No long-term change found in caries prevalence in early South-East Asians

Archaeological findings question relationship between rise of agriculture and oral health

Researchers from Germany have discovered that fluoride decreases the adhesive forces of oral bacteria and cariogenic pathogens in particular. Testing the adhesion of caries-inducing Streptococcus mutans, Streptococcus oralis and Staphylococcus carnosus to smooth, high-density hydroxyapatite surfaces, which were produced especially for the experiments and resembled tooth enamel in their composition, they observed lower adhesive forces after fluoride treatment of the surfaces in all bacteria species. Compared with untreated surfaces, the adhesion was only half as strong.

In contrast to prior studies that traced the cavity-preventive effect of fluoride back to effects on demineralisation, the findings suggest that the decrease in adhesive forces is a key factor of the cariostatic effect of fluoride. This could help improve dental fillings, dentures and implants in the future, the researchers concluded.

Taiwan, Philippines renew partnership

The dental associations of Taiwan and the Philippines have extended their partnership that provides basic dental services to Filipinos with no or limited access to oral health care. According to both organisations, the new programmes will start in July and primarily target people living in Luzon, the largest island of the country inhabited by 60 million.

The agreement was signed during the 104th annual convention of the Philippine Dental Association in April and is the third renewal of the partnership that was established in 2008. Since then, both organisations have been providing support to and medical equipment for dental programmes conducted in various parts of the Philippines.

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Clinicians use YouTube to explore origins of dental fear

Hong Kong/Perth/Australia/Shah Alam, Malaysia: With currently 800 million users per month, YouTube has become one of the most frequented websites on the Internet. Owing to its popularity, the video-sharing platform is increasingly used by scientists to research social patterns and behaviour. The latest study, conducted by paediatricians and public health experts across the Asia Pacific region, sought to investigate dental anxiety triggers in children and adolescents.

By analysing 182 videos with people expressing their views and experiences on the condition, they found that fear of the dentists not only has different manifestations and impacts but is also caused by yet underestimated factors like improper behaviour or work ethic of the clinicians. Another major cause was reported to be the influence of parents and peers who shared unpleasant dental experiences with their children or used their fear of a dental visit for making them more compliant.

Commenting on their findings, the researchers stated that results do not only allow better insight of how the condition emerges and manifests over time but also that social media like YouTube can offer some value for understanding health issues better. However, they recommended to confirm their findings through more examinations incorporating in-depth interviews with patients and parents.

“Dental fear and anxiety in children is known to cause uncooperative behaviour during dental visits, delays in treatment, sleep disorders and psychological issues that can affect daily life,” said co-author Professor Nigel King from the University of Western Australia’s Faculty of Medicine. “The personal narratives and original sharing uploaded spontaneously by patients and the public to YouTube provide a rich context to our existing knowledge of dental fear.”

Previous studies on children and adolescents have suggested dental fear to be caused primarily by negative dental experiences gained prior to treatment, among other reasons. According to a 2007 report from Sweden, approximately 1 in 10 children is currently estimated to suffer from the condition, however, other studies have considered this number to be higher.

Common treatment techniques for dental anxiety include the use of sedatives like nitrous oxide/oxygen or distraction methods.

International Imprint

Dental Tribune Asia Pacific Edition

Licencing by Dental Tribune International

Copy Editors: Sabrina Raaff

President/CEO: Torsten Oemus

Dental Tribune USA, LLC

International Sales Team

President/CEO: Torsten Oemus

Tel.: +49 341 48474-107 · Fax: +49 341 48474-173

Hofestr. 29, 04229, Leipzig, Germany

info@dental-tribune.com

Tel.: +49 341 48474-107 · Fax: +49 341 48474-173

Hofestr. 29, 04229, Leipzig, Germany

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National University of Singapore to expand dental faculty and services

SINGAPORE: The National University of Singapore’s Faculty of Dentistry is on the brink of a major expansion, Dental Tribune Asia Pacific has learned. Officials recently unveiled plans to transform the current facilities into an oral health-care centre, which will include the construction of a new, state-of-the-art building and extend the university’s clinical offering.

In addition, the centre will facilitate research on regenerative biology and tissue engineering, among other fields. The opening of the new centre is anticipated for 2017, according to reports by the Singapore newspaper The Straits Times.

Teaching, research and clinical services at the faculty are currently hosted in different facilities at the university itself and the National University Hospital. Established in 1929 by the British, the faculty offers a number of dental programmes, including a Bachelor of Dental Surgery and Master of Dental Surgery.

Speaking to Dental Tribune, the faculty would not divulge any further details on the matter, saying that the expansion is still in predevelopment.

Fossil teeth like this found in Thailand were examined by the researchers. (DTI/Photo courtesy of Sian Halcrow, University of Otago, New Zealand)

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Fossil teeth like this found in Thailand were examined by the researchers. (DTI/Photo courtesy of Sian Halcrow, University of Otago, New Zealand)

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DT Asia Pacific
Dear reader,

Have you visited Tokyo lately? In a few week or days, depending on where you get this edition, the next congress of the International Federation of Endodontic Associations (IFEA) is going to take place in the capital of Japan and for the first time, the Dental Tribune International Publishing Group will be represented not only by our Japanese licence partners Medical Tribune but also by Modern Dentistry Media from South Africa, who recently joined our network and will be organising FIEAs next congress in 2016. If you happen to be there, I encourage you to pay them a visit.

