By DTI

MELBOURNE, Australia: Evaluating the effectiveness of oral health promotion strategies for preventing dental caries and periodontal disease among children, researchers from the Cochrane Public Health Group have found that oral health education alone, such as classroom lessons, videos, comics and brochures, was ineffective.

Oral health education by itself ineffective

From analysis of the results of 38 international studies, the Cochrane researchers found that oral health education as a standard-alone measure, had no significant impact on caries in permanent or primary teeth and surfaces. Nonetheless, some of the studies reported improvements in gingival health, oral hygiene behaviours and oral cleanliness, the review showed.

“There is a general perception that oral health education will change oral health risk behaviours and promote good oral health practices,” commented Dr Shalika Hegde, a research fellow at Dental Health Services Victoria in Melbourne and part of the Cochrane Public Health Group, on the findings in an article on Dentistry.com. “However, this thinking is fundamentally flawed, as knowledge gained alone will not lead to sustained changes in oral health,” Hegde emphasised.

When coupled with other measures, such as supervised toothbrushing with fluoridated toothpaste, oral health promotion interventions were generally found to be effective in reducing caries in children’s primary teeth. Moreover, oral health education provided in an educational setting, combined with professional preventative oral care in a dental clinic, was effective in reducing caries in children’s permanent teeth, the researchers found.

Another most promising intervention approach for reducing caries in children—although additional research is needed—appears to be improving access to fluoride in its various forms and reducing sugar consumption, Hegde told Dental Tribune. Generally, the findings of this review will have global implications in the area of models of oral health care delivery and oral health promotion, research, policy and practice, Hegde concluded.

The review, which was the first of its kind at an international level, included data on 133,789 children in 21 countries from studies conducted between January 1996 and April 2014. All of the studies reviewed focused on community-based oral health promotion interventions for preventing caries and periodontal disease among children from birth to 18 years of age.

The review, titled “Community-based population-level interventions for promoting child oral health”, was published online on 15 September in the Cochrane Database of Systematic Reviews.
First Indonesia Dental Exhibition and Congress to be held in 2017

By DTI

JAKARTA, Indonesia/COLOGNE, Germany: Exclusively catering to the needs of the Indonesian dental industry and dental professionals, the country’s first comprehensive dental exhibition and congress will take place next year from 15 to 17 September at the Jakarta Convention Center. The event is being jointly organised by the Indonesian dental association (Persatuan Dokter gigi Indonesia) and trade show organisers Koelnmesse and PT. Traya Eksibisi Internasional. It will be held in alternate years to the established IDEM Singapore, the leading dental exhibition and conference in the Asia-Pacific region.

Alongside IDEM, the Indonesia Dental Exhibition and Conference will be positioned as a designated regional event, the organisers said in a press release. It will consist of a two-day scientific conference featuring localised educational content and a three-day exhibition that will offer a platform for over 200 manufacturers to meet and do business in the emerging Indonesian dental market, which is one of the fastest growing in Asia.

“Although every edition of IDEM Singapore has enjoyed strong support from Indonesian dental professionals we have come to recognise that there is still unrealised potential in the Indonesian market. Its healthcare industry is expected to grow by up to 20 per cent yearly, which points to an emerging need for a platform for dental professionals to learn more about well-established and effective technologies, research and skills,” Koelnmesse Managing Director Matthias Kuepper remarked.

Commenting on the decision to stage the new dental event, Dr Farichah Hanum, president of the Indonesian dental association, said that, by collaborating with two established exhibition organisers, dentistry in the country will hopefully be taken to new heights. “Indonesia has over 27,000 dentists nationwide, who face unique challenges in their daily practice,” Hanum said. The city of Jakarta—representing over 5,000 dentists alone—was chosen to host the event because it is the country’s central business and travel hub, he explained.

More information about the exhibition and the scientific programme will soon be available at www.indonesiaodentalsales.com.

Accuracy of optical scans and conventional silicone impressions

By DTI

IWATE, Japan: Aiming to evaluate the accuracy of digital impressions for use in implant placement, researchers from Iwate Medical University in Japan have compared optical impressions from an intraoral scanner with conventional silicone impressions. The analysis showed that the distance error of the optical impressions was slightly greater than that of the conventional method.

Fact for many dental practitioners, digital technology has become vital in daily practice. Others, however, still rely on conventional methods used in the profession long before the introduction of digital alternatives. However, the question that arises in this connection is whether—apart from benefits such as being faster and often more convenient—digital methods are verifiably more accurate than traditional techniques.

Aiming to shed light on this issue, the Japanese researchers compared a virtual model created from a scan by an intraoral scanner to a working cast fabricated based on a conventional silicone impression technique. The evaluation was limited to the use of optical impressions for implant placement. For this purpose, the researchers placed two implant abutments ( Nobel Biocare), one 5 mm and one 7 mm in height, in a master model.

To evaluate the error of the intra-oral scanner, the master model was scanned ten times with the Lava Chairside Oral Scanner (Lava COS, 3M ESPE). To evaluate the error of conventional impressions, ten working casts were scanned with a computer numerical control machine (Zeiss).

From comparison of the distance between two ball abutments that were connected to the implants, the researchers found that the trueness of distance error was 64.5 µm for the scanner and 22.5 µm for the working casts, making the conventional impression more accurate than the scanner.

For the 5 mm healing abutment, the mean angular error of the Lava COS was greater than that of the working cast, indicating signifi cant differences in trueness and precision. For the 7 mm abutment, it was not observed for the 7 mm abutment.

As distance errors of the optical impressions were slightly greater than that of the conventional impression, the researchers concluded that currently digital impressions are not equivalent replacements of conventional impressions for restorative procedures. However, they predicted that the development of information technology would most likely lead to improvement in the accuracy of optical impressions in the near future.
Dental fillings may contribute to increased levels of mercury in the body

By DTI

ATHENS, USA: Although the potential adverse health effects of mercury have been the subject of debate for a long time, the extent to which dental fillings affect mercury levels in the body was still unclear. New research has now found that people with multiple dental fillings exhibited significantly elevated levels of mercury in their blood compared with people who did not have dental surface restorations.

The study, which analysed data from nearly 15,000 individuals, is the first to demonstrate a link between dental fillings and mercury exposure in a nationally representative population. The researchers found that patients with more than eight fillings had about 150 per cent more mercury in their blood than those with none.

They further analysed exposure by specific types of mercury and found a significant increase in methylmercury, the most toxic form of mercury, associated with dental fillings, suggesting that the human gut microbiota, a collection of microorganisms living in the intestines, may transform different types of mercury.

Mercury exposure from dental fillings is not a new concern, but previous studies were inconsistent and limited, according to Dr Xiaozhong Yu, co-author and Assistant Professor of Environmental Health Science at the University of Georgia’s College of Public Health.

“This study is trying to provide the most accurate levels of exposure, which will form the scientific basis to make future risk assessment,” Yu said.

In response to the study, the American Dental Association (ADA) issued a press statement at the end of September that clarified that the association’s position on dental amalgam remains unchanged. “The mercury levels cited in the study did not exceed a level that according to the National Academy of Sciences would be known to cause adverse health effects. Thus no conclusions about the safety of dental amalgam should be drawn from this study. In addition, the study used data that included two different types of dental materials: composite, which does not contain mercury and dental amalgam, made from a combination of metals including silver, copper, tin and mercury. It is important to note that since the study does not differentiate between the two filling materials, the study’s findings may be prone to over-interpretation,” the ADA stated.

The ADA and the US Food and Drug Administration consider dental amalgam fillings safe for adults. However, they advise against its use in pregnant women and children under the age of 6.

The study, titled ‘Associations of blood mercury, inorganic mercury, methyl mercury and bisphenol A with dental surface restorations in the US population, NHANES 2003–2004 and 2010–2012,’ will be published in the December issue of the Ecotoxicology and Environmental Safety journal. It was conducted by researchers at the University of Georgia and the University of Washington.

