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Prof. Dr Norbert Gutknecht

DGL President

Laser application in modern dentistry

Dear colleagues and DGL members,

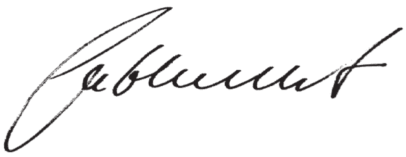
laser dentistry in Germany has made quite extraordinary progress. The German Association for Laser Dentistry (Deutsche Gesellschaft für Laserzahnheilkunde—DGL) was founded in 1991 in Stuttgart, Germany, as one of the first expert societies dedicated to laser dentistry. During a time when lasers were often frowned upon and viewed with incomprehension, practitioners and scientists engaging in research at universities focused their efforts on this topic. Painstakingly, one indication after another was integrated into practice workflows and treatment processes by means of scientific studies and clinical experiences. Ultimately, this scientific approach led to the DGL being admitted into the circle of organisations associated with the DGZMK (Deutsche Gesellschaft für Zahn-, Mund- und Kieferheilkunde).

With its multidisciplinary approach, DGL is an ideal cooperation partner for other dental expert societies. I am therefore particularly pleased that the 2020 annual congress of DGL will be held in cooperation with the German Association of Dental Implantology (Deutsche Gesellschaft für Zahnärztliche Implantologie—DGZI). Being Europe's oldest professional association for dental implantology, DGZI celebrates its 50-year existence this year.

We as scientific organisers will create an outstanding training event together with renowned speakers and our partners from the industry, in both a joint conference programme as well as the specialist main podium dedicated to laser dentistry. It goes without saying that your attendance is a key prerequisite for making our 29th International Congress a one-of-a-kind training event that is distinguished by the central values of DGL, namely: innovation, professional knowledge transfer, collegiality and friendship.

It is my great pleasure and honour to welcome you cordially to this year's annual congress of DGL, taking place on 6 and 7 November 2020 in Bremen, Germany.

Yours



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

An evaluation

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

Introduction

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

A successful root canal therapy is based on a number of factors: reduction of microorganisms to the minimum, sufficient and proper root canal instrumentation and disinfection, as well as well-adapted root canal obturation.[11] A crucial disadvantage of irrigant solutions is that their bactericidal effect is limited to the main root canal. Because of the narrow diameter of the dentinal tubules and the high surface tension of the liquid solutions, they are able to penetrate only a small distance into the tubules. The penetration depth of chemical disinfection only reaches 100 µm into the adjacent dentinal tubules.[12,13] However, the bacteria can penetrate over 1,000 µm from the canal lumen,[12] as described by Kouchi et al.[14] and Ando & Hoshino.[15] Therefore these bacteria are protected in the deeper layers of dentine. In this protected area, we find Gram-negative bacteria, which are characterised by their unusual migration qualities and their resistance to chemical irrigant solutions. They maintain their virulence against conventional endodontic techniques. And we find that, from this bacterial reservoir, the bacteria will spread to the periapical areas of the tooth, causing inflammation and infection.[12] Since conventional root canal therapy is not always successful, new methods could perhaps enhance the long-term prognosis and overcome the shortcomings of conventional instrumentation methods.[11]

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

The Nd:YAG laser seems to be the laser of choice in root canal therapy. It is also the best-documented laser in the literature for root canal sterilisation. Most of the studies concerned with the Nd:YAG laser in endodontics deal with the quantitative evaluation of bacteria reduction.[12] Laser irradiation has been widely introduced in endodontic treatments as an aid to disinfection and the removal of debris and the smear layer from instrumented root canal walls and might be a solution for the various limitations and shortcomings of mechanical and chemical disinfection. Microleakage continues to be a main reason for failure of root canal therapy, where the challenge has been to achieve an adequate seal between the internal tooth structure and the main obturation material, gutta-percha.[32] It has been found that approximately 60 % of endodontic failures are due to inadequate obturation of the root ca-

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

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

nal system.[33,34] Although gutta-percha is the most popular core material used for obturation, it cannot be used as the sole filling material because it lacks the adherent properties necessary to seal the root canal space. Therefore, a sealer and cement are always needed for the final seal.[35,36] The Resilon/Epiphany system uses a new obturation material that bonds chemically with the internal tooth structure, thereby decreasing the possibility of microleakage.[32]

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

Materials and methods

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

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

Acid etching was done using a 35 % orthophosphoric acid-etch gel for 15 seconds. After acid etching, all cavities were coated with a layer of primer (Syntac Primer, Ivoclar Vivadent), adhesive (Syntac Adhesive, Ivoclar Vivadent) and bonding agent (Heliobond, Ivoclar Vivadent) and light-polymerised (Translux, Kulzer) for 20 seconds. Then

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

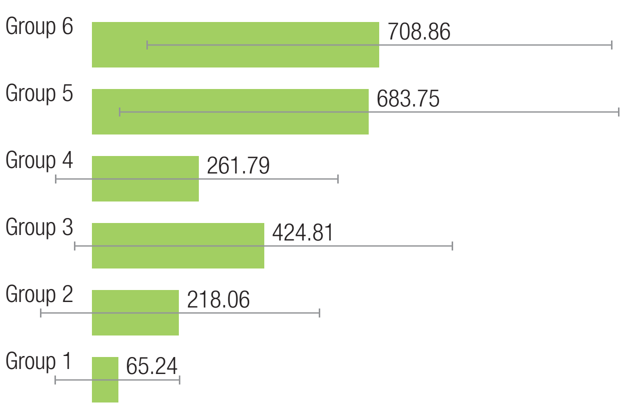
Table 2: Graded average dye penetration depths (µm). *Gr. = grade.*

a composite (Ivoclar Vivadent; Shade A3) was used in increments to seal the coronal 2 mm of the roots and was light-polymerised for 40 seconds. For the dye penetration test, the samples were first coated with two layers of nail polish (Sally Hansen, Del Laboratories), except for the last apical 2 mm, which was left exposed so that the dye could only penetrate the canal via the apical region. The samples of each group were then kept in separate containers of distilled water and incubated at 37 °C for five days, to stimulate clinical conditions.

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

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

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



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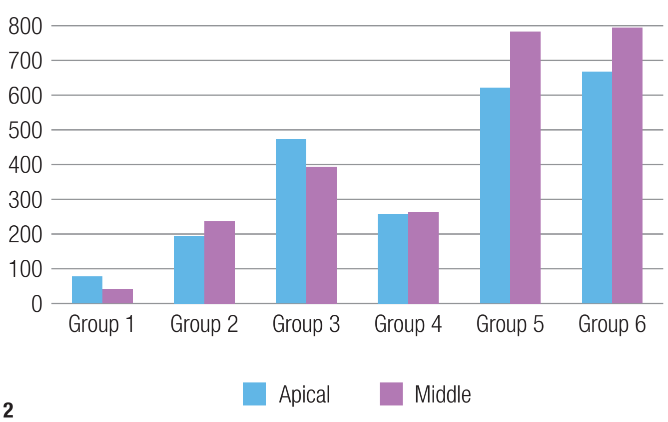