For all those readers missing out on the event, our newest endodontic supplement on pages 19 to 31 will give you an extensive overview about endodontic irrigants and retreatment are discussed concepts like intentional replantation and for the first time, the Dental Tribune International Publishing Group will be represented not only by our Japanese licence partners Medical Tribune but also by Modern Dentistry Media from South Africa, who recently joined our network and will be organising FIEAS next congress in 2016. If you happen to be there, I encourage you to pay them a visit.

A threat to the dental professional

The main purpose of the use of robots is to increase the precision, quality and safety of surgical procedures. Following the developments in industrial robot technology, robotics has found its way into the medical field and is used in a range of surgical disciplines. Robotics is not yet used in dentistry even though all the necessary technologies have already been developed and could easily be adapted. Some of the technologies are already used in dentistry, such as image-based simulation of implant surgery followed by the use of surgical guides, and creating digital impressions of preparations using an intra-oral scanner.

Such a robot would fundamentally be a dental drilling device coupled with a navigation device to determine the correct position of the device in relation to the patient. The robot would either be operated directly by a dentist or be preprogrammed to perform its functions based on imaging data (CT scan). Finally, an intra-oral scanner would be used to make digital impressions. This data would then be transferred to the lab to produce temporary crowns or bridges in a very short time using a milling machine and to manufacture the final restorations in much shorter time than with conventional procedures.

Robotic technology could offer dentistry improved accuracy, predictability, safety, quality of care and speed of treatment. One might wonder why robots have not yet been introduced to dentistry, as the functions needed are relatively simple. An explanation could be that it is an example of a disruptive technology, meaning that the current manufacturers of dental equipment might fear a negative effect on their current business and the alienation of dentists, as robots might be seen as a threat to dental professionals.

Dental Tribune International

Contact Info

Dr Steen Sindet-Pedersen
Professor of Oral-Maxillofacial Surgery at the European University College in Dubai, United Arab Emirates. He can be contacted at stensinden@hotmail.com.

Deutsche Zahnarztzeitschrift (Dental Tribune) South Africa

Contact Info

Prof. Shobha Tandon is Head of the Department of Pedodontics and Preventive Dentistry at the Babu Banarasi Das College of Dental Sciences in Lucknow, India. She can be contacted at shobhatandon2000@gmail.com.

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Ethnicity has been implicated in the susceptibility of patients to periodontitis and gingival recession. A new study from the US (Characterization of Dental Anatomy and Gingival Biotype in Asian Populations. Lee, Kim, Prusa & Kao, 2015) has added to the available evidence to further strengthen the notion that Asians are more prone to gingival recession and tooth loss.

The study examined 49 Asians from Japan, China, South Korea, and Vietnam, with an average age of 59. Data collection was carried out by three general dental practitioners, and seven index teeth were used. Tooth and root length were measured from dental panoramic radiographs, which were calibrated using 5 mm ball bearings. Gingival biotype was determined according to standard clinical protocols.

The results suggested that these 49 Asians had shorter roots and generally thinner gingival tissue compared with Caucasians. The authors used data from standard dental anatomy textbooks to obtain standard root lengths for comparison and data from European studies to obtain the Caucasian gingival biotype frequency.

The gingival biotype has important implications for increased susceptibility to recession. Gingival biotype (the relative thickness of the gingival tissue surrounding a tooth) has important implications for managing periodontal disease, as thin tissue is more likely to experience gingival recession. They may have shorter roots than average; therefore, if there is attachment loss due to periodontitis, we must be very careful to prevent further attachment loss or tooth loss will soon follow.

Correct preventative advice and treatment must be a cornerstone of managing all patients, and this group even more so.

...the residual attachment is an important prognostic indicator for teeth with periodontitis.

While clinical periodontal measurements of probing depth and recession are used to work out the clinical attachment level, in many instances, the residual attachment is an important prognostic indicator for teeth with periodontitis. Indeed, one of the reasons for using periapical or panoramic radiographs rather than bite-wing to assess periodontal status is the simple fact that one can evaluate the root length. By combining the clinical and radiographic information, one can estimate how much of the root is still attached.

Clearly, 7 mm of attachment loss on a root that is 10 mm long

Correct preventative advice and treatment must be a cornerstone of managing all patients...

The gingival biotype has important implications for increased susceptibility to recession
Extracting a tooth should be the last resort in space

An interview with former NASA dentist Dr Michael H. Hodapp, USA

A toothbrush of Buzz Aldrin, a crew member of Apollo 11 and one of the first humans to ever walk on the moon, was recently auctioned for $822,705. Fifty years later, astronauts are still using everyday oral care products on their missions. Dr Michael H. Hodapp, USA, about his work, the possibility of dental emergencies in space and how to maintain good oral health on future long-term missions to Mars.

Daniel Zimmermann: Do you know how many dentists are currently employed by the agency?

Dr Hodapp: Owing to the recent cutbacks to NASA’s budget, they have closed the NASA dental clinic so there are no dentists contracted by the agency at this point. Astronauts seek dental care from private practitioners, and are followed closely by NASA-employed flight physicians.

Dr Hodapp, how did you become involved with NASA?

In 1994, another dentist working for NASA informed me that a position had become available to care for the astronauts and their families at NASA, and asked me if I would be interested. After a series of interviews, I was appointed to the position. I served NASA as a contractor for over a decade before I went back into private practice in 2004. However, I am still called on occasionally as a consultant for dental issues aboard the International Space Station (ISS) and future exploration-class missions.