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NOW AS A FLOW!
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An interview with Dr Diego Vezzoli, Italy, about the new Lisa steriliser from W&H

By DTI

Hygiene is of top priority for many dental practices. In addition to increased safety for both the practice and the patients, the efficient structuring of workflows with state-of-the-art reprocessing technologies plays a particularly important role. Dr Diego Vezzoli, a dentist at the Studio Dentistico Eurodent in Palazzolo sull'Oglio in Italy has been using the new Lisa from W&H for several months. The W&H sterilizer provides support in the form of rapid, reliable instrument reprocessing for practice to cope with an average daily treatment volume of 20–40 patients. The 8-member practice team truly values the advantages offered by the new Lisa. In a recent interview, Dr Vezzoli spoke about the advantages of the new W&H sterilizer.

What role does the new Lisa play in the hygiene cycle in your practice?

Dr Vezzoli: It is very important. The new Lisa sterilizer from W&H boasts optimized cycle times and thus speeds up our day-to-day work. The reprocessing time between patient treatments is now very short, so the instruments are rapidly available for the next use.

Efficient, time-saving work is a focus of every modern dental practice. How would you assess Lisa’s reprocessing?

Dr Vezzoli: I’m very satisfied with my experience of the Lisa. In addition to the simple navigation concept, our assistants also appreciate the ergonomics of Lisa in their day-to-day work. They are two considerable advantages compared with the sterilizers that we used before. We’re satisfied on all fronts. Now, comprehensive quality management is a fundamental standard in every dental practice. At the same time, patient safety is always afforded top priority. As such, complete documentation of sterilization cycles is indispensable. How does the new Lisa support you in this task?

Dr Vezzoli: It is very important. The simplicity of the system is a considerable advantage. For example, you have the option of creating a label for the sealed sterile goods to confirm that they are sterile. The cycle is completed when the sealed instruments are opened in the patient’s presence and the label is added to the patient’s file. In addition to the professional hygiene processes, the patient is also aware of the safety and the high priority afforded to sterilization in our practice. The traceability offers the patient security and is also an important quality criterion in our practice.

Do you also use the new Lisa mobile app in your practice?

Our practice team loves the new tool! In my opinion, the Lisa Mobile App can offer valuable support in times with high work volumes and it helps with the optimization of workflows.

What do you think of the design of the new Lisa? Would you describe the dimensions as “practical”?

I think that Lisa fits into rooms very well. The compact dimensions and flexible front feet make it easy to integrate the sterilizer in our hygiene workflows.

To finish off, could we ask for your personal evaluation of the new Lisa?

I’m very satisfied with my investment. And it’s not just me, my practice colleagues are also very happy with the new Lisa. Thank you for your time!

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“Going green is our business, not somebody else’s, but everybody’s responsibility”

An interview with Dr Claudio Pinheiro Fernandes, Brazil

By Kristin Hübner, DTI

Measures to reduce waste and pollution to conserve natural resources such as water and energy already play a major role in many aspects of daily life. Likewise, acting in an environmentally friendly manner is becoming increasingly important in dentistry as well. Dental Tribune spoke with Dr Claudio Pinheiro Fernandes, head of the Sustainable Dentistry Center at Fluminense Federal University in Nova Friburgo in Brazil and consultant to the FDI World Dental Federation’s Science Committee, about sustainability principles in dentistry, the preservation of natural resources and the economic dynamics of going green.

Dental Tribune: Being environmentally friendly is becoming increasingly important in everyday life. When did this topic first gain momentum in dentistry?

Dr Claudio Pinheiro Fernandes: Sustainability is relevant to everyone and we face this challenge every day. Every single newspaper that one opens includes some thing about climate change or sustainable development. It is the responsibility of dentistry too to become involved as a profession to pursue sustainability in the field of oral health for the good of society.

The dental profession is being challenged by the increasing demand for better oral health care for more people in more countries than ever. At the same time, we have the challenge of needing to do so using less resources. In this context, the question of how exactly we are to do that arises.

What can dentists do and what defines a sustainable practice?

As dentists, we have to realise that there are certain aspects and areas of our work that can be organised better. From a procedural point of view and concerning the equipment used, there are certain sustainability principles to consider. Take a simple example: when one buys a refrigerator or an air conditioner today one looks for energy efficiency labels that indicate the most efficient device in terms of its energy use. This means that it is good both for one’s pocket, being cheaper to run, and for the environment, since it needs less energy. Why do we not have this kind of labelling on dental equipment? We could introduce energy-efficient dental equipment, with labels indicating the device’s energy use. That would be one way of going green.

Another thing to keep in mind is how much water we use. That is an extremely important issue in dentistry. A dentist uses eight times more water than the average person does—a large volume! Usually the equipment used in daily practice causes this high consumption. For example, some brands of suction equipment use clean water to drive the suction mechanism. On average, they use 200 litres per hour and this water goes from the pumps directly to the drain. Of course, suction is important, but could we not apply different technologies to achieve the same result? Do we have to waste clean water for this?

In many respects, dentists cannot implement a shift themselves alone; awareness of the importance of sustainability is important on the company side as well.

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Images are courtesy of Prof. Dr. Fábio Duarte da Costa Aznar

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Dr Claudio Pinheiro Fernandes
BUSINESS

That is why the FDI is taking a stand on the sustainability issue right now. The whole thing got started back in 2012 during the Rio+20 meeting, the United Nations Conference on Sustainable Development, in which the FDI had decided to participate. Back then, we had already begun collecting information and thinking about what we could do in dentistry. I represented the FDI in those meetings and I was able to see how much we could do even without going to a great deal of trouble. For example, the most sustainable thing to do is to focus on prevention. If we act on prevention of oral disease, this would reduce the need for extensive treatment and the related use of products and, in particular, the associated large volume of waste, as well as the substantial amount of water and energy required. And the large carbon footprint that all of this creates.

Speaking of waste management, what should dentists consider? A great deal of waste is generated in dentistry and some of it is very toxic. Another issue that the FDI has pursued is the Minamata Convention on Mercury, which includes the phase-down of dental amalgam. We have to face our responsibility of dealing with amalgam waste, for example. Nordic countries are a good example in this regard, having implemented well-established management practices for many years.

One area in which we could do a great deal more is the management of recyclable materials. All the disposables that we use in dentistry generate hundreds of kilograms of waste every day. What can we do to address recycling of those materials? A considerable amount of waste is generated with disposable barriers, gloves and masks. Much of this could be safely recycled with current technologies.

How open is the dental community regarding this? When it comes to change, such as going digital, there are early adopters and some that find it difficult to adjust to something new.

That is a good point. Digital dentistry represents a different mindset on production. The primary objective is to have more control and to be more efficient in production, however, a third point is that digital technology generates less emissions, since there is less production and less product waste. This is just one example that serves to demonstrate that there are many more efficient means of manufacture. Certainly, digital dentistry is one of those areas of increasing technology use that results in greater sustainability. Science, technology and innovation play a key role in most areas of business. Improvements in efficiency, accessibility and cost-effectiveness of products and processes may allow fulfillment of global need in a more sustainable way.

Furthermore, dental research needs to be directed towards improving sustainability in dentistry.

Dentistry may be considered a very conservative profession. How difficult is it to change the predominant mindset?

We are doing that already. One way or another, people are coming to realise that going green is our business, not somebody else’s, but everybody’s responsibility. We as dentists have to play our part as well. In addition to efficient equipment and waste management, we should consider the topic of recycling, particularly in light of all the products that we use in daily practice.

I think that the most important thing is education. We need to include education on sustainable development in undergraduate programmes and in continuing education programmes. That way, new and experienced dentists alike will learn how to actually practise environment-friendly dentistry. The national dental associations too can do a great deal to increase awareness and promote sustainable development. A good example is the Norwegian Dental Association, which has decided to include sustainability aspects of dentistry in its agenda.

What is the situation right now? Is the topic covered in the curriculum at all?

There is a great deal going on right now. I would say that we are in the moment of great activity. For example, the International Organization for Standardization has developed very good materials for action. There is also a United Nations Educational, Scientific and Cultural Organization platform for integrating education on sustainable development. It is called Education for Sustainable Development. In addition, it should be noted that many universities are already going green today. So, there is progress.