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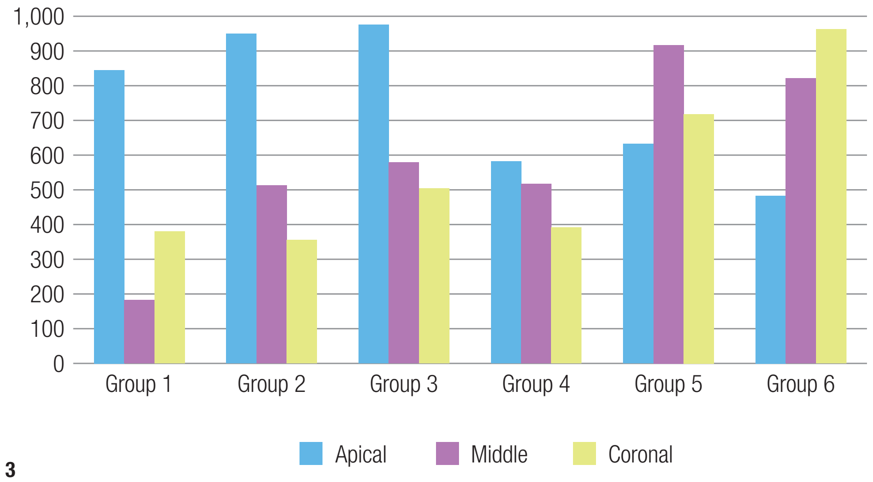
Fig. 1: Average dye penetration depth (µm) in all six groups. **Fig. 2:** Average dye penetration depth (µm) in all six groups based on the images of the vertical cuts of the roots.



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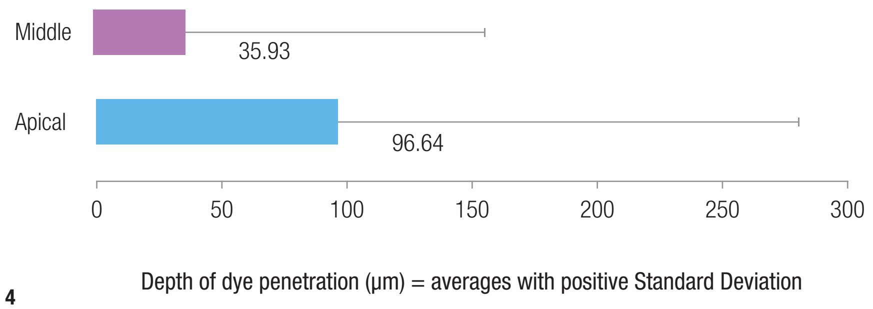

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Fig. 3: Average dye penetration depth (µm) in all six groups according to the images that resulted from the horizontal sections. **Fig. 4:** The average dye penetration depth in the apical thirds was greater than in the middle thirds in Group 1, but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

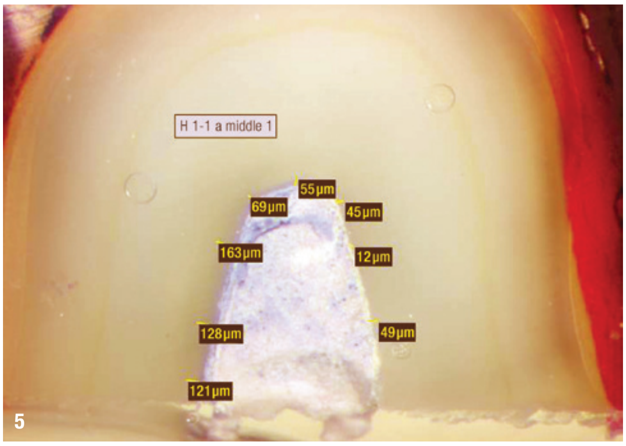
rank test ($p < 0.05$). The three examiners were unaware of the grouping of the teeth, and differences were reconciled by agreement. Since the magnification achieved by this technique was equal to 0.63x for the vertical cuts and 2x for the horizontal cuts, all the examiners could evaluate the samples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

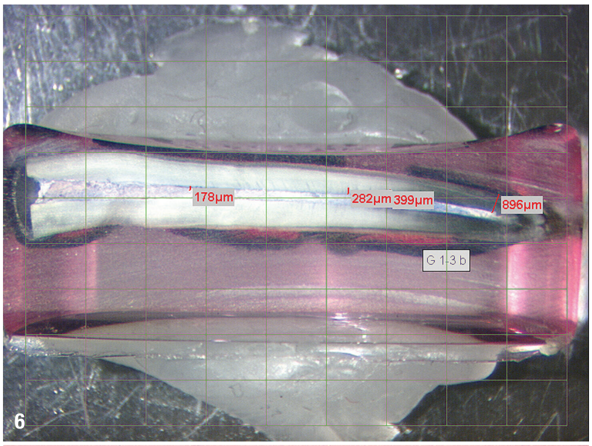
The extent of the leakage was scored as follows:

- 0: no penetration
- 1: penetration up to 500 µm
- 2: penetration up to 1,000 µm
- 3: penetration more than 1,000 µm.

Results

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





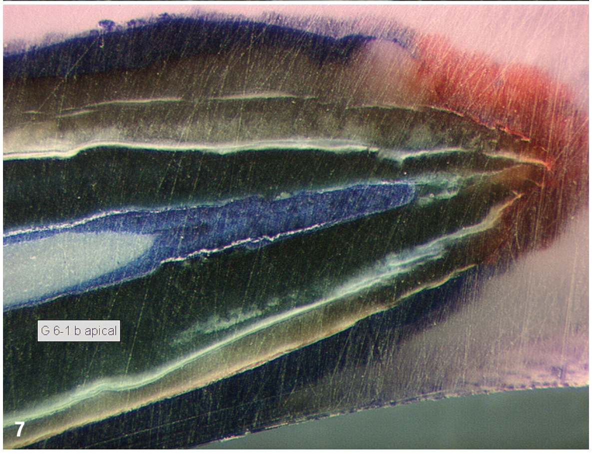


Fig. 5: A sample of cross-section cuts under the microscope. Dye penetration depth was measured by a computer programme. **Fig. 6:** A sample of vertical cuts of roots. Measurements are not as accurate as for horizontal views. **Fig. 7:** The apical region can be seen with more detail in vertical cuts,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

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

Discussion

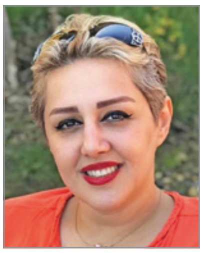
No study has reported on the combined use of laser and Resilon. In studies that used Resilon as a filling material, a similar efficacy to that of gutta-percha was observed. Thus, the concern of the current investigation was to determine whether Resilon would show an acceptable integrity with the dentinal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

Conclusion

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

Literature

about the author



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Innovative endodontics using SWEEPS technology

Tips and tricks

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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.

<table>
<tr><th>Chemomechanical systems</th><th>Positive pressure systems</th><th>Negative pressure systems</th></tr>
<tr><td rowspan="2">XP-endo Finisher</td><td>Hand dynamic</td><td rowspan="5">EndoVac</td></tr>
<tr><td>Sonic</td></tr>
<tr><td rowspan="3">Self-Adjusting File</td><td>Multi-sonic</td></tr>
<tr><td>Ultrasonic</td></tr>
<tr><td>Laser-activated irrigation (PIPS* and SWEEPS**)</td></tr>
</table>