How important is oral health for astronauts in general?

Oral health is a primary concern for astronauts and goes hand in hand with general health. All astronaut candidates are initially screened for dental issues prior to selection, and all those selected are expected to adhere to a meticulous oral hygiene routine and maintain good oral health. The primary goal is prevention. Yet, even with the highest standards in prevention, the potential for a dental emergency in space still exists. A recent analysis of all medical conditions determined that the one condition most likely to result in departure from the ISS is a dental abscess.

Russian cosmonaut Yuri Viktorovich Romanenko had to go through two weeks of incapacitating tooth pain during the Soyuz mission in 1978. When were dental emergencies first included in mission protocols?

Unfortunately for Romanenko, according to reports, the Soviets did not have a dental contingency protocol at that time. The Russian space programme has since made provision for such emergencies, however.

During the US Mercury programme, the flights were so short that there was no need for an in-flight dental emergency protocol, and prevention was the primary focus. Owing to the extended time spent in space during the Gemini programme, a toothbrush was added to flight kits as a preventative measure.

A toothbrush of Buzz Aldrin, one of the first humans to ever walk on the moon, and one of the first humans to go to space, has since made provision for dental emergencies, however. The potential for a dental emergency in space still exists.

How frequently are astronauts given pre-flight check-ups?

Astralonauts undergo pre-flight exams 18 to 24 months before launch. During this exam, the astronaut undergoes a thorough clinical and radiographic exam, including bitewing and panoramic X-rays. All necessary treatment is then to be completed 90 days prior to launch. The astronaut undergoes an additional exam to rule out any hidden pathology or any unreported recent oral injuries 50 to 90 days before launch. The astronaut is also expected to follow a meticulous oral hygiene routine during flight.

No in-flight dental emergency has ever been reported by NASA. What kind of problems do you think are most likely to occur?

While the chances of a dental emergency occurring in space are low, the potential is always there. For instance, when astronauts move large objects, the inertia of mass and velocity can potentially cause facial injuries and result in either a medical or dental emergency or both. Besides breaking a tooth, other considerations include laceration, laceration, grinding, split teeth or the fracturing of a cusp while chewing. Even with most meticulous dental exam and hygiene programme, there is always a possibility that a tooth abscess could form due to trauma, hidden caries or a failing root canal.

Which dental emergencies are astronauts trained to handle by themselves?

There are two crew medical officers (CMOs) aboard every mission and they are trained to perform a number of dental and medical emergency procedures. On board, CMOs have the capability to treat with antibiotics and analgesics, administer anaesthesia, place temporary dental fillings, replace a crown with temporary cement, treat exposed pulp, and as a last resort, extract teeth. Any emergency treatment would involve communication with ground support flight physicians, as the CMOs are not necessarily physicians or dentists themselves. However, since the ISS is in low Earth orbit, such emergencies would likely result in a return to earth for proper treatment.

Future missions will take astronauts to other planets in the solar system, like Mars. Have you ever thought that these long-term flights pose regarding oral health?

We still do not know the long-term effects of space flight on the teeth, alveolar bone and periodontal health. It is well documented that during space flight bone mineral density decreases in weight-bearing bones. It is not clear how this affects the teeth and alveolar bone and whether crew members are more susceptible to tooth decay or periodontal disease.

Skylab oral health studies determined that there were increased counts of caries-producing bacteria such as Streptococcus mutans among crew members. It was concluded that this was due to the dehydrated diet that astronauts consume. This could be a potential contributor to oral health issues during extended missions, especially if a crew member begins to lapse in proper oral care.

Dental emergencies in space would be challenging to handle as well. A mission to Mars would require a flight duration of six to nine months. Owing to the alignment of earth and Mars, the nominal mission would spend either 50 days or a year and a half on the Martian surface. Were an oral emergency to occur during the outbound flight, there would not be a safe-return-to-earth capability. Not enough fuel could be carried to counteract the forces of launch that propel the crew on their voyage. In essence, all emergencies would have to be handled by the CMOs either in flight or on a planet with a little more than one-third of the gravity of earth.

“...even with the highest standards in prevention, the potential for a dental emergency in space still exists.”

Dr Michael Hodapp served as consultant for NASA between 1994 and 2004.
In space, “for every action, there is an opposite and equal reaction” has special meaning to the treating CMO and the crew member receiving treatment. Just the act of giving an injection would send the crew member and CMO darting away from each other if proper techniques were not followed. The luxury of gravity does not exist, and simple procedures can become major challenges without it. Consider for a moment trying to give CPR without the force of gravity holding you in place.

Working in the oral cavity poses special concerns, since the very act of breathing not counteracted by gravity would have a tendency to draw anything loosely held within the oral cavity back into the lungs.

There is also the concern of the limited medical skills of CMOs, and the one-way communication delay with ground support of 20 to 25 minutes. In other words, it could take 45 minutes for a flight physician to deliver instruction to the treating CMO. Prayers would be in order for the afflicted crew member.

What measures are being considered to overcome these problems?

Recent discussions in relation to exploration-class missions have proposed instrumentation for semi-annual dental exams and cleaning for each crew member, as well as additional equipment for the diagnosis and treatment of dental emergencies. Some of the equipment considerations include a high-definition intra-oral camera system, a method for detecting interproximal decay and osseous infections while limiting radiation, as well as a battery-operated dental handpiece and headlight.