Behind it all, there is one driving force, the United Nations’ 2030 Agenda for Sustainable Development. This agenda has defined 17 sustainable development goals that were adopted by all member states in September 2015. This is very recent, but we are on a schedule of looking into the reduction of poverty, the reduction of hunger, better health for more people and more educational opportunities—a number of issues that will improve the environment on the one hand, as well as social and economic development on the other. By utilising the environment in an intelligent, sustainable manner, we allow society to develop in a healthy way. We need to have jobs, we need to produce, but we can all do that in a responsible manner and at the same time sustain a good economy.

When it comes to food and clothing, an eco-friendly lifestyle is often more expensive than the alternative. For dentists, is there an economic barrier to going green as well?

Yes, there are challenges regarding entry, and investment is required because everything must be reoriented to the future. As with everything, it is very difficult to start all over again, but when attitudes change, when dentists actively decide to pursue sustainability, then they will start reviewing their own procedures and little by little implement change. The good news is that, once one actually starts to implement a sustainable approach, it becomes evident that energy and resources were wasted before—which is not a good business strategy. There will be a return on investment. One’s patients, one’s clients and the public will recognise one as an active member of a responsible society. It will take time and effort, but the dental profession will achieve this.

So in the future it could be a selling point for companies to identify themselves as “green”.

Yes, this is already happening in many business areas, because the public is driving sustainability awareness by seeking more sustainable alternatives. As always, there may be some companies that already say that about themselves even if they have not achieved that yet. However, standards have already been established to determine whether certain things have been applied based on these indicators of sustainability. Auditors and reviewers are able to evaluate objectively whether sustainability is being achieved by the company.

Of course, investment is required in the beginning. However, some business reports indicate that going green can save as much as 40 per cent of costs on water, energy and unnecessary product waste, which is a great deal of money. Many companies, big and small, are already considering it their corporate responsibility to act for the social and environmental good.

Thank you very much for the interview.
**Why interdental brushes are essential for good oral health**

Prof. Denis Bourgeois is not only the Dean of the University of Lyon’s dental faculty in France but also a pioneer in research on oral prophylaxis, interdental biofilm management, and interdental brushing techniques. He was the first to test for 19 major pathogens in the interdental biofilm known to be involved in periodontitis in young healthy adults. Furthermore, he has suggested interdental brushes to prevent interdental biofilm accumulation as well as to decrease the development of periodontal diseases and even systemic diseases.

"An interdental brush can remove around 96 billion bacteria from each interdental space," said Bourgeois during his presentation at the FDI Annual World Dental Congress in Poznań, Poland.

Despite advances in good oral health care, many patients and dental professionals remain uncertain about oral physiopathology and the concept of disruption of biofilm instead of elimination of dental plaque. According to various studies, conventional toothbrushing is not effective in removing interproximal plaque successfully. Recommendations on oral hygiene practices from dental practitioners have focused on the methods of daily toothbrushing and interdental cleaning instruments as standard for achieving and maintaining good oral health. However, uncertainty has remained about oral physiopathology and the concept of disruption of interdental biofilm.

**Sixteen billion bacteria in one interdental site**

So why does interdental cleaning actually matter? The anatomy of the interdental space does not allow for an efficient salivary self-cleaning mechanism and makes cleaning this area difficult. As a means of further understanding the mechanism of periodontal pathologies, Bourgeois was the first to use real-time polymerase chain reaction to quantify and visualize the interdental biofilm of even healthy individuals compared to periodontitis. "The effective presence of these periodontal pathogens is a strong indicator of the need to develop new methods for disrupting interdental biofilm in daily oral hygiene," concluded Bourgeois.

**Bleeding as a clinical reference**

Despite good oral hygiene habits, many patients experience interdental bleeding. "As we have seen, the interdental space is a source of bacterial contamination and has an effect on overall health," said Bourgeois in his presentation. According to the latest research, 41 per cent of young adults without periodontal disease or clinical gingivitis have experienced interdental bleeding at least once. This information should be considered critical for daily oral hygiene and interdental cleaning in particular. "There is a need to use interdental cleaning tools in order to achieve optimum oral health. If you do not use them, you could essentially stop using a toothbrush, as bleeding will occur otherwise anyway in the future."

In a study titled "Efficacy of interdental calibrated brushes on bleeding reduction in adults: a 3-month randomized controlled clinical trial," a test group was asked to use a standard manual toothbrush twice daily and an interdental brush daily. Based on the hypothesis that interdental brushes reduce interproximal bleeding, Bourgeois and his team instructed periodontally healthy and young individuals how to use interdental brushes daily and correctly. In addition, a calibrated colorimetric probe helped to effectively determine the interdental space and right brush size. As the study suggests, the overall interproximal bleeding was reduced by 47 per cent after one week and 71 per cent after three months. Bourgeois and his team concluded that interdental cleaning can be considered as "an effective means to help individuals maintain and/or achieve optimal oral health."

As the general access widths of interdental spaces were mostly unknown in young adults, Bourgeois and his colleagues also assessed the distribution of these widths in this group in a study titled "Access to interdental brushing in periodontal healthy young adults: A cross-sectional study." In a study titled "Efficacy of CURAPROX interdental brushes during his presentation at the FDI congress in Poland this year.

**Interdental brushes prove to be superior**

Conventionally, interdental brushes were only recommended for patients with large interproximal spaces, while dental floss was recommended for narrow spaces. As technology advanced, so did the innovation with interdental brushes, and as a result, interdental brushes can now be used for very small interproximal spaces to clean the space between teeth effectively. "Dental floss used to be the common tool for narrow spaces. However, dental floss is no longer preferred, as its use is not supported by conclusive scientific evidence. For interdental brushes, we have scientific evidence. Interdental brushes have become the best tool for cleaning interdental spaces," said Bourgeois.

As Bourgeois concluded at the end of his presentation, "The interdental brush currently represents the primary and most effective method available for interproximal cleaning. Interdental brushes are specifically designed to clean between the teeth in accordance with the interdental space access diameter. The method of choice for interdental cleaning then is to select the largest size that can penetrate into the interdental space and then to fill this space completely without causing discomfort or trauma." By using a calibrating Curaprox IAP colorimetric probe, a suitably sized interdental brush will help individuals achieve optimal biofilm disruption through thorough interdental cleaning with minimal trauma.

For all studies, Bourgeois and his team selected the CPS Prime series of interdental brushes of the Swiss oral care brand CURAPROX.

More information can be found at www.curaprox.com.
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Treatment of localised gingival recession

A clinical case utilising ZEISS EyeMag Pro F loupes with Feather Light LED

By Dr Matthew Garnett, UK

A 32-year-old female patient complaining of discomfort and pain from her mandibular anterior region was referred for a specialist periodontal opinion. She was experiencing sensitivity of the teeth, tenderness and intermittent gingival bleeding. She felt that there had been progressive deterioration over the last two years (Fig. 1).

The patient regularly saw her general dental practitioner, who was undertaking supportive care that included scaling, polishing and desensitisation with the use of fluoride varnishes. Having been given oral hygiene advice, she was using a soft-bristled manual toothbrush on a twice daily basis in order to maintain her plaque levels. Medically, she was a fit and healthy non-smoker, working as a primary school teacher. As far as she was aware, she did not have any parafunctional habits such as clenching or grinding her teeth. There was no history of previous orthodontic treatment.

Clinical examination using the ZEISS EyeMag Pro F loupes (Carl Zeiss) established that all permanent teeth were present, excluding her third molars, and she had a caries-free dentition. She showed a good level of oral hygiene, although there were some small plaque and calculus deposits present throughout the dentition. Assessment of the area of main concern showed there was a reduced vestibular sulcus with calculus deposits present through-out the dentition. Assessment of the gingiva revealed some apical to the recessive defects. There was no sign of frank attachment loss affecting both the maxillary and mandibular central incisors. Protrusive and lateral guidance involved these teeth, but there was no significant mobility (Fig. 2).

Radiographically, there was no apical pathology and there was minimal interdental crestal bone loss. The interdental bone between teeth #41 and #31 was, however, limited owing to mild overcrowding (Fig. 3).