* 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/


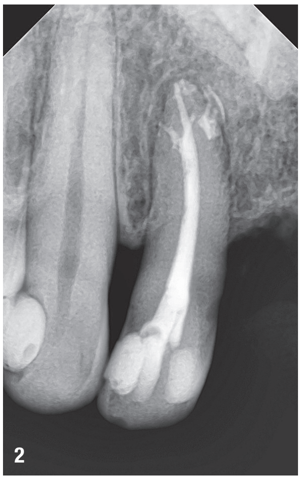
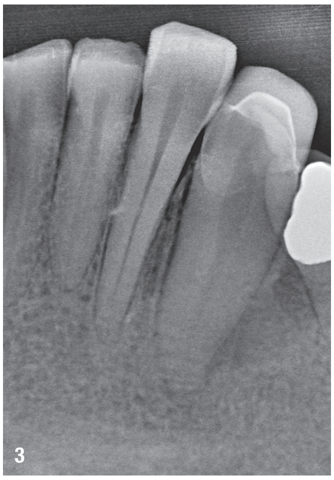
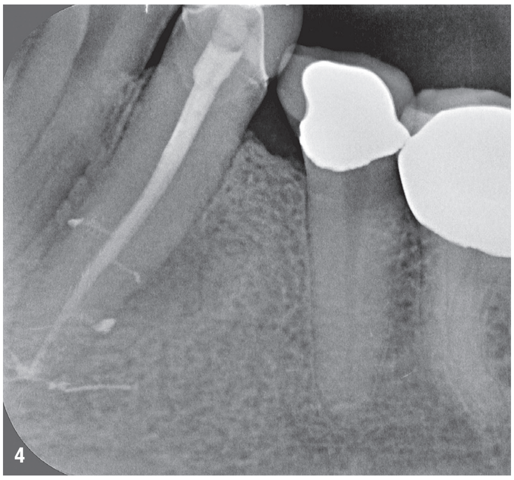

Fig. 1: Tooth #12—the radiograph showed a large periapical lesion. The asymptomatic tooth was prepared with an ISO 25/.06 TF Adaptive file (Kerr Dental). **Fig. 2:** Tooth #12—root canal filling was performed with mineral trioxide aggregate (ENDOSEAL MTA, Maruchi). Note the sealing of the apical ramification, 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]

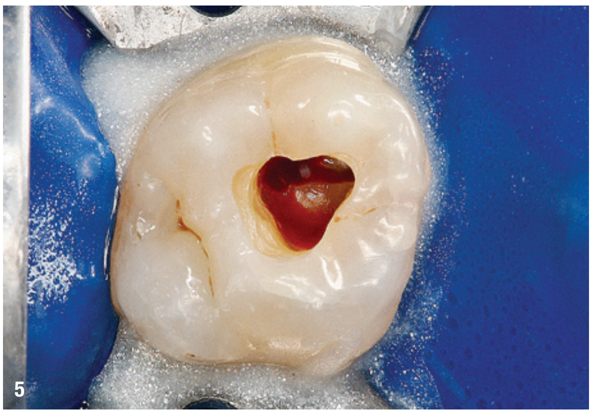

Fig. 5: Proper isolation for SWEEPS is important. A liquid dam was interlocked beneath the dam clamp. Traditional access cavity preparation of the maxillary first molar was performed using a cylindrical or round diamond bur under magnification (4.5–6.0x).

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 (3–5 ml) and simultaneous activation by Er:YAG laser (2,940 nm; LightWalker AT, Fotona), using the dual-pulse (25 µs 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 (400 µ) 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 (20 mJ at 15 Hz and 0.6 W) 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 repeated for two to three cycles for single-rooted teeth and up to three or four cycles for premolars and molars.

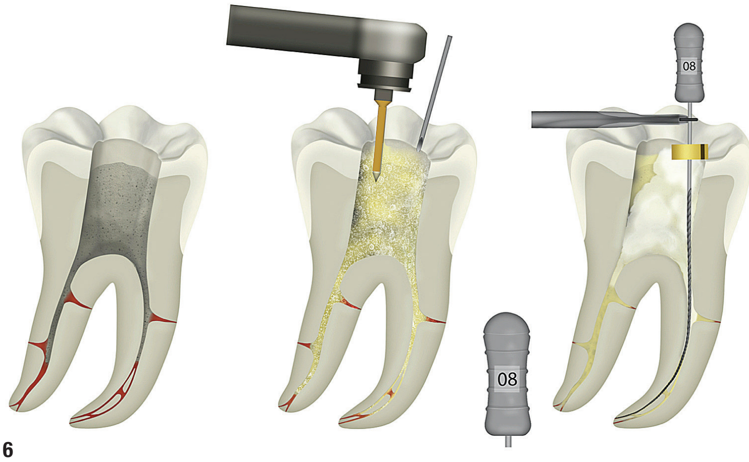

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Fig. 6: After the cavity access has been prepared, laser-activated irrigation of NaOCl using SWEEPS is performed in the access cavity. Then lubricant gel containing urea peroxide is placed on the file (or in the cavity) to lubricate and avoid tissue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

The initial irrigation phase also decreases the bacterial load. The access cavity can now be observed under magnification (6–10 x) 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 3–4 mm 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 1 mm shorter,

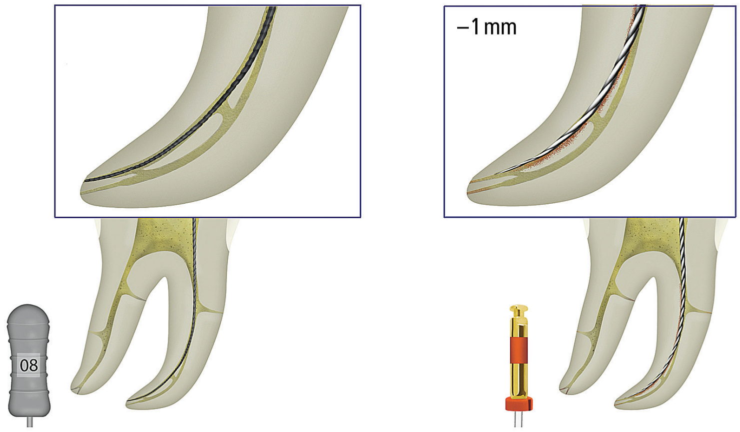

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Fig. 7: In order to prevent possible over-instrumentation of the apex with enlarging of the apical opening, the authors suggest working to 1 mm shorter than the anatomical length. **Fig. 8:** Recapitulation with the smaller first instrument (ISO 06 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 NaClO 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.