Material considerations include an intermediate restorative material that is easy to use, does not require special equipment for mixing or curing, releases fluoride, and could last for the duration of an exploration-class mission. The US Navy is currently conducting research on a restorative material that fits this description. A glass ionomer restorative material is also under consideration, although this would require special packaging to allow for controlled mixture by hand in a microgravity environment.

Discussion about medications indicated that all drugs would need to be freshly manufactured and would require special packaging to maximise shelf life, especially those medications that are sensitive to moisture and radiation.

Software considerations include training videos for the crew members to review and train to keep abreast during their travel.

President Obama speaks of sending humans to Mars as early as 2018. Do you believe that these plans are realistic? It is my understanding that there are no definitive plans for a manned mission to Mars in the near future. Recent cuts to NASA's budget have slowed progress for a manned mission to the red planet. Our closest neighbour is explored using robotics, and there is much to learn about Mars prior to risking the lives of humans on such a distant journey.

However, planning and research for manned exploration-class missions is still being conducted, and the Orion project is still in progress. There are so many hurdles to overcome before such a journey could be undertaken. Currently, NASA is formulating plans for a three-month mission to rendezvous with a near-earth asteroid. This would be a scientific mission requiring a one-month flight to rendezvous with the asteroid, conduct research and fly back to earth.

If NASA offered you the opportunity to go to space, would you accept it? Since I was a young boy I have looked to the heavens and been fascinated by its beauty and have always dreamt of going into space. Given the opportunity, I would go in a heartbeat.

Thank you very much for this interview.
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**DTI**

**BIBERACH, Germany/SINGAPORE:** KaVo has announced a digital 3-D cone-beam X-ray system called 3D eXam that is claimed to generate high-resolution 3-D radiographs at a lower cost and with less radiation compared with traditional panoramic X-ray tomography.

According to the German dental equipment manufacturer, the volumetric diagnostic imaging system of KaVo 3D eXam provides clinicians with a detailed view of all oral and maxillofacial structures for sound diagnostic data that allows a thorough analysis of bone structures, as well as orientation of the teeth. Optimum implant placement can be assessed as well, the company said.

For the analysis of the bone morphology of the temporomandibular joint (TMJ), the TMJ cleft and joint function, 3D eXam can also capture 5-D images of the condyles as part of the surrounding structures. Furthermore, it replaces panoramic, cephalometric and individual-tooth images with a single volumetric image.

According to KaVo, 3D eXam has an average exposure time of only 8.5 seconds, which reduces exposure to radiation and the quality loss caused by patient movement. Owing to its high definition, 3D eXam provides excellent resolution even for small voxel sizes of 0.125 mm.

Japanese corp close to market entry in the Philippines
Lion starts joint venture with Peerless Products Manufacturing

**DT Asia Pacific**

PASAY CITY, the Philippines: The Lion Corporation has announced that the launch of its Philippines Peerless Lion joint venture is in its final stages. The first products, ranging from toothbrushes to mouthwash, are anticipated to be distributed from the middle of this year, representatives of both companies disclosed during a convention held by the Philippine Dental Association in Pasay City in April.

The joint venture with Peerless Products Manufacturing, a producer of soaps and household cleaners based north of the capital Manila, will give the Tokyo-based oral health care giant access to a market worth PhP 70 billion (US$14 billion), which Filipinos are estimated to spend annually on oral health care products. Currently, the toothbrush and toothpaste market in the South East Asian country is dominated by global companies like Colgate-Palmolive, GlaxoSmithKline and Unilever, according to a 2009 report by US market intelligence provider Research and Markets.

Lion, which also manufactures a number of beauty products and pharmaceuticals, will hold a majority share of 51 per cent in the new joint venture, while Peerless will hold 49 per cent. Both companies agreed to cooperate back in 2011.

Already active in most South-East Asian markets, Lion is also operating in South Korea and China, through affiliates. With its Systems, Kodomo and Zact brands, the company holds approximately one-third of Japan’s US$1.2 billion toothbrush and toothpaste market. Recently, it launched a new toothpaste targeting consumers suffering from hypersensitivity and periodontal disease, among other products.

Last year, Lion gained ¥244.2 billion (US$2.4 billion) from its consumer products business, of which 17 per cent was achieved through overseas sales.

Indian dental business receives large-scale investment

**DT Asia Pacific**

NEW DELHI, India: Indian private equity firm Asian Health Care Fund (AHF) has confirmed that it will be investing significantly in one of the country’s largest dental chains. According to CEO Ajay Kumar Vij, his company intends to pump INR 840 million (US$70 million) into Western Indian-based Total Dental Care, which runs dental clinics in Mumbai and Pune under the mydentist brand.

In addition to the investment from AHF, mydentist is also reported to have received INR 800 million (US$8.5 million) from its main investor, Seedfund, in Mumbai.

Founder and CEO Vikram Vora said in a statement that with the upcoming cash injection his company aims to increase the number of mydentist clinics from 40 currently to over 120 across both cities. Opportunities for expansion into other parts of the country are also being evaluated, he said.

Mydentist is AHF’s first investment since the fund was set up by Vij and the chairman of the Dabur group, Kandur Burman, in 2010. According to Burman’s company, it is intended to identify opportunities for investment in the country’s booming healthcare sector. Dabur is one of the largest consumer goods providers in India, selling foods, and personal and health-care goods like toothpaste. Last year, it reported revenues of INR 852.8 trillion (US$966.2 billion) worldwide.

