter in the day-to-day interaction with patients? I'm here to teach you. There are plenty of issues—many of which we have already thoroughly discussed in previous parts of this series—which might put you in a difficult position, possibly even make you lose sleep, or lead to your self-confidence being seriously shaken. Imagine the feeling that you are able to overcome every problem that you could possibly face and that you can properly serve your patients by offering them the best solutions for their medical or aesthetic problem. How amazing would that be? Because let's face it: we are not only dentists, but also entrepreneurs, and we have to look at our clinics and dental practices as businesses that we have to run. Are you ready to find solutions for all of these problems?

Today's challenging topic is: how to deal with difficult and rude patients. Do you feel anxious and stressed out every time they visit your practice, or do you grow increasingly nervous with each day an appointment with a rude patient is drawing nearer in your calendar? Do not despair—in the following I will teach you five crucial and practical steps that will help you to stay calm and focused when faced with a difficult situation involving a rude and/or impolite patient.

5 essential steps

1. Think before you speak

Being the leader of a dental clinic, engaging in conflict with your patients is never a good idea. You should therefore always give yourself a moment to reflect and think about the situation you're in before you start to speak. Allow yourself time to consciously breathe in order to balance yourself and take control of the interaction. Envision yourself as the conductor of an orchestra who is responsible for making the individual players follow your desired path. It is vital that you never ever engage in a discussion or start treatment on a patient if you are angry about him or her, or about the situation involving this particular patient.

2. Don't take anything personally
Rude or impolite patients are mostly angry with themselves, rather than with you—their dentist. Remember that it is only human to project one's self-discontent onto others. Whatever these patients say to you, it is most likely something that only has more to do with themselves, rather than with you or with something you might have done wrong. Here's a trick: try to imagine these patients as being physically very small before and during your encounter with them. In this way you will be able to take control of situations like these more efficiently.

3. Be proactive
Be sure to send out the treatment protocols of rude patients immediately after having finished their treatment sessions. Here's why: usually, these types of patients have issues with trust. Being rude or impolite is often only a protective shield protecting them from being hurt or disappointed. It is therefore vital to do everything you can in order to make them feel safe, and to show them that they have no reason to be suspicious.

4. Be brave, be vocal!
If patients are being rude to you—be brave and call them out on it! Figure out what could be the worst possible scenario while assessing the situation. With this risk management tip, you will immediately be able to acknowledge the fact that you could master any arising circumstance. Express your feelings verbally and tell your patient that he or she is being rude to you. You might be surprised about how ignorant the other person is towards the entire situation. Listen to what they have to say in defence. Show empathy and react with phrases like 'I understand you', instead of saying 'you are right'. It would be a pity to not see the forest for the trees!

5. Be calm and humane
Good interpersonal skills are essential for building lasting relationships. Therefore, always speak the truth without letting hurt feelings get in your way. Try to get to the bottom of a concrete issue by asking your patient questions, sit down with him or her and work out a solution that works for the both of you. A true win-win situation. At the end—make a gesture. For instance, offer your patient a warm handshake to show your positive attitude towards resolving the problem and departing with him or her on good terms.

How easy was that, right?

Use the above-mentioned steps as a protocol in your daily practice and you will soon notice that you are in control again and have greater peace of mind. With these five steps at your disposal, you will know exactly how to resolve a difficult problem and how to establish a customer-oriented service culture. In addition, I am confident that—if implemented correctly—these tips will help you achieve a significant increase in income. Just try it and feel free to share your thoughts with me!

I am sure that you are looking forward to the next issue of roots **magazine** with great anticipation, where in the fourteenth part of this series I will take a deep dive into yet another fascinating topic, namely: how to reject a patient (politely) without putting the reputation of your practice in jeopardy as a consequence. I will present you with the five most important steps that will help you remain calm and balance your stress levels. Until then, remember that you are not only the dentist at your clinic but also its manager and leader.

In case you have any questions or requests, if you would like to have further information on this topic, or if you simply need guidance in solving certain situations, don't hesitate to get in touch by e-mailing me at dba@yiannikosdental.com or visit our website, www.dbamastership.com. I am looking forward to our next step towards business growth and educational development. Let's keep in touch!

Part XII of this series: "Turning medical tourists into loyal patients" will appear after the restrictions related to the ongoing global pandemic are lifted.

about

Dr Anna Maria Yiannikos (DDS, LSO, M.Sc., MBA) is one of the first two women worldwide to have obtained a master's degree in laser dentistry. She has owned a dental clinic for 30 years now and leads the innovative Dental Business Administration Mastership Course at RWTH Aachen University in Germany. She is an adjunct faculty member of the Aachen Center for Laser Dentistry.

contact

Dr Anna Maria Yiannikos
Adjunct Faculty Member of AALZ at RWTH Aachen
University Campus, Germany
DDS, LSO, M.Sc., MBA
dba@yiannikosdental.com
www.dbamastership.com

How to send us your work

© 32 pixels/Shutterstock.com

Please note that all the textual components of your submission must be combined into one MS Word document. Please do not submit multiple files for each of these items:

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

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

Text length

Article lengths can vary greatly—from 1,500 to 5,500 words—depending on the subject matter. Our approach is that if you need more or fewer words to do the topic justice, then please make the article as long or as short as necessary.