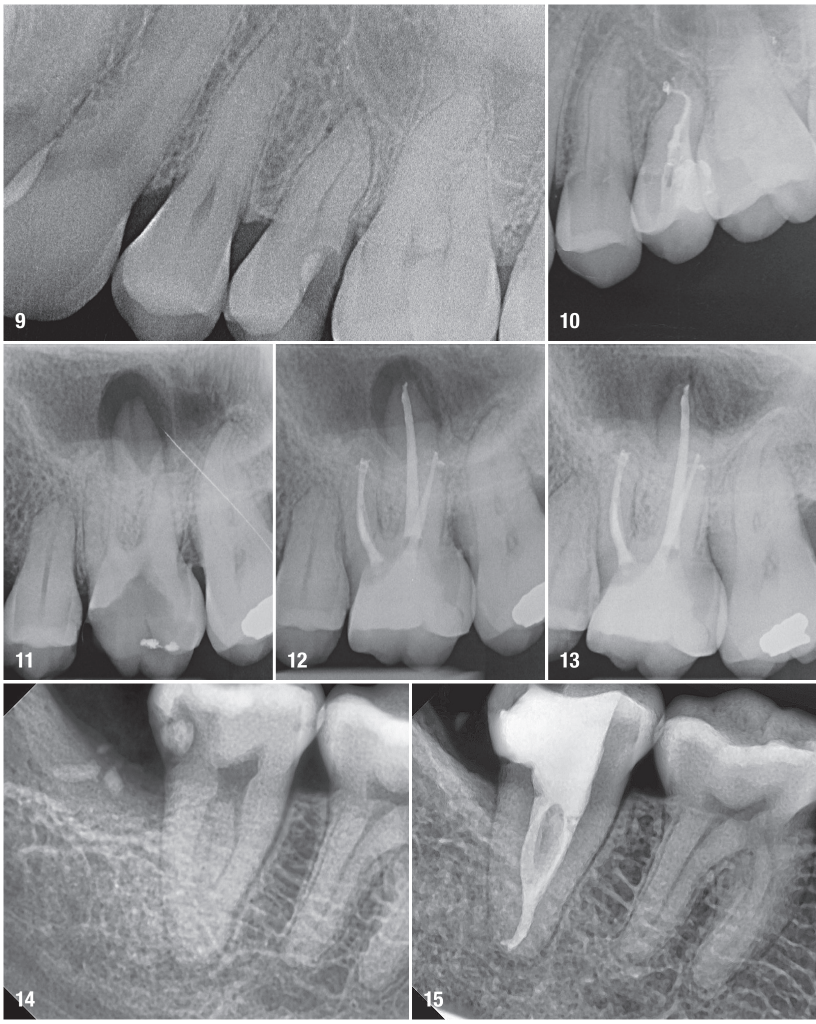

Fig. 9: The symptomatic maxillary second premolar showed a periapical lesion on radiographic examination. The preparation of the buccal and palatal canals was performed with a 25/.08v ProTaper Gold (F2) to 4 mm short of the radiographic apex. A size 10 hand instrument was used up to 2 mm short of the 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).

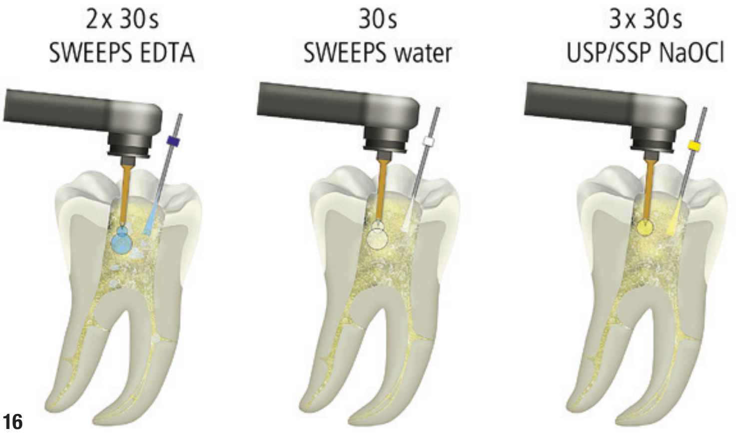

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Fig. 16: SWEEPS final irrigation protocol: at the end of therapy, the final irrigation protocol entails two cycles of 17 % EDTA activated by Auto-SWEEPS for 30 seconds each and 30 seconds of resting time, followed by rinsing with distilled water activated 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.

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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.

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Literature

Photo-biomodulation with a 970 nm wavelength laser

A clinical case report

Drs Tony Cheuk Kit Lee & Kenneth Luk, China

Case outline

A 16-year-old male patient presented with Class II Division I malocclusion with a buccally positioned maxillary left canine which was transposed with a short-rooted maxillary left first premolar (Figs. 1a & b). The orthodontic treatment plan involved extraction of the left and right first premolars and the retained maxillary left primary canine to reduce the 5.5 mm overjet and improve alignment of the maxillary and mandibular dentition.

Fig. 1a: Initial clinical situation.

Maxillary and mandibular metal fixed appliances with 0.022 x 0.028 in. slot brackets were bonded, and initial levelling and aligning were performed. Sliding mechanics were applied during initial space closure. However, during the end of the space closure stage, the last 1.5 mm of space between the maxillary left canine and the maxillary left lateral incisor was found to be stationary and difficult to close up (Fig. 2). Both power chain and loop mechanics on TMA archwire were applied for a year, yet the space between these teeth remained.

Laser intervention

Currently, diode laser wavelengths range from 445 nm (visible blue colour) to 980 nm (near infrared). Owing to the optical properties of these wavelengths, they are mainly absorbed by haemoglobin and melanin. Variations in the absorption coefficients of these two chromophores determine the penetration depth of the wavelength into the dental alveolar bone. Since the blue (445 nm) and red (660 nm) wavelengths are much better absorbed by melanin and haemoglobin, absorption is mainly on the surface of the mucosa. There is comparatively less absorption into thicker alveolar bone than with the near-infrared wavelength.

The use of low-level or low-intensity laser therapy in photo-biomodulation (PBM) is known for the modulation of the host inflammatory response. Cytochrome C in mitochondria is the primary photoreceptor (chromophore) for the blue, red and infrared light spectrum. The non-thermal photochemical interaction has direct effects on mitochon-

Fig. 1b: Initial radiograph. Fig. 2: Radiograph showing the last 1.5 mm of space between the maxillary left canine and the maxillary left lateral incisor.

drial activation in proliferation, ATP production, action potential in excitable cells, priming of lymphocytes, and production of lymphokines, cytokines and neurotransmitters. The NADPH oxidase activation generates reactive oxygen species which generate nitric oxide for vaso-dilation. The chemical mediators of the inflammatory process, such as interleukin-10, interleukin-4 and superoxide dismutase, are increased while the pro-inflammatory factors, such as tumour necrosis factor alpha (pain-related) and interferon gamma, are decreased. The result of these effects on oedema allows for a smaller volume of oedema, preventing cell death and allowing better regeneration of nerve cells. The effects of PBM on bone stimulate the proliferation, differentiation and synthesis of osteoblasts; increase the activity of alkaline phosphatase; increase cell adhesion; increase bone remodelling and turnover; and increase angiogenesis. PBM also induces cells to produce fibroblast growth factor to stimulate wound healing.

Laser and wavelength of choice

The SiroLaser Blue diode laser (Dentsply Sirona) consists of 445, 660 and 970 nm wavelengths. The 970 nm wavelength was chosen for the power setting available in this unit. This wavelength was applied to activate the bone cells and thus aimed at accelerating the tooth movement.

The diode laser used for treating this case was set to the following parameters:
- Wavelength: 970 nm
- Mode of operation: continuous wave
- Power: 200 mW
- Fibre size: 8 mm multi-tip
- Fluence: 0.4 J/cm^2
- Exposure time: 20 seconds
- Dose per point: 8 J/cm^2

Treatment procedure and irradiation technique

The areas of irradiation were the buccal and palatal aspects of the residual interradicular space and apices of the maxillary left canine and maxillary left lateral incisor. The multi-tip was placed with light pressure in contact with the mucosa during irradiation. The procedure was repeated at a two-week interval.

Result and discussion

The space was found to be closed after one month of the first diode laser application (Fig. 3), and the case was debonded and retained with a maxillary fixed lingual retainer (Fig. 4). There are many variations in wavelength, parameter and method of irradiation for PBM in acceleration of orthodontic tooth movement. Tissue composition and age of the patient also affect the outcome of the PBM therapy.

Fig. 3: Clinical situation one month after the first diode laser application. **Fig. 4:** Occlusal view: the case was debonded and retained with a maxillary fixed lingual retainer.

Conclusion

The use of the 970 nm diode wavelength was able to assist in difficult orthodontic movement of the maxillary left canine and left lateral incisor.

Acknowledgement: I would like to thank Dr Kenneth Luk for the laser guidance in this clinical case.

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Dr Tony Cheuk Kit Lee is a Hong Kong-based dentist who specialises in Orthodontics. He completed both his Bachelor of Dental Surgery and his Master of Orthodontics at the University of Hong Kong in China. In addition, he obtained the Advanced Diploma in Orthodontics from the same University. Dr Lee is currently working in private practice in Hong Kong.