In addition to Dabur, AHF is believed to have several other investors.
“Progress is not realised until technology is available to the masses”

An interview with Ultradent CEO, Dr Dan Fischer

Daniel Zimmermann
DT

At the International Dental Show in Cologne, Germany, US company Ultradent launched a new restorative option with the Edelweiss composite veneer system. Company president Dr Dan Fischer sat down with Dental Tribune International to speak briefly about the concept behind the unique system and its advantages compared with commonly used ceramics.

DT International: Dr Fischer, you seem to be very excited about this IDS.

Dr Dan Fischer: The activity here is extraordinary and we have never been busier than we are at this show. Our people always try to raise the bar and offer better products for the whole dental team. It has also been nice to rub shoulders with old friends again.

Your company has become a household name in dental offices worldwide. How would you describe your business philosophy?

We are known as an innovative company that aims to go to places where others have not been before. That means that we also tread a different path to many manufacturers, driven by our passion to reach a larger segment of humanity. For instance, we have zero interest in developing ceramics for dentistry that only five per cent of the world’s population can afford.

As a company, we want to be able to offer lower socio-economic groups preventative measures and affordable materials like the new Edelweiss veneers that are being presented here. I think Henry Ford said it best when he said that progress is not realised until technology is available to the masses. Our first goal is to reach the masses.

Your company has delivered a high level of support, sometimes even when quality adhesives are used. Direct-placed composite can provide a very good result, but for the majority of clinicians it can be time-consuming and produce results that are not ideal.

Dental veneers are very popular indeed. What are the shortcomings of the current market offerings, and how does your company plan to position itself?

Dental veneers have been used extensively for many decades now and ceramics have been by far the most common materials used. It is important for clinicians to remember, however, that a ceramic must be supported chiefly by enamel not dentine—even when quality adhesives are used. Direct-placed composite can provide a very good result, but for the majority of clinicians it can be time-consuming and produce results that are not ideal.

For these reasons, we developed a laser-sintered, pressure- and heat-formed composite veneer system with Edelweiss. The laser sintering offers a predictable, quality, aesthetic finish that is extremely wear resistant. The heat formed (500 °C) composite bonds at very high values, but it can also flex, allowing it to perform well and with greater resistance to cracking, even when bonded to dentine. Since Edelweiss composite veneers are preformed, their laser-sintered enamel shells provide a more cost-effective alternative to laboratory veneers.

In addition, Edelweiss allows for ideal shade selection via the composite used to customise the veneers to the preparation. This can be done for a direct modality or an indirect modality.

Edelweiss veneers offer a great solution not only for the patient on a budget, but also for teenagers and people who play contact sports. They are also great when used for lower anterior veneers because the wear against opposing dentition is superior to that of ceramic. Edelweiss is an incredibly versatile veneer option.

“It looks like the product has already generated much interest here. That is right and our office in Cologne was very keen on having Edelweiss veneers here for the first time. We already have many students using them and loving them back in the US, as well as some very enthusiastic dentists offering courses. I am sure that they will help us to fulfil our vision of reaching more patients.

You are known to work closely with your customers regarding education. Will you also be offering hands-on seminars for Edelweiss users?

We have already begun with educational support. As recent- ly as last week, two hands-on courses were provided at the annual American Academy of Cosmetic Dentistry meeting in Seattle, Washington, for example.

What is the global launch schedule for Edelweiss, and will it be available everywhere?

Edelweiss will soon be available everywhere. For example, the inventor of Edelweiss Dr. Stephan LampJ just completed a multi-city, multi-country trip through South-East Asia. The response there was very good.

Thank you very much for the interview.
KaVo 3D eXam
Cone Beam 3D Dental Imaging System

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Quick Scan speeds scanning time to just 4.8 seconds, producing high volume images quickly with lower dose to the patient.

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A minimally invasive approach to correcting diastemas

Metal-free restorations have become well established in aesthetic restorative dentistry. New clinical applications and possibilities provide users with a vast array of treatment options. Minimally invasive and in some cases even preparation-free restorations have become feasible owing to new materials and recent advances in adhesive techniques. It is recommended, however, that the indication at hand be carefully assessed to achieve a restoration that meets the given aesthetic and functional requirements optimally.

A 31-year-old male patient presented to us with a request for the aesthetic improvement of the anterior region (Fig. 1). A clinical examination showed us a large anterior diastema. His medical history did not reveal any symptoms or complaints related to the occlusion or temporomandibular joint dysfunction.

Metal-free crowns however may present an alternative treatment option. This option may not always sufficiently prevent the loss of healthy tooth structure because closing the gap with conventional ceramic veneers necessitates an invasive preparation method.

If this treatment option is selected, the tooth is provided with a small cervical shoulder on the basis of a diagnostic wax-up. Additionally, approximately 2 mm of tooth structure is removed in the incisal region and the vestibular area is slightly reduced. Whilst, without doubt, this presents a suitable treatment option, some dentists feel that this preparation method is not adequately conservative. The issues concerning the removal of healthy tooth structure can be avoided by using non-preparation ceramic veneers, which do not require any reduction of tooth structure.