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

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

Text formatting

We also ask that you forego any special formatting beyond the use of italics and boldface. If you would like to emphasise certain words within the text, please only use italics (do not use underlining or a larger font size). Boldface is reserved for article headers. Please do not use underlining.

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

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

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

Image requirements

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

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

In addition, please note:

- We require images in TIF or JPEG format.
- These images must be no smaller than 6 x 6 cm in size at 300 DPI.
- These image files must be no smaller than 80 KB in size (or they will print the size of a postage stamp!).

Larger image files are always better, and those approximately the size of 1 MB are best. Thus, do not size large image files down to meet our requirements but send us the largest files available. (The larger the starting image is in terms of bytes, the more leeway the designer has for resizing the image in order to fill up more space should there be room available.)

Also, please remember that images must not be embedded into the body of the article submitted. Images must be submitted separately to the textual submission.

You may submit images via e-mail, via our FTP server or post a CD containing your images directly to us (please contact us for the mailing address, as this will depend upon the country from which you will be mailing).

Please also send us a head shot of yourself that is in accordance with the requirements stated above so that it can be printed with your article.

Abstracts

An abstract of your article is not required.

Author or contact information

The author's contact information and a head shot of the author are included at the end of every article. Please note the exact information you would like to appear in this section and format it according to the requirements stated above. A short biographical sketch may precede the contact information if you provide us with the necessary information (60 words or less).

Questions?

Magda Wojtkiewicz
(Managing Editor)
m.wojtkiewicz@dental-tribune.com

SUBSCRIBE NOW!

DTI—international magazine subscriptions

dti Dental Tribune International

I would like to subscribe to:

CAD/CAM dental labs
2 issues per year

- ☐ e-paper €5.50 per issue
- ☐ e-paper €10 annual subscription
- ☐ print €30 annual subscription

ceramic implants
2 issues per year

- ☐ e-paper €5.50 per issue
- ☐ e-paper €10 annual subscription
- ☐ print €30 annual subscription

cosmetic dentistry
1 issue per year

- ☐ e-paper €5.50 per issue
- ☐ print €15

digital dentistry
4 issues per year

- ☐ e-paper €5.50 per issue
- ☐ e-paper €20 annual subscription

implants
4 issues per year

- ☐ e-paper €5.50 per issue
- ☐ e-paper €20 annual subscription
- ☐ print €46 annual subscription

ortho
2 issues per year

- ☐ e-paper €5.50 per issue
- ☐ e-paper €10 annual subscription
- ☐ print €30 annual subscription

prevention
2 issues per year

- ☐ e-paper €5.50 per issue
- ☐ e-paper €10 annual subscription
- ☐ print €30 annual subscription

roots
4 issues per year

- ☐ e-paper €5.50 per issue
- ☐ e-paper €20 annual subscription
- ☐ print €46 annual subscription

www.dental-tribune.com/shop/

Full Name

E-mail

ZIP | City | Country

Address

Credit Card Number | Expiration Date | Security Code

Date | Signature

Dental Tribune International GmbH
Holbeinstr. 29 | 04229 Leipzig | Germany

Tel.: +49 341 48 474 302
Fax: +49 341 48 474 173

www.dental-tribune.com
info@dental-tribune.com

Terms & conditions: Subscriptions will be renewed automatically every year until a written cancellation is sent to Dental Tribune International GmbH, Holbeinstr. 04229 Leipzig, Germany, six weeks prior to the renewal date. All prices include VAT, shipping and handling.

roots

international magazine of endodontics

Imprint

Publisher and Chief Executive Officer
Torsten R. Oemus
t.oemus@dental-tribune.com

Managing Editor
Magda Wojtkiewicz
m.wojtkiewicz@dental-tribune.com

Designers
Franziska Schmid

Copy Editors
Sabrina Raaff
Ann-Katrin Paulick

International Administration

Chief Financial Officer
Dan Wunderlich

Chief Content Officer
Claudia Duschek

Clinical Editors
Nathalie Schüller
Magda Wojtkiewicz

Editors
Franziska Beier
Jeremy Booth
Brendan Day
Monique Mehler
Kasper Mussche
Iveta Ramonaite