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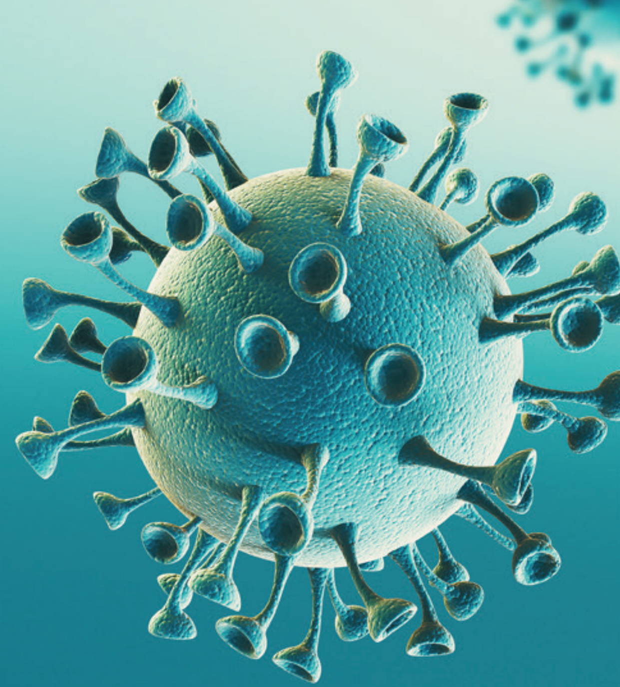

Practice strategies in the age of corona

Dr Anna Maria Yiannikos, Germany & Cyprus

Dear friends and colleagues,

We have all been facing an extremely unknown and difficult situation these past few weeks and yes, it is completely normal to be afraid and feel worried about your clinic's future in the post-coronavirus era. I would like to begin with a quote from Nelson Mandela, who said: "When conditions change, you must change your strategy and your mind. That's not indecisiveness, that's pragmatism."

Some may accuse us of being naive, if we continue to believe that patients in the future will behave the same way they did before the COVID-19 crisis, especially during surgical procedures. We should accept this as a fact. The fear of becoming infected has increased significantly in the past few weeks and is expected to remain heightened for the time being. The need for social distancing measures will remain strong. Unnecessary visits to friends, family and others will mostly be avoided and people will become more health-conscious. Cleanliness and proper hygiene should be paramount these days. In the following I will provide you with 7 essential tips, which, I believe, contain the most important advice I ever gave in an article.

1. Increase electronic engagement

For one thing, set up your website and general online presence in a way that makes it easy for people to book appointments online. In addition, offer new patients to send them the required medical documents via e-mail, so they can fill it out at home before coming to an appointment. They can return these completed forms by e-mail as well, in order to reduce waiting times at the reception area of your practice. Moreover, offer patients a quick video meeting with you via Viber, WhatsApp, FaceTime or Messenger, where they can express their dental issues ahead of a physical consultation. This builds trust, since patients can get to know you before an actual physical appointment and they will be reassured that they will receive exactly the treatment they need with you as their dentist. Further procedures can then be carried out at your clinic. Remember: people need encouragement to take action and you will be there for them when they do!

2. Make sure that your patients feel protected

Owing to the current pandemic, patients are most likely to be more aware of diseases and, of course, you should continue to take the protective measures that you would normally take during dental procedures—these are ever more important during the COVID-19 period. In addition, you may consider providing additional protective gear like shoe shields for walking around the clinic for your patients. This will make them feel safe and protected during appointments and it shows that their safety is important to you.

3. Reassure patients that they can rely on you

Especially in times like these where most people avoid crowded places and try to live by the concept of social distancing, it is vital for you to reassure them that it won't come to any delays in your clinic. Make sure that you establish a system that both reduces waiting times and keeps physical contact between patients at a minimum. In these uncertain times, it is important to assure patients that they won't be running into other patients at your clinic and thus bearing the risk of becoming infected.

4. Show empathy and give comfort

Some people are likely to lose their jobs as a result of the current pandemic, or at least experience a decline in their income. Therefore, showing empathy is vital. Comfort your patients like a friend would do. Apart from that, avoid losing loyal patients only because they are not able to afford certain procedures anymore owing to the current situation. You can minimise this risk by offering patients to prioritise certain dental conditions over others. This should happen in written form, where you need to include the important note that this treatment plan is based on recent findings and will be in place for no more than three months. However, remind them (preferably also in written form) that their dental problems will be likely to deteriorate further over time.

5. Look at things from a patients point of view

Many of you are probably anxious about the likely decline in the number of the cosmetic cases that you would normally have treated in the near future. And yes, the truth is that some people probably will not have the budget for cosmetic surgeries in the months ahead. Many people will reduce their social presence and thus there will not be many opportunities for them to proudly show off treatment results and their new smiles to others. Patients will only accept treatment proposals and spend money on them, if they understand these treatments are beneficial to their health (human beings are conscious about their personal health, after all).

Hence, start to emphasise the strong link between the immune system and dental health when speaking to patients. Try to see the world from their point of view: how does it feel, after living for so many days in lockdown and self-isolation, to face the daily fear of getting infected and/or being socially discriminated, if you behave in a wrong way? Wouldn't you be relieved that your favourite dental clinic implements processes that are aimed at benefitting the health of patients? Furthermore, it is our moral duty to enhance our patient's health, as well as to communicate this approach to them—not only on a theoretical level, but also practically.

6. Think more digitally

I would argue that the more your clinic embraces means of digital dentistry, the more it will thrive! Why? These days, patients will prefer fewer visits to doctors in order to minimise the exposure to possible viral dangers and the risk of getting infected. Hence, digital means such as CAD/CAM systems, or intra-oral scanners and cameras, which imply fewer physical patient contact and a more forward-thinking attitude, should be added to your clinic's armamentarium in order to set your clinic apart and attract new patients even in times of a pandemic.

7. Demonstrate your new processes

Start demonstrating the newly developed processes and rules for your clinic or practice by communicating them to your patients: send newsletters to the patients in your database, produce and post short videos of you and your staff using and applying these new processes and opt for social media channels that have the widest possible reach.

Remember—life will go on!

My dear colleagues, make this "stay home" period a productive one, since there will now be plenty of time to make all the necessary changes to your clinic's workflows and processes. It is important to remember that life will go on after this crisis. However, you need to adapt to and prepare for the post-pandemic era. Be proactive and start designing your own new set of rules. Those who understand this concept are more likely to prosper eventually. In my next article, I will delve more deeply into the implications the current pandemic has for dentists and their clinics in the future. Until then, remember: this is your time to get ready and prepare for the things to come! For any further questions, information, requests and guidance feel free to reach out to dba@yiannikosdental.com.

about the author

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.

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Laser-assisted prophylaxis around zirconia implants

France-based dentist Dr Fabrice Baudot has specialised in periodontics, laser-assisted surgery and implant dentistry and has a particular interest in zirconia implants. In this interview with *laser*, Dr Fabrice Baudot, founding member and scientific leader of the European Academy of Ceramic Implantology (EACim), explains why dental lasers have become an essential part of his daily practice and sheds light on the clinical benefits of combining laser-assisted surgery and ceramic implantology.