A diagnosis of Class IIb Miller’s defects affecting teeth #41 and #31 was made, along with the associated marginal gingivitis. This had probably been exacerbated by a high mandibular labial frenal insertion and pre-existing labial bone deficiency (defhiscence or fenestration) as a result of the mild overcrowding. The condition may have been exacerbated by some occlusal overload and attrition (Figs. 4 & 5).

After the diagnosis, the patient was advised on additional preventative measures with appropriate toothbrushing techniques. She was subsequently reviewed after further simple scaling and polishing procedures. She then consented for a surgical approach to the mandibular anterior region. The proposed treatment was an internal frenectomy and pre-existing labial bone deficiency (defhiscence or fenestration) as a result of the mild overcrowding. The condition may have been exacerbated by some occlusal overload and attrition (Figs. 4 & 5).

Surgical treatment

First, the creation of a partial-thickness supra-periosteal pouch...
in the region of teeth #42 to #32 was achieved with the use of tunnelling instruments. There were partial papilla separation and internal frenotomy (Fig. 6). After this, an autogenous connective tissue graft was harvested from the left anterior lateral aspect of the palate. This was subsequently guided through the tunnel to rest over the exposed root surfaces of teeth #41 and #31. In addition to this, the graft would provide supplemental support for the overlying soft tissue in the region (Fig. 7). The gingival soft tissue lay passively over the connective tissue graft prior to suturing and wound closure (Fig. 8).

Coronal advancement of the overlying pouch/flap was achieved with a continuous suture technique. Tension-free closure of the wound was possible; however, specific caution was required particularly in the region of tooth #31 owing to the previous separated frenal insertions. Were there to be excessive coronal advancement of the pouch/flap, this could have led to potential wound breakdown due to increased tension in the region. The connective tissue graft was intentionally left exposed to allow for an increase in the zone of keratinised tissue after healing (Figs. 9 & 10).

At the two-year review, the patient reported no sensitivity or tenderness in the region and was delighted with the outcome. She was able to fully clean the teeth and excellent gingival health was observed (Fig. 11). At the review stage, there were no signs of inflammation, no bleeding on probing, and no swelling or oedema present. Although there was still minor recession (1 to 2 mm) present affecting teeth #41 and #31, it was not possible to achieve full root coverage owing to the general positioning of the teeth, the attritive wear present, and the limited support and width for the interdental papillae, especially in between teeth #41 and #31. The persistent mild recession was no cause of concern for the patient.

At three months post-treatment, the hard palate donor site was fully healed with no signs of scarring (Fig. 12).

The thickness of the gingiva and the zone of attached keratinised tissue had been increased, in addition to the vestibular sulcus being deepened. All of these features enabled the patient to fully maintain the area. The crucial aspects for a successful outcome for the case were to ensure careful soft-tissue handling, good adaptation and stability of the connective tissue graft at the recipient site, and tension-free wound closure.

Dr Matthew Garnett is a specialist periodontist and currently works as a consultant in restorative dentistry at Newcastle Dental Hospital. He also works independently in private practice in the North East region of England. Garnett can be contacted at matthew.garrett@uclh.nhs.uk.
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Paring down a complex case

Extensive all-ceramic restoration for the upper and lower jaws

By Dr Tetsuya Uchiyama and Michiro Manaka, Japan

This awarded entry in the Asia-Pacific category of the IPS e.max Smile Award 2016 describes the case of a patient who was treated with tooth-supported and implant-borne restorations. This initially complex case was expertly solved by using a straightforward treatment approach and establishing a uniform colour base for the all-ceramic restorations.

The abundant variety of solutions offered by contemporary dentistry—diverse materials, different technologies, customised approaches—is very much appreciated by patients and clinicians alike. Nevertheless, complex cases continue to present many challenges. In prosthetic dentistry in particular, extensive restorations in the upper and lower jaws are often necessary. In these cases, it is important to obtain a full view of the situation and to analyse it in detail and then to develop a treatment plan. The main aim is to pare down the complex situation to a simple and sound base for the fabrication of the restorations.

Clinical case

The 66-year-old patient complained about her inability to chew properly, as well as the unattractive appearance of her teeth. In the upper jaw, she had various defective metal–ceramic restorations, which were already become loose (Figs. 1a–c). In the lower jaw, a free-end gap extended from tooth #135 to #137. The crown on tooth #134 was also loose. The gingival margin of tooth #133 had clearly shifted towards the apical aspect. The curve of Wilson (transversal curvature) deviated, which added to the general disharmony. The shade of the different restorations varied quite considerably. Furthermore, the optical properties of the individual restorations did not match properly. The patient requested restorations that would look and function like natural healthy teeth.

The main goal was to establish a stable occlusal situation that would enable natural masticatory functions and a harmonious aesthetic maxillofacial situation. For this purpose, the existing crowns and bridges had to be replaced and the gingival contour had to be adjusted. Tooth #134 had to be replaced with an implant, which would function as an additional abutment. Further treatment with implants was planned for the mandibular posterior region.

From wax-up to provisional

The diagnostic wax-up is generally considered to be an indispensable part of complex treatment planning. The loss of tooth substance, which is the vertical dimension of occlusion, is verified in wax. The teeth are then adjusted on the model using additive (in some cases subtractive) means to achieve the desired situation. The treatment plan was discussed with the patient and modified as necessary. In this case, the diagnostic wax-up served as the foundation for all the subsequent working steps. The horizontal and vertical aesthetic lines and planes were determined and the upper and lower facial heights were evaluated by means of a radiographic image (Fig. 2). In addition to the clinical and aesthetic diagnosis, a manual functional and structural analysis provided important reference points for the treatment plan.

For the wax-up procedure, the incisal plane was lowered in the articulator. The incisal edges were slightly reduced (3 mm) to obtain an ideal lower face height. In addition, the angle of the occlusal plane was tilted (6°) anticlockwise. The chewing surface was successively modelled until optimum occlusal conditions were achieved (Fig. 3). The cross-mounting method—articulating the upper wax-up against the lower jaw and vice versa—was used to fabricate the provisional composite restorations (Figs. 4a–f).

Once the old restorations has been removed, we were faced with an additional challenge (Fig. 6). Metal build-ups and various fillings in the abutment teeth created a rather patchy overall impression. As a result, the appearance of the abutment teeth
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Surgical treatment

The patient was given a local anaesthetic and then an implant was placed in the region of tooth #14. Tooth #13 was extracted. The gingival contours of tooth #13 needed to be improved significantly. Therefore, targeted soft-tissue conditioning measures were initiated. For the next few months, the patient had to wear the temporary restorations, which had previously been fabricated. The area around the implant was placed to heal properly during this period. In addition, the patient was able to accustomed herself to the new functional and aesthetic situation.

The shape and shade of the prepared abutment teeth had to be adapted. The two lateral incisors and the maxillary canines were non-vital and discoloured. When stained areas of prepared teeth have to be concealed and tooth shades are suitably adjusted, it is important to visualise the completed crown for each of the individual teeth (Fig. 7). Changing the perspective from full view (maxillofacial) to detailed view (soft tissue) simplifies the visualisation process and tooth preparation.

Impressions and provisional restorations

The peri-implant soft-tissue contour around tooth #14 was optimally shaped by the provisional restoration. As a result, an impression could be taken of the emergence profile (Figs. 8a & b). The impressions of the prepared teeth in the upper and lower jaw were taken with the double-cord technique, and the master casts were produced in the laboratory. The long-term temporary was fabricated in three segments. The first segment comprised teeth #32-12; the second segment, the restored posterior teeth #13-17; and the third segment, teeth #44-47 (Figs. 9a & b). Once the first segment had been finished, the incisal pin of the articulator was lowered in order to create a space of approximately 1 mm in the anterior region. This gap was closed with the provisional of the other two segments. The temporary restoration was now ready for placement in the mouth (Fig. 10).

After the provisionals had been placed, their functional and aesthetic parameters were checked and the patient was released from the practice. During the subsequent months, she managed very well with the long-term temporary and she was satisfied with the aesthetic aspects. The implants that would replace teeth #35-37 had not yet been placed at this stage. Experience has shown that a step-by-step treatment approach minimises the risk of error. Therefore, the implants were placed eight months later.