Conservative though it may be, it entails some limitations mainly related to aesthetics and the working procedure in the dental laboratory. Although correcting a diastema seems to be a straightforward procedure initially, a deeper look makes it clear that several treatment possibilities are available. It also raises questions concerning whether it will be possible to close the gap between the teeth completely and whether an appropriate emergence profile will be achieved in the interproximal region. Other issues include whether “black holes” will remain visible in the interdental space or whether the interdental papillae will be present at the end of the treatment.

When selecting a treatment option, we should always aim for the best possible aesthetic outcome that requires the removal of minimal tooth structure.
Reliable

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of the least possible amount of tooth structure. In other words, we aim to achieve the best possible solution. With this in mind, we decided to use ceramic veneers and apply a preparation technique that, from our point of view, was suited to achieve that goal by not preparing a cervical shoulder and by reducing the incisal, vestibular and proximal surfaces only minimally. It served to provide appropriate guide surfaces for the veneers and to achieve ideal conditions for the dental technician to create true-to-nature restorations.

Taking an initial impression using an addition-reaction silicone (Virtual, Ivoclar Vivadent) is indispensable for accurate treatment planning, the fabrication of a diagnostic wax-up and the implementation of preliminary treatment steps. A diagnostic wax-up was made by the dental laboratory and then used as the basis for the mock-up (Systeme, clk II) with the help of a silicone key. The result and the proportions of the teeth, contoured in wax, in the oral cavity could thus be accurately visualised. It was found that the size and shape created a harmonious and natural-looking overall impression (Fig. 2).

The silicone key for the diagnostic wax-up was also useful as a reference in the preparation. First, the incisal surface was reduced by approximately 1 mm. The silicone key demonstrated that some portions of the incisal area only needed to be smoothed out, as they already offered enough space (Fig. 3). Next, the proximal areas were slightly reduced in order to create a guide surface for the veneers. This reduction should cause the proximal margins to be positioned slightly towards the vestibular. The vestibular preparation involved only the reduction of the ridge between the proximal and vestibular surfaces (Fig. 4) and the reduction of the vestibular area to allow for the contouring of the veneer (Fig. 5a).

Finally, the preparation was finished with grinding discs at reduced rotational speed. The result was then checked with the silicone key to ensure that a sufficient amount of tooth structure had been removed for the design of the veneers (Fig. 5b). For the working procedure in the laboratory, an impression was taken using (virtual) and the double-cord technique (Fig. 6).

Thin ceramic veneers were fabricated with the IPS e.max System (Ivoclar Vivadent) using the press technique and carefully individualised with the layering technique. The technician’s extensive technical expertise and skills were very important in achieving this task, particularly considering the limited amount of space available (Figs. 7 & 8). During the try-in, the accuracy of fit, shape and shade were checked and the design was evaluated to ensure that it adapted well. Try-in and shade determination were performed using the Variolink N Try-In pastes (Ivoclar Vivadent) in various shades. We opted for the Transparent shade and to achieve ideal conditions for the dental technician to create true-to-nature restorations.

Prior to cementation, the tooth surface was conditioned with 57 % phosphoric acid for 30 seconds, followed by rinsing with water, drying with air and application of ExciTE F adhesive (Ivoclar Vivadent: Figs. 9 & 10). The adhesive was spread in a thin layer and light cured. Meanwhile, the veneers were pretreated with 5 % hydrofluoric acid for 20 seconds, rinsed with water, dried and silanised with Monobond N (Ivoclar Vivadent). For cementation, Variolink N was used.

The veneers were placed in situ one by one (Fig. 11) and cured with a bluephase 20 curing light (Ivoclar Vivadent) — restoration margins should be covered with a glycerine gel or AirBlock Liquid Strip (Ivoclar Vivadent) to avoid the formation of an oxygen inhibition layer. Finally, excess composite material and the retraction cords were removed (Figs. 12 & 13), the occlusion and articulation adjusted, and the restorations finished using OptraFine ceramic polishers (Ivoclar Vivadent).

Conclusion

Correcting a diastema with minimal removal of healthy tooth structure was a successful approach in this case (Fig. 14). In conclusion, advanced metal-free ceramic systems could be said to be the best choice for aesthetic dental treatments, as they offer ideal results, functionality and durability.  

Contact Info

Dr. Roberto Yoshiida maintains a private practice in Lombardia in Brazil. He can be contacted at roberto@yoshida.roberto@yoshida.com.br.

Marco Celestino is in charge of the laboratory Aliança in São Paulo in Brazil. He can be contacted at aliancia@ laboratorioaliansa.com.br.
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A novel solution for anterior implant aesthetics
Implant placement combined with hard- and soft-tissue augmentation via the VISTA technique

Nowadays, implant therapy in the anterior aesthetic region requires more reliable materials and surgical techniques in order to enhance clinical outcomes. Owing to patients’ increasing expectations, practitioners have to strive for a result that not only meets expectations, but also satisfies aesthetic demands.

The creation of a natural and harmonious restoration in the aesthetic zone has stimulated debate among clinicians for at least a decade. In this case report, hard- and soft-tissue augmentation was performed simultaneously with implant placement using the Vestibular Incision Subperiosteal Tunnel Access (VISTA) technique. With the help of this technique developed by Dr Homayoun Zadeh, it is easy to regenerate damaged labial bone and close the jumping gap of extraction sockets. Moreover, it can improve blood supply and soft-tissue stability.