Peri-implantitis is an increasing problem in today's dental implantology. It is especially associated with titanium implants. What treatment benefits does the laser offer in this context?
Indeed, peri-implantitis is a real scourge for which we do not yet have good therapeutic solutions. Dr Stefan Renvert, in his 2012 book titled *Peri-implantitis*, said, "As in all pathologies, the best form of treatment is very often prevention and peri-implantitis is no exception." From this point of view, the Er:YAG laser can provide us with certain solutions for the daily practice. The cause of peri-implantitis might be multifactorial, but the microbiological aspect and the contamination of implant surfaces by biofilms seems to be a key point. With its well-demonstrated bactericidal properties, the Er:YAG laser is an excellent complementary instrument to conventional instrumentation for regulating the development of biofilm around implants and cleaning contaminated implant surfaces. We capitalise on two major effects of the Er:YAG laser in the management of peri-implantitis: firstly, there are photo-ablative effects of the laser, which are used for the micro-ablative cleaning of implant surfaces and the removal of inflammatory tissue. These ablative effects allow us to clean so-called peri-implant wounds; secondly, there are photoacoustic effects, which are based on shock waves generated by the Er:YAG laser emission that agitate the water-based antiseptic irrigation solutions that can be used to clean the peri-implant space.

> "Indeed, peri-implantitis is a real scourge for which we do not yet have good therapeutic solutions."

When it comes to oral surgeries, we usually exploit the photo-ablative effects of the Er:YAG laser. If we compare the Er:YAG laser to air polishers, which appear to be the reference for cleaning implant surfaces, the Er:YAG laser shows similar results on rough titanium surfaces, but without leaving powder debris on the surgical site. It can be argued that it is as effective and at the same time cleaner than conventional instruments. As opposed to other lasers, the Er:YAG laser is the only laser that can safely treat hard and soft tissue simultaneously without generating uncontrolled thermal effects. It can particularly be used on bone without the risk of thermal damage and even in confined spaces, as is often the case in dental implantology. In peri-implant maintenance, we exploit the photoacoustic effects, leading to an emulsifying of biofilm without altering the delicate tissue–implant interface. The shock waves generated by Er:YAG radiation with a wavelength of 2,940nm cause a 3D expansion of the irrigation solution, and the agitation effect of the solution destabilises the biofilm in a way well beyond what conventional instrumentation is able to achieve. These repeated preventive measures which are tailored to the patient's individual physiology make it possible to maintain peri-implant homoeostasis without altering the surrounding tissue environment. The treatment protocols are very simple to follow and clinical application only takes a few minutes.

> "I use the Er:YAG laser for peri-implant maintenance on a daily basis."

Ceramic implants are not particularly associated with peri-implant inflammation. Are there useful laser applications designed for ceramic implants too? What is possible and what isn't?

I use the Er:YAG laser for peri-implant maintenance on a daily basis. This concept of clinical application is based on the emulsion of biofilm that develops around the transgingival part of implant restorations and even beyond, in cases of peri-implantitis. Dr Kenneth S. Kornman's article "The host response to the microbial challenge in periodontitis: Assembling the players", published in 1997 in *Periodontology 2000*, made me realise the importance of exposing pathogens to defence systems to preserve periodontal and peri-implant homoeostasis. The Er:YAG laser and its photoacoustic effects enable the meeting between the pathogenic agents and the immune defence system, as explained by Kornman in his article. In an excellent journal article ("The effect of material characteristics, of surface topography and of implant components and connections on soft tissue integration: A literature review") published on 1 September 2006 in *Clinical Oral Implants Research*, Belgium-based Prof. Eric Rompen elaborated on the importance of implant materials regarding the nature of tissue attachment. Only titanium and zirconia allow hemidesmosome attachment, creating a kind of barrier against biofilm. Other materials used for transgingival connections, such as gold or fired ceramics, do not favour attachment. A real pocket is formed around this type of connection, which can pose a risk factor for the development of peri-implantitis. Deep laser-assisted peri-implant maintenance is particularly indicated around gold or UCLA-type fired ceramic connections.

With zirconia and titanium connections, the attachment is of better quality and the use of the Er:YAG laser is less justified when it comes to maintenance. When treating established peri-implantitis, the Er:YAG laser with its micro-ablative properties makes, in my opinion, a real difference compared with conventional instrumentation. Again, it is a very clean and efficient tool. It disinfects the treated sites without altering the adjacent surrounding tissue. Numerous studies have shown its safety on titanium, but there are, as far as I know, very few studies showing the effects of the Er:YAG laser on zirconia implants. I have only *in vitro* experience under an operating microscope of the use of the Er:YAG laser on zirconia implant surfaces (Z-Systems and CERALOG) because I have not had to deal with any cases of peri-implantitis around these implants. According to my observations, the implant surface of zirconia implants appears to be completely inert to Er:YAG radiation and reacts much less than titanium. The organic materials which are present on a ceramic implant surface are literally vaporised owing to the micro-ablative effect of the Er:YAG laser, leaving a perfectly clean and visibly unaltered surface as a result. It therefore appears that the Er:YAG laser is very effective in cleaning ceramic implants.

> "In my opinion, the only laser that is truly effective and safe in peri-implant spaces is the Er:YAG laser."

Are there any material-specific factors that need to be particularly considered when treating ceramics with lasers?

In my opinion, the only laser that is truly effective and safe in peri-implant spaces is the Er:YAG laser. As has been done for titanium implants, the effects of laser radiation should be tested at different power levels, under different circumstances and for different exposure times. Micro-ablative effects on zirconia should be observed by means of a scanning electron microscope (SEM) and possible surface alterations, especially in the microtexture, should be evaluated. One thing that seems fundamental to me is the aspect of the thermal rise of zirconia under the effect of Er:YAG radiation. There is only one *in vitro* SEM study, conducted by Dr Stefan Stübinger in 2008 ("Effect of Er:YAG, CO_2 and diode laser irradiation on surface properties of zirconia endosseous dental implants"; *Lasers in Surgery and Medicine*), which shows and evaluates the effect of radiation from three different lasers on zirconia. The carbon dioxide laser seems to alter the surface of zirconia, and the Er:YAG laser penetrates the surface of zirconia. The diode laser appears to be more suitable, but this study has not been confirmed yet by other studies. The clinical application of the diode laser seems to me, when looking at it *in vitro*, much more problematic than the Er:YAG laser, especially in areas close to the bone as is systematically the case in implantology. The risk of collateral thermal effects especially on the bone is of major concern with diode laser radiation.

Alterations of the implant surface under the effect of laser radiation appear to occur only at powers well beyond those effective in destroying biofilm and organic material. Owing to its peak water absorption, the wavelength at 2,940 nm of the Er:YAG laser is effective at the lowest energy levels and therefore cannot, in clinical use, significantly alter the implant surface. The important thing is to be able to manipulate Er:YAG radiation under visual control at high magnification to optimise power settings at the lowest effective energy levels and at tangential incidence to the surface to limit the concentration of energy transmitted to the implant support and thus limit the potential effects of the radiation on the implant surface to be treated. The clinical experience and mode of use of the laser is fundamental and deserves to be widely studied to confirm the safe clinical efficacy of lasers on zirconia implant surfaces.

about the interviewee

Dr Fabrice Baudot is a French dentist specialised in periodontics and implantology. He currently leads a practice that is specialised in laser-assisted microsurgery. His therapeutic approach is always based on minimally invasive surgery. Dr Baudot is frequently invited to speak at international dental conferences, and he is the author of numerous scientific publications.

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Interviewee details

Master of Science course "Lasers in Dentistry" offered again

The University of Excellence, RWTH Aachen University, has been offering the accredited postgraduate "Lasers in Dentistry" Master of Science programme in collaboration with the AALZ Aachen Dental Laser Center and RWTH International Academy since 2004. This year, the programme aimed at dentists who want keep pace with their patient's wishes for innovative and gentle treatment methods will be offered again in Aachen, Germany.