Owing to the focused approach, the complex initial situation was reduced to a comparatively straightforward case that could be treated with permanent all-ceramic restorations. The main challenge for the dental laboratory technician was to conceal the differently coloured abutment teeth effectively. The objective was to cover the non-vital and stained teeth with zirconium dioxide frameworks. In order to fulfil all of the functional and aesthetic requirements, the decision was taken to press ceramic materials on to the frameworks and then customise the restorations with layering ceramics. This approach may sound somewhat complicated, but it would ultimately help to reinforce the stability and reliability of the treatment result.

Fabrication of the restorations

First, the provisional restorations, or rather its functional characteristics, had to be copied. The cross-mounting method was used for this purpose. Subsequently, a precision wax-up was fabricated and digitalised. It was correspondingly cut back prior to the CAD/CAM fabrication of the zirconium dioxide frameworks.

In the next step, these zirconium dioxide copings, which were to conceal the discoloured tooth structure (Fig. 10), were covered with pressed ceramic. The press technique allows the wax-up and its functional details to be reproduced in ceramic with utmost precision. In preparation for the ceramic press process, the restorations were built up in wax on the copings and then pressed with the fluorapatite glass-ceramic IPS e.max ZirPress in Shade A3 (Vivadent). Next, they were cut back as required, ensuring the full contour of the functional parts and the incisal area. Finally, the restorations were layered with IPS e.max Ceram veneering ceramic (Vivadent, Figs. 11 & 12).

The teeth were characterised in accordance with the age-related requirements of the patient using Dentin, Incisal, Impulse and Malmekon materials. The all-ceramic restorations were tried in after the first firing and then completed.

After the last try-in, the restorations were permanently placed according to the established protocol. The stained tooth structure was optimally concealed. The healthy natural soft tissue successfully adapted to the ceramic surface. The implants healed completely and the radiograph showed a stable situation. The vertical dimension, incisal edge contour and occlusal plane corresponded to the conditions established during the provisional phase (Figs. 13a-c, 14 & 15). The shape and shade of the ceramic restorations successfully matched those of the natural mandibular anterior teeth and harmonised with the face of the patient.

Conclusion

Comprehensive restorative therapy demands a clear and well-organised treatment strategy. The route and the goal must be defined right at the beginning in order to establish a sound and straightforward basis for the treatment procedure even in complex cases. This approach simplifies the treatment for all the parties involved and meets their highest demands.

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The ultimate goal of endodontic treatment is the prevention and/or treatment of apical periodontitis, such that there is complete healing and absence of infection while the overall long-term goal is the placement of a definitive, clinically successful restoration and preservation of the tooth. Successful endodontic treatment depends on a number of factors, including proper instrumentation, successful irrigation and decontamination of the root-canal system right to the apical terminus in addition to hard to reach areas such as isthmuses, and lateral and accessory canals.\(^1\) (Fig. 1a & b)

The challenge for successful endodontic treatment has always been the removal of vital and necrotic remnants of pulp tissue, debris generated during instrumenting, the smear layer, microorganisms, and micro-toxins from the root-canal system.\(^2\) It has been accepted that even with the use of rotary instrumentation, the nickel-titanium instruments currently available only act on the central body of the root canal, resulting in a reliance on irrigation to clean beyond what may be achieved by these instruments.\(^3\) Shaping canals creates sufficient space to hold an effective reservoir of irrigant that, upon activation, can penetrate, circulate and digest tissue by these instruments.\(^4\) ‘Shaping beyond what may be achieved in a reliance on irrigation to clean the root-canal system.\(^5\) It has been the removal of vital and necrotic remnants of pulp tissue, and lateral and accessory canals.\(^3\,\,4\)

Several challenges often arise during root canal preparation. Some of the most common ones are anatomic factors that may prevent negotiation to the apical terminus, as well as inadequate formation, perforation and file separation. The introduction of Nickel-Titanium (NiTi) alloy in endodontics presented a significant improvement, allowing good results in terms of cleaning and shaping of root canals, while reducing operative time and minimising iatrogenic errors.\(^5\,\,6\)

Thanks to the superior mechanical properties of the NiTi alloy, it was possible to endo- deliverable NiTi instruments of greater tapers in continuous rotation, increasing the effectiveness and rigidity of the cutting. However, several studies reported a significant risk of intracanal separation of NiTi rotary instruments.\(^7\) In fact, file separation via torsional and cyclic fatigue has created the biggest fear and risk for dentists using rotary NiTi files for root canal treatment.\(^7\,\,8\)

Although multiple factors contribute to file separation, cyclic fatigue has been shown as one of the leading causes.\(^7\) Fatigue failure usually occurs by the formation of microcracks at the surface of the file that starts from surface irregularities or during the grinding process during the manufacturing process that changes the crystalline structure completely so the triangular cross section NiTi file blank can be twisted while maintaining the natural grain structure. More precisely, TF instruments are created by taking a raw NiTi wire in the austenite crystalline structure phase and transforming it into a different phase of crystalline structure (B-phase) by a process of heating and cooling. In the B-phase, NiTi cannot be ground but it can be twisted. Once twisted, the file is heated and cooled again to maintain its new shape and convert it back into the austenite crystalline structure, which is super elastic once stressed. The manufacturing process aims at respecting the grain structure for maximum strength as grinding creates microcrack points during the manufacturing of the instruments.\(^9\,\,10\)

Because TF files are twisted and not ground, no surface microcracks occur on their surface and therefore do not need to be polished away, thereby not dulling the cutting edges and retaining their efficient cutting ability.\(^11\)

Because of the increased flexibility, the TFs maintain the original canal shape better, minimises canal transportation and stays centred even in severely curved root canals.\(^12\) In addition to the development of heat treated TF technology to improve the performance and safety of NiTi instruments, the file design has also been changed with respect to file dimensions, tip configuration, cross-section and flute design. More recently, a third factor has become important in this search for stronger and better instruments: Movement Kinematics, the branch of motion in which the objects move.\(^13\)

This reduction of instrumentation stress (both torsional and bending stress) is the main advantage of reciprocating movements. It has been shown that a lot of different reciprocating movements can be used, each one affecting the performance and the safety of the NiTi instruments. Therefore, when discussing the advantages and disadvantages of reciprocation, the exact motion should also be mentioned, since the actual angle of reciprocation can have substantial influence on both the clinical and experimental behaviour of NiTi instruments.\(^14\)

Another possible advantage of reciprocation could be better maintenance of original canal trajectory, mainly related to lower instrumentation stress and consequently its elastic return. However, it must be underlined that reciprocation does not affect the inherent rigidity of the instruments. If a quite rigid NiTi instrument is slightly forced into a curved canal, it will create more canal transportation than a more flexible one, due to its inherent tendency to straighten. Moreover, tip design could strongly influence canal transportation,
with a cutting tip being more dangerous that a non-cutting pilot tip.

While reciprocation with NiTi instruments has become very popular due to its simplicity with a significant number of published articles, some of these have shown that there are disadvantages in the reciprocating torque demand on the file, due to entrainment of debris within the flutes. To mitigate this, some authors have advocated the use of NiTi glide path instruments, before using a WaveOne or Reciproc instrument, but in this case the overall technique is no longer a single file technique but a more complex and more costly technique which utilises stand, but vary depending on the anatomical complexities and the intracanal pressure placed on the instrument. This ‘adaptive’ movement is therefore meant to reduce the risk of intracanal failure, without affecting performance. Due to the fact that the best movement for each different clinical situation is automatically selected by the Adaptive motor. It is quite interesting that the clinician will hardly perceive the differences in the changing motion, due to a very sophisticated algorithm, which permits a smooth transition between the changing angles.

As far as disadvantages of reciprocation are concerned, TF Adaptive movement with cutting angles (CW) much greater than WaveOne/Reciproc movements. This results in the TF Adaptive instrument working for a longer time with a CW angle, which allows better cutting efficiency and removal of debris through a patent apical foramen. The SM 1 file (20 tip size) is an excellent flexible Glide Path file which may be used with either sequence to pre-enlarge the canal thereby decreasing instrument stress for the next larger size file in sequence. This allows a safe and positive removal of the original canal trajectory (Figs. 2 & 6).