For achieving an appearance similar to natural teeth, adequate hard- and soft-tissue support is a prerequisite to implant placement in the ideal position.4-6 From a prosthetic point of view, the ideal position for an implant usually requires the establishment of a significant amount of bone and soft-tissue volume using grafts in order to maintain aesthetics during the healing process and tissue remodelling.7-8 An aesthetic outcome therefore still remains challenging, even for an experienced clinician.

Since 2002, many articles focusing on immediate or early implant placement in extraction sockets have been published. Studies have shown that immediate placement can reduce treatment time. However, this involves different classifications and treatment recommendations. In 2005, for example, Dr Joseph Kan introduced a novel classification for immediate implant placement, in which buccal bone and histotype are carefully measured (Table 1).9 For Class I and 2, immediate implant placement is possible and predictable.

Soft-tissue contour is a concern in aesthetic restoration. Therefore, Kan tested a new technique called bi-laminar subepithelial connective tissue.10-12 For Class I and 2, immediate implant placement is possible and predictable.

The VISTA technique is a new concept in aesthetic implant dentistry.9 Instead of making a horizontal incision in the sulcus or in an experienced clinician.

Table 1: The extraction defect sounding classification.

<table>
<thead>
<tr>
<th>Defect type</th>
<th>General assessment of affected</th>
<th>No. of teeth lost</th>
<th>Ridge type</th>
<th>Bone level</th>
<th>Distance to ideal soft</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Poor</td>
<td>2-3</td>
<td>Thinner</td>
<td>6-8 mm</td>
<td>≥ 6 mm</td>
<td>Immediate</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>narrower</td>
<td></td>
<td></td>
<td>two stage</td>
</tr>
<tr>
<td>2</td>
<td>Moderate</td>
<td>1-2</td>
<td>Thicker</td>
<td>3-5 mm</td>
<td>≥ 6 mm</td>
<td>Immediate</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>narrower</td>
<td></td>
<td></td>
<td>two stage</td>
</tr>
<tr>
<td>3</td>
<td>Severe</td>
<td>2-3</td>
<td>Thicker</td>
<td>3-5 mm</td>
<td>≥ 6 mm</td>
<td>Immediate</td>
</tr>
<tr>
<td></td>
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<td>two stage</td>
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</table>

The clinical examination revealed a relevantly healthy periodontium, with localised bone destruction visible on tooth 27. Previously, tooth 27 had been treated endodontically. She had a Class I interdental occlusal relationship, but denied bruxism and therefore the use of night-guard protection. There was no temporomandibular joint disorder and the head and neck examination was within normal limits.
In addition to its elegant and stylish design, its ease-of-use, its high image resolution and its reliability, the I-Max Touch 3D offers the ideal field of view (FOV) for use in dental imaging. With SimPlant® software pre-loaded, the I-Max Touch 3D is a MUST-HAVE for your implant planning procedure.
The extraction socket was healing with granulation tissue after one week. The CT image showed about 10 mm (mesiodistally), 7 mm (buccolingually) and 22 mm (corona-apically). According to Kam’s sagittal root classification, the sagittal root position was Class I.10

Local anaesthesia was administered (2% lidocaine with 1:100,000 epinephrine). The granulation tissue was then removed and buccal bone thickness was measured. According to the periodontal probe measurement, the buccal bone was very thin, as we could feel the vibration of the buccal plate. Therefore, hard- and soft-tissue augmentation were indicated in this particular case (Figs. 9–13) and the VISTA technique was consequently performed.

A vertical incision was made first on the middle frenum, 2–5 mm apical from the papilla in order to preserve the papilla. A Buser periosteal elevator was used to raise a full thickness flap from the vertical incision. The flap was extended to the bottom of the vestibule and coronal to the straight buccal surface of the sulcus at the extraction site (Figs. 14–17).

After the flap had been reflected, the loss of buccal plate could be observed at the extraction site. In order to obtain a good primary closure after grafting, connective-tissue grafting for coverage was recommended. After connective tissue had been harvested, platelet-rich fibrin was placed into the donor site, and sling sutures were used to achieve a good closure and haemostasis (Figs. 16–23).

Drilling was performed in accordance with the recommendations of the manufacturer of the implant system. The ideal implant position was determined to be 2.5 to 3 mm apical to the buccal gingival margin, with 1.5–2 mm between the implant and adjacent tooth and with 2–3 mm from the cervical height of contour to the buccal surface of the implant platform.10–12 After the osteotomy had been performed, a 4.2 x 14 mm platform-switching implant was placed, which achieved good initial stability (Figs. 24–28).

Two membranes were placed horizontally and vertically to augment the site via the vertical incision. Freeze-dried bone allograft mixed with bovine bone was used to maintain the volume. After that, the connective-tissue graft was sutured to the flap to cover the socket. The vertical incision was then closed and the graft was held in place (Figs. 29–34).

After four months of healing, a simple second-stage surgery was performed. Only a single incision was required to replace the healing abutment, which helped to push soft tissue buccally to improve appearance (Figs. 35–36). Two weeks later, after the soft tissue had healed, an open-tray impression technique was used to fabricate the final restorations on both teeth 11 and 21 (Figs. 41–42). Figures 33 to 40 show the seating of the crowns.

At the half-year follow-up appointment, a CT scan showed that the bone graft was stable. A harmonic result had been achieved (Figs. 17 & 18).