In standard academic studies in dentistry, the use of dental laser technology and laser-assisted treatment concepts are usually not part of the curriculum. Building on a university degree in dentistry, the two-year extra-occupational M.Sc. course teaches the necessary professional knowledge for laser applications in the dental practice at the highest academic level in theoretical and practical modules. The most important theories and application options regarding the use of lasers in dentistry are taught. Participants obtain sound theoretical knowledge in lectures and seminars led by renowned and experienced international researchers and practitioners. Skill training sessions, exercises, practical applications, live surgeries and workshops with intensive assistance from scientific associates with doctorates guide participants towards the successful and professional use of dental lasers in their own surgeries.

AALZ Aachen Dental Laser Center

During the ten modules, students remain in ongoing contact with the RWTH Aachen University and the lecturers between attendance days via an e-learning system. This allows established dentists to remain active in their surgeries while completing their Master's degree. Participants receive a certificate for every module that they pass. Students complete the Master course by handing in a Master thesis in which ten clinical cases are presented and discussed. On graduation day, the RWTH Aachen University confers the Master of Science (M.Sc.) degree. In addition, graduates receive a Diploma Supplement from RWTH Aachen University upon completing the programme.

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- Certificates with ECTS credit points are given out upon successfully finished modules
- Comfortable learning environment thanks to state-of-the-art seminar rooms
- Master's degree certificates are legitimised by apostilisation for applications abroad

This year's instalment of the M.Sc. course "Lasers in Dentistry" will start on 17 September 2020. For more information, visit www.aalz.de or contact info@aalz.de.

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Diagnostics, implants, bone and tissue

What's possible with dental lasers?

OEMUS MEDIA AG, Germany

Congress programme

There is a wide range of efficient and state-of-the-art laser systems being offered on the dental market today. In countless dental clinics around the world, the laser is considered an essential part of the clinic's armamentarium. No wonder, because the advantages associated with laser-assisted procedures are multifaceted. For one thing, procedures can be carried out in a more efficient and gentle fashion by means of lasers, as opposed to conventional treatment methods. Depending on the wavelength used, modern-day laser systems are suitable for a wide variety of dental indications. For instance, they are particularly useful when it comes to implant procedures: today, lasers are often successfully used for the management of hard and soft tissue and the decontamination of implant surfaces as part of peri-implantitis therapy. It can be argued that the resulting improved osseointegration and accelerated wound healing ultimately have a significant influence on the long-term success of inserted implants.

Against this backdrop, the 29th International Congress of the German Association for Laser Dentistry (Deutsche Gesellschaft für Laserzahnheilkunde—DGL) will be held on 6 and 7 November 2020 at the Congress Centre of the Maritim Hotel in Bremen, Germany. It will feature first-rate scientific lectures from renowned speakers, table clinics as well as live surgeries and tutorials, which will be streamed into the conference room in high definition. According to the theme "Laser application in modern dentistry", the objective of the Bremen event will be to set new standards in laser dentistry and to anchor this particularly innovative dental field even more strongly in other specialist areas such as implantology, periodontics or endodontics. The congress will offer ample opportunity for interdisciplinary and intercollegial exchange with laser enthusiasts from all around Germany and abroad.

Parallel to the annual congress of DGL, the 3rd Future Congress for Dental Implantology of the German Association of Dental Implantology (Deutsche Gesellschaft für Zahnärztliche Implantologie—DGZI) will take place in Bremen. The two expert societies will share the congress infrastructure, industrial exhibition area and facilities for the table clinics. Additionally, there will be a special programme dedicated to oral hygiene. For more information, go to www.dgzi-jahreskongress.de or contact event@oemus-media.de. Both DGL and the organiser OEMUS MEDIA AG are looking forward to welcoming you to the Hanseatic city of Bremen this November.

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Laser-safety loupes are especially required in dentistry. Due to the optical characteristics of a loupe the protection of the eyes is notably considered. When used in laser-assisted applications, loupes allow for an increase in the power- and energy density of the laser. Within dentistry, precise laser treatments and, as a consequence, successful treatment outcomes can be achieved using loupes. The new F27 magnifying eyewear combines the already proven F22 eyewear frame and a newly developed adapter with the magnifying glass of one of the leading German manufacturers. By virtue of the large number of available laser protection filters for this spectacle frame, a suitable magnifying glass can be configured for almost every laser application. Especially in combination with the HR2.5x/340 mm binocular loupe, the F27 can cover the entire range of dental laser applications. Additionally, laservision offers magnifiers with working distances of 420 and 520 mm for many more requirements. For further information on the available shields and filters for the innovative laser safety loupes, contact LASERVISION GmbH & Co. KG—we are always at your disposal.

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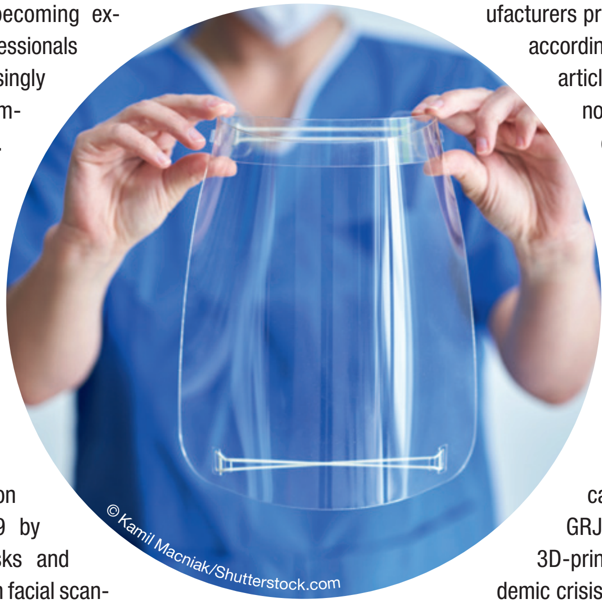
Protection from COVID-19 with

3D-printed masks and face shields



Owing to mask supplies fast becoming exhausted, many healthcare professionals around the world are increasingly unable to comply with the recommended infection control practices. The shortage has prompted extended use and reuse of face masks in healthcare settings, thus increasing the professionals' risk of contracting SARS-CoV-2. To help ease the depleted supplies, many federal agencies have relaxed regulations on mask use and some institutions have taken the initiative to help those fighting on the front line against COVID-19 by producing 3D-printed face masks and shields. These masks are based on facial scanning, 3D imaging and 3D printing and consist of two 3D-printed reusable polyamide composite components, a face mask and a filter membrane support produced with the help of CAD. Additionally, the masks employ a disposable head fixation band and a filter membrane, both available from industrial manufacturers producing FFP2/3 protective masks, according to a recently published research article. In this article, the researchers note that clinical testing, including dermatological considerations, leakage and virological testing of the reusable components of the masks, has not been performed yet. This, according to them, is crucial before use, as are proper cleaning and disinfection control. The article was first published on 30 March 2020 in the *International Journal of Oral & Maxillofacial Surgery* and can be accessed online (Swennen GRJ, Pottel L, Haers PE. Custom-made 3D-printed facemasks in case of pandemic crisis situations with a lack of commercially available FFP2/3 masks, International Journal of Oral and Maxillofacial Surgery(2020),doi:https://doi.org/10.1016/j.ijom.2020.03.015).