TF Adaptive technique
The TF Adaptive technique has been proposed in order to maximise the advantages of reciprocation, while minimising its disadvantages. By using a unique, patented motion, the innovative TF Adaptive Motion technique, together with an original three file technique, most clinical cases can be treated effectively and safely (Fig. 2).

TF Adaptive employs a patented unique motion technology, which automatically adapts to instrumentation stress, when used in the Elements Motor while in TF Adaptive setting (Fig. 3). When the TF Adaptive instrument is not (or very lightly) stressed in the canal, the movement can be described as a continuous rotational movement, allowing better cutting efficiency and removal of debris. The cross-sectional and flute design are meant to perform at their best in a clockwise motion.

More precisely, it is an interrupted motion with the following CW-CCW angles: 600–600. This interrupted motion is as effective as continuous rotation in lateral cutting, allowing optimal brushing or circumferential filing for better debris removal in open canals. This interrupted motion also minimises iatrogenic errors by reducing the tendency of ‘screwing in’ (aka pull down), that is commonly seen with NiTi instruments of great taper that are used in continuous rotation.

On the contrary, while negotiating the canal, due to increased instrumentation stress and metal fatigue, the motion of the TF Adaptive instrument changes into a reciprocation mode, with specifically designed CW and CCW angles that may vary from 600–00 to 370–50 (Fig. 4). These angles are not common of (debris and less tendency to push debris apically and laterally), because the flutes are designed to remove debris in a CW rotation. This results in TF Adaptive taking advantage of the use of a motion that is more similar to continuous rotation for optimal debris removal. There are obviously some changes in the angles depending on canal anatomy (the more complex, the smaller the CW angle), but they do not seem to significantly influence the overall result. On the contrary, these changes influence residual metal fatigue. Since TF instruments used with Adaptive movement were found to have superior resistance to cyclic fatigue when compared to the same TF instruments used in continuous rotation.

As mentioned before, flexibility is a fundamental property to minimise iatrogenic errors while negotiating canals, both in reciprocation and in continuous rotation. The use of a reciprocating movement, therefore, does not significantly help a NiTi instrument of greater taper to negotiate curved canals with no iatrogenic errors. It mainly helps to reduce instrumentation stress and the risk of intracanal failure. In addition, a study aimed to compare the frequency of dentinal microcracks after root canal shaping with two reciprocating (Reciproc and WaveOne) and one combined continuous reciprocating motion. Twisted Files Adaptive (TFA) rotary system. Ninety molars were chosen and divided into three groups of 30 each. Root canal preparation was achieved by using Reciproc R35, Primary WaveOne and TFA systems. All the roots were horizontal- taly sectioned at 3.5 and 3 mm from the apex. The slices were then viewed under a microscope at ×25 magnification to determine the presence of cracks. The significance level was set at P < 0.05. The results found that instrumentation with Reciproc produced significantly more complete cracks than WaveOne and TFA (P = 0.002). The TFA system produced significantly less cracks than the Reciproc and WaveOne systems apically (P = 0.004). The study concluded that within the limits of this study, the TFA system caused less cracks than the full reciprocating system (Reciproc and WaveOne). Single-file reciprocating files produced significantly more incomplete dentinal cracks than full-sequence adaptive rotary motion.

The TF Adaptive technique is basically a three file technique, designed to treat the majority of cases encountered in clinical practice. Available are two sets of three file systems, one for small, calcify- ing and severely curved canals and one system for more standard and larger canals, allowing for a gentle taper and increased apical preparation in both scenarios. The number of instruments within each sequence can also vary and adapt to canal anatomy, with the last instrument of the sequence

TF Adaptive to follow these criteria, and safely enlarge canals with minimal risk of iatrogenic errors linked to the weakening and canal/ apical transportation. The use of a more rigid alloy would not have made this possible, especially in curved canals.

TF Adaptive technique
TF Adaptive is an intuitive, colour-coded system designed for efficiency and ease of use. The colour-coded system is based on a traffic light. The first instrument in sequence is green. The second instrument in sequence is yellow and the third instrument in sequence, if required, is red. Green means go. Yellow means continue or stop. Red means stop (Fig. 2).
Coronal access and glide path

1. Place rubber dam.
2. Obtain straight line coronal access with slightly diverging axial walls adhering to the concept of Minimally Invasive Endodontics.
3. Achieve apical patency and establish an apical glide path using #8 hand file, follow that with a #10 hand file and continue at least with a #15 hand file. Glide path may be facilitated with the M1 Safety Handpiece (Kerr Endodontics, Orange, CA) (Fig. 7). The pulp chamber should be filled with NaOCl (Sodium Hypochlorite).

Canal size and file sequence determination (Figs. 5 & 8)

Small Canals (SM)

Using tactile feel, if you struggle to get a #15 K File to working length (WL) then the canal size is deemed to be ’small’.

- Use the Small Pack (one colour band) and its instrument sequence. The small sequence may also be used in severely curved canals as well as roots that may be very thin and the risk of strip perforation is a possibility.
- Establish working length
  - Slowly advance the green (SM1 or ML1) with a single controlled file you started with until working length.
  - Confirm canal patency with a #15 hand file K-File.

Medium/Large Canals (ML)

Using tactile feel, if a #15 K File feels loose at working length then the canal size is deemed to be ’medium/large’.

- Use the Medium/Large Pack (two colour bands) and its instrument sequence.
- Establish working length
  - Working length should be established with a reliable apex locator. A radiograph may help the clinician as well.

TF Adaptive canal shaping technique

1. Use the TF Adaptive setting on your Elements Motor (Fig. 9).
2. Insure the pulp chamber is flooded with NaOCl or EDTA and make sure the file is rotating as you enter the canal.
3. Slowly advance the green (SM1 or ML1) with a single controlled motion until the file engages dentin then completely withdraw the file from the canal to avoid extrusion. Do not force apically. Do not peck.
4. Wipe off the flutes. Deliver irrigant to the pulp chamber and confirm canal patency with a #15 handle K-File.
5. Repeat steps 3 and 4 using the file you started with until working length is achieved.
6. Repeat steps 3 and 4 with the yellow SM2 or ML2 until the file reaches working length. If the desired apical size is achieved the sequence is complete. For larger apical sizes, repeat steps 3 and 4 with the red SM3 or ML3 until the file reaches working length.

Note: All TFA files may be used in a brushing manner directed towards the external surface of the root away from the canal curvature when retrieving the file from the canals.

Obturation

TF Adaptive matching Gutta Percha in combination with the Elements Free Cordless Obturation system2 may be utilized to obturate the root canal system. Alternatively, TF Adaptive carriers may be used.

Conclusions

TFA employs Twisted File technology and Adaptive Motion Technology. The TF Adaptive file design is based on clinically proven Twisted File technology, which means the file is twisted to shape for improved file durability, features R Phase Technology to improve file flexibility and strength while maintaining the original canal curvature minimizing canal apical transportation (Fig. 10).

Adaptive Motion Technology is based on a patented smart algorithm designed to work with the TF Adaptive file system. The authors have also found that Adaptive Motion Technology works well with other ground file rotary systems making their use safer especially in smaller and curved canals. This technology allows the TF Adaptive file to adjust to intra-canal torsional forces depending on the amount of pressure placed on the file. This means the file is in either a rotary or reciprocation motion depending on the situation and adjusts appropriately.

This winning combination results in exceptional debris removal with the tried and trusted classic rotary Twisted File design and less chance of file pull down and debris extrusion with Adaptive Motion Technology.

Disclaimer: Drs. Gambarini and Glassman are the inventors of Adaptive Motion and receive a nominal royalty from Kerr.