Executive Producer
Gernot Meyer

Advertising Disposition
Marius Mezger

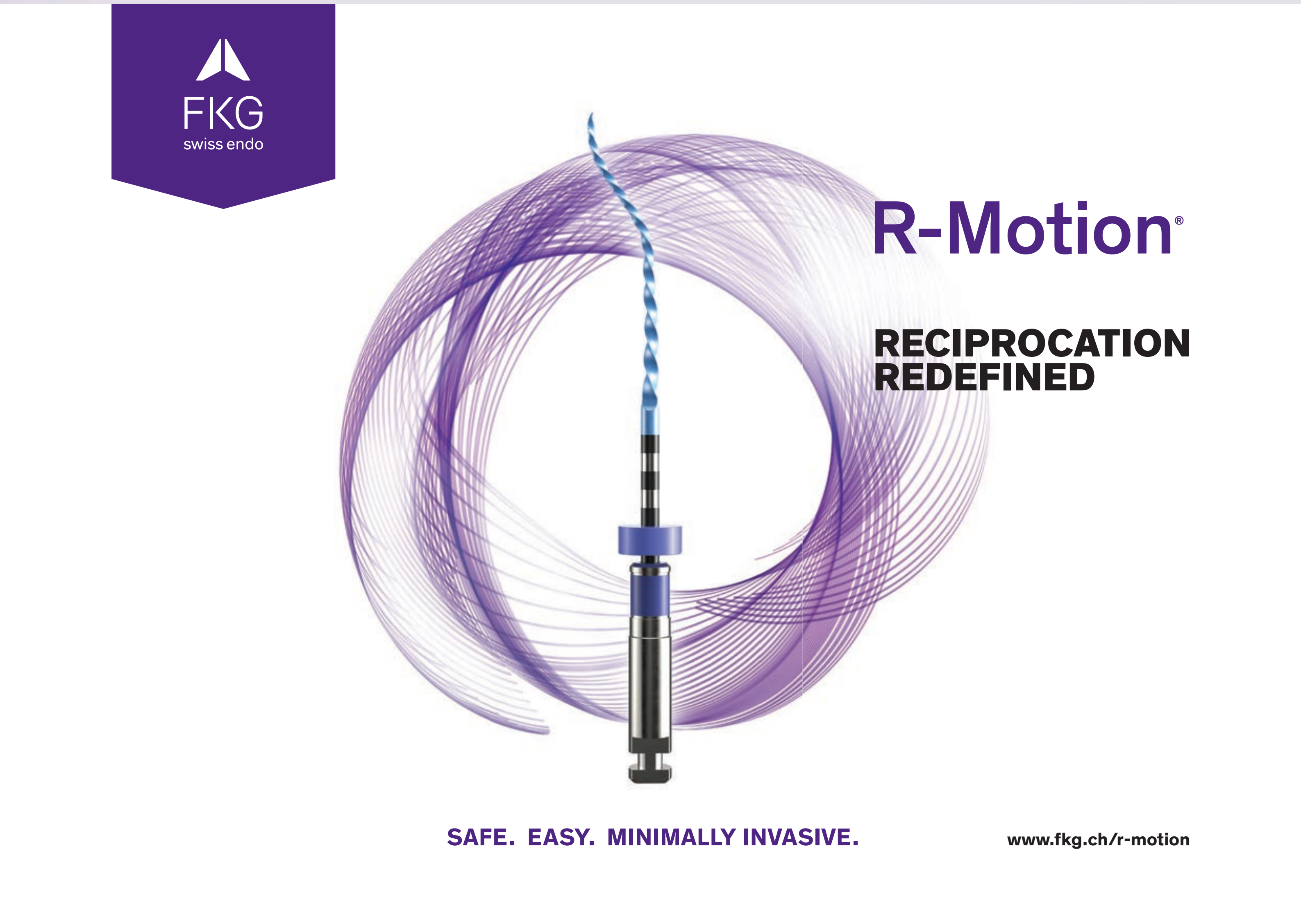
Art Director
Alexander Jahn

International Headquarters

Dental Tribune International GmbH
Holbeinstr. 29, 04229 Leipzig, Germany
Tel.: +49 341 48474-302
Fax: +49 341 48474-173
General requests: info@dental-tribune.com
Sales requests: mediasales@dental-tribune.com
www.dental-tribune.com

Printed by
Löhnert Druck
Handelsstraße 12
04420 Markranstädt, Germany


FKG
swiss endo
RACE® EVO
THE RACE LEGACY
SAFE. EFFICIENT. SOFT CONTROL.
www.fkg.ch/race-evo


FKG
swiss endo
R-Motion®
RECIPROCATION REDEFINED
SAFE. EASY. MINIMALLY INVASIVE.
www.fkg.ch/r-motion