Source: Dental Tribune International

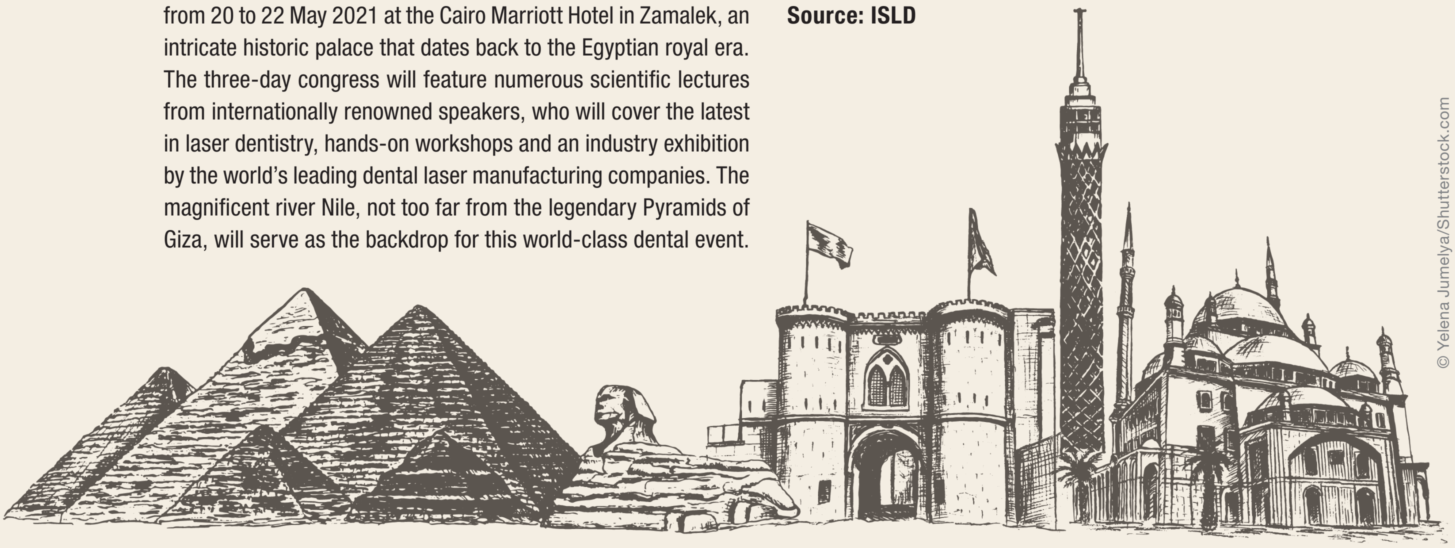
18th ISLD World Congress

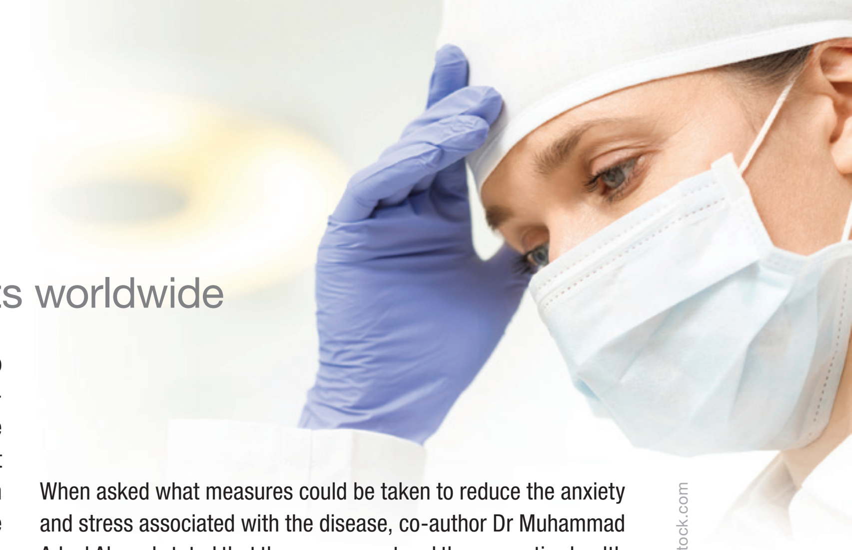
Postponed to 2021

The International Society for Laser Dentistry (ISLD) initially planned to hold its 18th annual congress in early October of 2020 in Cairo in Egypt. Owing to the travel and other restrictions that have arisen from the current COVID-19 pandemic, however, the decision was made to postpone the event to 2021. Hosted in collaboration with Misr International University, the event is now set to take place from 20 to 22 May 2021 at the Cairo Marriott Hotel in Zamalek, an intricate historic palace that dates back to the Egyptian royal era. The three-day congress will feature numerous scientific lectures from internationally renowned speakers, who will cover the latest in laser dentistry, hands-on workshops and an industry exhibition by the world's leading dental laser manufacturing companies. The magnificent river Nile, not too far from the legendary Pyramids of Giza, will serve as the backdrop for this world-class dental event.

In addition, congress attendees will have plenty of opportunity to engage in enlightening conversations and professional exchange with colleagues from around the world. Further information on the 2021 event hosted by the leading expert society worldwide for laser dentistry can be found online at www.isldcairo2020.com.

Source: ISLD





COVID-19: Study reports constant

Fear and anxiety among dentists worldwide

COVID-19 has not only impeded access to healthcare, but also caused fear and anxiety among healthcare workers. After conducting a study to understand how dentists in different parts of the world are coping with the fear of acquiring the disease and what strategies and modifications dental practices are implementing in order to combat SARS-CoV-2, researchers have highlighted the devastating psychological effects that the disease has had on dental professionals. In the study, the researchers surveyed a total of 650 dentists from 30 countries using online questionnaires. Most dentists (76 %) were working in a hospital setting, and of these, 74 % were in private and 20 % were in government institutions. The findings showed that more than two-thirds (78 %) of general dental practitioners experienced anxiety and stress owing to concern about the adverse effects of COVID-19. The majority of the dentists (90 %) were aware of the recent changes in treatment protocols, but only 61 % said their practices have amended treatment protocols for infection control as a result of the pandemic.

When asked what measures could be taken to reduce the anxiety and stress associated with the disease, co-author Dr Muhammad Adeel Ahmed stated that the government and the respective health organisations should arrange mandatory continuing medical and/or dental education sessions and workshops for dentists, dental hygienists and other staff in order to help them understand the guidelines regarding the provision of dental care services during the SARS-CoV-2 pandemic. The study, titled "Fear and practice modifications among dentists to combat novel coronavirus disease (COVID-19) outbreak", was published online on 19 April 2020 in the *International Journal of Environmental Research and Public Health*.

Source: Dental Tribune International

Dr Xavier Struillou elected

New President of the EFP

Xavier Struillou is the new President of the European Federation of Periodontology (EFP), the global benchmark in periodontal science and practice and in implant dentistry. Associate Professor of periodontology at the University of Nantes in France, Dr Xavier Struillou succeeds Prof. Filippo Graziani from the University of Pisa in Italy at the top position of the EFP, a scientific organisation that brings together 37 national member societies and more than 16,000 periodontists and other oral healthcare professionals from Europe and around the world. A member of the executive committee of the EFP since 2017 and coordinator of European Gum Health Day 2018, Xavier Struillou is the first Frenchman to lead the EFP since Jean-Louis Giovannoli, who was the federation's first President back in 1992. Listening to EFP-affiliated societies and collaborating closely with them are high among Struillou's priorities: "At the EFP we aim to inspire our member societies, to guide them, and to serve them. The heart and the engine of our federation is our 37 affiliated societies. Their drive is the EFP's drive, and we are deeply indebted to them." For further information contact press@efp.org.

Source: European Federation of Periodontology

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