Dr. Gary Glassman is the author of numerous publications. He lectures globally on endodontics, is on staff at the University of Toronto, Faculty of Dentistry in the graduate department of endodontics, and is Adjunct Professor of Dentistry and Director of Endodontic Programming for the University of Technology, Kingston, Jamaica. Gary is a fellow of the Royal College of Dentists of Canada, Fellow of the American College of Dentists and the endodontic editor for Oral Health dental journal. He maintains a private practice, Endodontics, Orange, CA)

Gianluca Gambarini is a full-time Professor of Endodontics, University of Rome, La Sapienza, Dental School. He is head of the Endodontic Department international lecturer and researcher. He is author of more than 450 scientific articles, three books and chapters in other books. He has lectured all over the world (more than 350 presentations) and has been invited as a main speaker in the most important international (AEE, IFEA, ESE) and national endodontic congresses in Europe, North and South America, Asia, Middle East, Australia and South Africa. Prof. Gianluca Gambarini still maintains a private practice limited to Endodontics in Rome, Italy.

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A commitment to German quality

By Marc Chalusky

In the field of endodontics, instruments of different sizes and angles and with various handles have been developed for root canal therapy—from simple stainless-steel files to today’s high-tech instrumentation systems. VDW is one of the most well-known manufacturers of endodontic products in the world. Most of the 52 million instruments it produces annually are manufactured in Munich in Germany. For more than 145 years, VDW has been operating from its site in the heart of Europe, where it manufactures endodontic instruments in a shift operation. The company granted Dental Tribune an exclusive look behind the scenes of its high-tech facility, spanning 3,000 m².

Not all files are equal

Endodontic instruments are essentially of three designs: K-type files, reamers and Hedstrom files. Reamers and Hedstrom files have a triangular or square cross-section and a cutting edge angle that determines the cutting and debriding performance and therefore the effectiveness of the instrument. The design of the instrument tip, which cuts either actively or passively, is crucial. An inactive tip advances the instrument safely within the canal. The instruments generally have a handle, a shaft and a working part. While the length of the working part remains the same at 16 mm, the length of the shaft can measure between 5 mm and 15 mm.

A colour-coding system is used for easy visual identification of the diameter. The ISO standard specifies the lengths, dimensions, tolerances and minimum requirements for mechanical resistance. Colour coding of white, yellow, red, blue, green and black, and various symbols indicate the individual types and sizes of instruments. The standard also precisely specifies the conicity, accurate to the millimetre. The tolerance range is less than 0.02 mm, but the measurement of the tolerance may be significantly over the limit, depending on the manufacturer. Additionally, silicone stoppers are used to determine the length of the root canals.

The manufacturing process for Hedstrom files consists of eight steps: straightening the wire, grinding, washing, ring marking, injection moulding of the handle, printing, attaching the stopper and packaging. For barbed braces, the wire is first straightened, then machined, washed and straightened again, the handle injection moulded and the instrument finally packaged. Reamers and files are generally machined into a triangular or square form and then twisted. In this way, depending on the bending moment, torsion and deflection, instruments are formed that have absolute flexibility and the highest possible fracture resistance. The bending moment indicates that moment of the bending of the instrument during production when it no longer reverts to its original form. An instrument once bent cannot be bent again, otherwise there is a risk of brittleness and fracture. The torsion, that is the twisting of the files, differs depending on the force effect and material.

The instruments' cross-section and the material used play an important part here, and thus in turn has an effect on the production. Finally, the angle of twisting (deflection) and the strength determine the quality of the instrument, especially the cutting performance. Sharpness decreases with repeated use.

Visions of endodontic heaven

Dental Tribune was granted direct access to operations at one of the most innovative manufacturers in the field of endodontics. While the company has a 145-year history, the well-maintained business premises look very modern. VDW was one of the first European manufacturers of endodontic instruments, and today offers products for the entire treatment process—including preparation and irrigation, root canal filling and post-endodontic maintenance. VDW emphasises simplicity and efficiency in its systems, allowing both general practitioners and specialists to provide optimal treatment in a few steps. At the facility in Munich, Gregor Picard, Director of Operations at VDW, took us through the entire production process for the company's manual, rotating and reciprocating instruments.

Just in front of the main entrance, visitors are given an overview of VDW's products, such as file and reamer sets for root canal preparation with rotational cutting, debriding and filling action, divided into sterile and non-sterile instruments. Using the Flexicut and Niti K type-files, preparation is problem-free even in the case of severely curved and narrow root canals. The company is particularly proud of its RECIPROC system, consisting of reciprocating instruments for mechanical preparation, paper points and gutta-percha Apex locators, obturation systems such as GUTTAFUSION, an ultra-sonic device and materials for filling root canals are displayed in another glass case.

The tour began with the machines for cutting and straightening the wires (Fig. 1). Most file systems use highly flexible, fracture-resistant stainless steel combined with a special alloy for almost 30 years, the industry has relied not only on chromium-nickel-stainless-steel alloys but also on nickel-titanium alloy (NiTi), known for its pseudo-elasticity. NiTi files are used particularly in severely curved root canals. Owing to other beneficial properties, including shape memory (the material returns to its original form), super-elastic behaviour and good biocompatibility, dentists are increasingly opting for NiTi files, but not dispensing with stainless-steel files. “We are constantly working on new alloys, materials and geometries. However, it is just a question of refinements these days,” said Picard.

The wires are subsequently machined. Straight after this procedure, an employee checks the finished instruments using a digital measuring system and visually inspecting them under a microscope. This system, like the entire production process, is fully automated (Fig. 2). The process is properly validated to ensure that VDW can always provide the same quality and reliable monitoring. The washing plant cleans the instruments and completely removes the oil used in production, for example. A gripper then takes the deposited instruments and machines in the ring marking. The colouring is done within a few seconds. The ink is then dried and the instrument is inspected again by camera (Fig. 3). The next procedure is attaching the handle. The robot trims the instrument at the top so that it is wide enough to connect the wire firmly to the handle. “This step is often left out with fake copies so that the handle slips off,” said Picard, referring to the counterfeit products on the market, which is a global concern for both manufacturers and dentists. This is followed by the injection process to form handles around the wires, which are first placed into the machine depending on the ISO diameter of the instruments. The plastic used is a high-performance polymer that can be sterilised repeatedly and can therefore be used in autoclaves.

The glasses are recycled to a certain extent. Injection moulding...
to allow sterile packaging after the washing procedure. An automated packing facility sorts all of the instruments into boxes and blister packs. The instruments are then deposited into crates within the clean room environment. Employees line these with sterile bags and they are then sealed with lids in the clean room area and sent for final packaging. They are marked to indicate sterilisation status. VDW sends the goods for sterilisation again before shipping in order to ensure that there are no bacteria when they leave the warehouse. If desired by a customer, a small laser can be used to mark the blisters for individual needs.

The warehouse follows a chaotic storage process—in a positive sense. With storage locations defined according to aisles, the products are stored in available spaces where they fit best, rather than according to category. This allows for the most efficient use of space. The system tracks the available spaces, scans the goods and knows automatically when sufficient goods have been removed. Each order is digitised and production begins immediately after receipt. Because logistics and production are completely coordinated, there is no overlap in distribution. At the time of the visit, an employee was preparing a few pallets for China (Fig. 4).

Everything is monitored
even more impressive than the almost fully automated production technology. The specially developed camera system is probably one of the most advanced in the dental industry. One example is the ring marking. Each ring is checked for diameter, width and colour application. The system will then indicate ‘green’, signifying that all is OK, or ‘red’ to flag a problem (Fig. 4). Instruments with no ring colour are automatically removed. Another camera checks the twisting of the reamer and files according to length and degree of twisting, preventing any warped instruments from going any further in the production process. Yet another camera checks the barbs on the reamers. A further camera monitors the status of the boxes and blisters and verifies the geometries of the instruments and their colours by means of images. The camera system is connected in real-time to the workstations in the instruments and packaging—even individual instruments—and the data can be accessed automatically. Another camera checks the labels. If there has been a printing error or an incorrect label has been used, the affected item is immediately separated by the machine.

Each process step undergoes quality control by cameras (Fig. 4). This means that no rejects proceed to the next stage. “The longer a defective item is in the production process, the greater the associated costs incurred. A single defective file in a blister means that the entire pack must be removed,” explained Picard. In this way, the company guarantees the safety and quality of its products, and fulfills the strict regulatory requirements.

**Trialed and tested and constant change**

Even after 145 years, manual work still has its place in production. Each reamer and file is elaborately finished by hand (Fig. 7). VDW initially wished to automate this manual work too, but the employees are so good at their work that they can produce the tip with exactly the required cutting angle very quickly. Thirty-five million instruments therefore include some manual production and additional inspections. In addition, the company also has an automated system for the automated removal of files. Another camera checks the twisting of the reamer and files according to length and degree of twisting, preventing any warped instruments from going any further in the production process. Yet another camera checks the barbs on the reamers. A further camera monitors the status of the boxes and blisters and verifies the geometries of the instruments and their colours by means of images. The camera system is connected in real-time to the workstations in the instruments and packaging—even individual instruments—and the data can be accessed automatically. Another camera checks the labels. If there has been a printing error or an incorrect label has been used, the affected item is immediately separated by the machine.

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**That nasty term “file breakage”**

During the tour, the term ‘file breakage’ came up often. All dentists are familiar with the nuisance of an instrument breakage, for both themselves and their patients. There are many reasons for a breakage, ranging from a complicated root canal anatomy to incorrect preparation techniques or poor processing of materials. In the case of severely curved root canals especially, the file fragment can only be removed with great effort or pain. As recently as 30 years ago, stainless-steel instruments with only a rotational cutting action led to frequent file breakage. The cutting action of reciprocating instruments is different. These new files work with a reciprocating motion, which reduces the risk of breakage. VDW produced a new generation of reciprocating files to improve efficiency and reduce the number of breakages. The new files are designed to break at a specific point, which prevents further damage and reduces the risk of injury to the patient.

**A specific focus on Asia**

VDW has been represented in Japan for ten years, but other Asian-Pacific countries have been directly served since 2007. The Asian market has great potential for us. Since 2005, China has been the number one market in Asia. Of course, we are always interested in new markets for our products; for example, VDW has been represented in Vietnam since the beginning of 2016,” Hu explained.

For some years, VDW has been focusing more intensely on China (Fig. 8). “In June, VDW had its own stand at the Sino-Dental exhibition in Beijing. Being the largest dental trade fair in China, it attracted about 60,000 visitors. Sino-Dental
Apical transportation

Microsurgical handling of a procedural error during apical mechanical preparation

Prof. Leandro A.P. Pereira, Brazil

Endodontics is the dental specialty that is concerned with treating or preventing pulp pathologies and apical periodontitis. The main objectives of endodontic treatment are to clean and disinfect the entire length of the root canal system up to a healthy level. When, through meticulous treatment, such objectives are achieved, success rates can exceed 94 per cent.1,2 In pursuit of such results, during endodontic therapy, mechanical preparation is carried out with endodontic instruments and chemical preparation with irrigating solutions.

After cleaning and shaping, endodontic filling must be performed to fill three-dimensionally and seal the endodontic space in order to prevent bacterial recontamination, maintain the physiological conditions achieved through the previous steps. The mechanical preparation of the root canal system is of utmost importance in the process of establishing endodontic sanitation.3 It is responsible for physically removing the infected dentine and, consequently, bacteria located within the dentinal tubules. In addition, it increases the diameter and shapes the main canals, facilitating flow of larger volumes of irrigating solutions to the apical third.4 It also creates a favourable conical shape for endodontic filling. Therefore, it directly influences the quality of the disinfection process and, consequently, the prognosis of the case.

Procedural errors during mechanical preparation may make it impossible to achieve the required disinfection levels. Youssuf et al evaluated 128 endodontically treated teeth using digital radiography and found procedural errors in theCanal transportation of Type III, it is possible to clean and fill the canal effectively. Apical transportation of Type IV is not possible and requires the use of gutta-percha endodontic filling. Apical transportation of Type V is not possible and requires the use of gutta-percha endodontic filling.

Clinical case

A 55-year-old female patient, American Society of Anesthesiologists Physical Status Class II, visited the dental office complaining about spontaneous, constant pain, exacerbated during mastication and apical palpation in the region of teeth #13 and #11, which had been treated endodontically over the course of the last three months. The patient reported that she did not feel pain before the initial endodontic treatment began. After the first endodontic session, during which teeth #13 and #11 were treated, disinfection and proper filling. Thus, these steps should be performed as well as possible and be followed by an apical microsurgery to remove the untreated apical region.

Fig. 1: Initial clinical view of tooth #11.— Fig. 2: Initial clinical view of tooth #13.— Fig. 3: Initial radiograph.— Fig. 4: Tomographic image demonstrating the transportation of the foramen of tooth #11.— Fig. 5: Tomographic image demonstrating the transportation of the foramen of tooth #13.— Fig. 6: Clinical image captured under the operating microscope showing the original canal trajectory and apical deviation of tooth #11.— Fig. 7: Radiograph of an apical file positioned in the apical deviation of tooth #11.

Fig. 8: Apical cap with MTA Repair HP.— Fig. 9: Canal drying of tooth #12 with SurgiTip (MANUFACTURER).— Fig. 10: Retrofilling of tooth #12 with MTA Repair HP.— Fig. 11: Immediate postoperative radiograph.— Fig. 12: Control radiograph five months later of the periapical repair.
configuration of endodontic access already suggested problems in chemical-mechanical preparation of the root canal system (Figs. 1 & 2).

Endodontic therapy was begun in teeth #13 and #11, and transportation of the foramen Type III was radiographically observed. On tooth #12, there was a full crown, a metallic intra-radicular retainer and signs of a poor endodontic treatment (Fig. 3). On the CT scan, it was possible to visualise the transportation of the foramina of the two teeth (Figs. 4 & 5).

Owing to the severe apical deviation of teeth #11 and #13, the recommended treatment was endodontic retreatment, complemented by an apical microsurgery. Treatment of tooth #12 was also needed through cleaning, shaping and disinfection of the canal system with consequent endodontic filling. However, as the prosthetic crown of this tooth was adapted and microsurgery was already planned for the neighbouring teeth, the decision was to perform a retrograde endodontic treatment.

Treatment was initiated with the endodontic retreatment of tooth #11, followed by that of tooth #13. The canals were irrigated with 2.5 % sodium hypochlorite, followed by 17 % EDTA, both with passive ultrasonic irrigation and prepared with RECIPROC 50 (VDW). Using an operating microscope and peri-apical radiographs, it was possible to visualise the apical deviation of tooth #11; however, it was not possible to follow the original trajectory (Figs. 6 & 7). The same occurred with tooth #13. Owing to the great irregularity of the walls of the canals after transportation of the foramina, it was not possible to perform the proper locking of a gutta-percha cone. For this reason, the decision was to perform an apical cap of 4 mm with MTA Repair HP cement (Angelus; Fig. 8). The filling of the rest of the canals was performed using thermo-plasticised gutta-percha with MTA-Fillapex cement (Angelus). MTA-Fillapex contains particles of MTA in its composition.

After the end of this stage, the patient underwent apical microsurgery, during which the apical area corresponding to the apical iatrogenic region was removed with a piezoelectric instrument and a W1 tip (CV Dentus). On tooth #12, a piezoelectric apicectomy using the same instrumentation was performed, and the canal was retro-prepared to the depth corresponding to the apex of the molten metal core present. After drying the canal with a surgical suction pump coupled to a vacuum pump, the procedure continued with retrofilling using MTA Repair HP (Figs. 9–11).

Five months after microsurgery, the patient returned for clinical and radiographic control. Clinically, she did not complain about pain or discomfort. Radiographically, a rapid repair of the periphery of the three teeth involved was observed (Fig. 12).

Conclusion

The chemical-mechanical preparation phase of the root canal system is of utmost importance for the success of endodontic therapy. Operational errors at this stage, including transportation of the foramina, can dramatically compromise the prognosis of a case.

Therefore, it is extremely important to prevent these. Depending on the severity of the error, however, it can be repaired. Post-operative clinical and radiographic control showed that microsurgical complementation can be a safe and predictable clinical option.

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