Discussion

Articles on immediate or early implant placement recommend preserving the labial bone and augmenting the soft tissue, changing the thin biotype to a thick biotype. The question is whether immediate implantation will be able to halt the labial bone resorption. Unfortunately, the answer is no. After a long-term follow-up, many anterior immediately placed implants without bone grafting showed extensive lateral labial bone resorption. Considering this, it is not adequate to preserve labial bone only; it also needs to be augmented to be thicker than 1 mm. It should ideally be 2 mm thick.

In Asian populations, ideal candidates for anterior immediate implantation are rare unless the criteria stated above can be met by performing augmentation procedures. Combining immediate implantation with al-laminar subepithelial connective-tissue graft can change soft tissue from a thin to a thick biotype and offer better resistance to long-term remodelling and physical trauma. However, hard-tissue augmentation remains almost impossible.

In order to perform a bone-grafting procedure, an open-flap and tension-free periosteal re-leasing incision is usually used in order to achieve adequate volume and primary closure. Inevitably, this ends with a large wound and incorrect marginal position. In areas demanding high aesthetics, it rarely achieves satisfactory results. Fortunately, the VISTA technique with hard- and soft-tissue augmentation can help clinicians without preparing the blood supply and more easily maintains an intact gingival margin. In this case report, hard- and soft-tissue augmentation was performed simultaneously with implant placement. By utilising the VISTA technique to regenerate damaged labial bone and to close the jumping gap of the extraction socket, blood supply is improved and soft-tissue stability is increased. The VISTA technique can offer greater benefits to the patient and operator, and it can shorten treatment time in the aesthetic zone.

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

Contact Info

Dr Ou Yi-Kun is a Doctor of Dental Surgery from the National Tung-Ming University School of Dentistry. He can be contacted at oufans.csdc@gmail.com.

Contact Info

Dr Chen Cheng-Yu is a Doctor of Dental Surgery from the National Tung-Ming University School of Dentistry.
Intentional replantation: A viable treatment option for specific endodontic conditions

Intentional replantation is defined as the purposeful extraction of a tooth in order to pair and protect or cause of treatment failure and thereafter the return of the tooth to its original socket. Any tooth that can beatraumatically removed in one piece is a potential candidate for intentional replantation. However, specific indications include:

- All other endodontic non-surgical and surgical treatments have failed or are deemed impossible to perform;
- Limited mouth opening that precludes the performance of non-surgical or peri-radicular surgical procedures;
- Root canal obstructions; and
- Resorptive or resorption root defects that exist in areas that are not accessible via the usual surgical approach with excessive loss of root length or alveolar bone.

The contraindications may include:

- Long, curved roots;
- Advanced periodontal diseases that have resulted in poor peri-radicular support and tooth mobility;
- Multi-rooted teeth with diverging roots that make extraction and reinplantation impossible; and
- Teeth with non-restorable caries.

In order to provide the best long-term prognosis for a tooth that is to be replanted intentionally, the tooth must be kept out of the socket for the shortest period possible, and the extraction of the tooth should be atraumatic to minimise damage to the cementum and the periodontal ligament.

The periodontal ligament attached to the root surface should be kept moist with saline, Hank’s Buffered Salt Solution (HBSS), ViSpan or Dextran solution for the entire time the tooth is outside the socket.

We have documented three clinical cases to exemplify the potential of intentional replantation as a viable treatment option in select endodontic cases.

Case I

A 14-year-old male patient presented with a fractured Lentulo spiral extending 3 to 4 mm beyond the apex of the mesiolingual root canal of tooth #46 (Fig. 2a–d). The tooth was badly broken and the instrument tightly screwed into the root canal. All efforts to remove the spiral were futile, and we were concerned that it would fracture at the apex.

Apical surgery was ruled out because accessibility to the mesiolingual root would have been limited. We decided to replant the tooth intentionally and discussed this treatment option with the patient, who agreed to our proposal. Since the tooth was badly broken, we planned to reinforce its core with a post in the accessible labial side. The tooth was moist by immersing it in ViSpan.

With help of the forceps, it was then gently curetted and the enamel junction (CEJ), as this may have damaged the cementum and the periodontal ligament.

Following extraction, we kept the tooth moist by immersing it in ViSpan. With the breaks of the forcepts, we held the tooth by its crown and cut the overextended Lentulo spiral. Thereafter, we performed a 5 mm long root-end preparation with an ultrasonic tip, at the apical end of all three canals. A retrograde filling was done with mineral trioxide aggregate (MTA). The extraction socket was then irrigated with normal saline and gently suctioned to remove blood clots. The socket was filled with tricalcium phosphate in order for the tooth to be 5 to 10 mm higher than before. This helped in planning a good post-endodontic restoration.

The tooth was carefully reinserted into its socket and brought into occlusion with digital manipulation and patient bite force. The tooth was stabilised in its socket with a suture. The patient was re-evaluated after seven days, and the sutures were removed.

Case II

A 22-year-old male patient presented with a history of trauma to his maxillary anterior region. Clinical examination revealed an Ellis Class III fracture of tooth #12, with the fracture line extending to the root palatally. Once the mobile fragment had been extracted, we realised that the fracture line extended 2 to 3 mm sub-cementally. In order to bring the apical end of the fracture line to a supracrestal position, we consid-

ered two options: orthodontic extru-
sion and intentional replantation. The patient did not accept orthodontic as an option owing to the ex-
tended treatment time required.

Once the tooth had been atraumatically extracted, it was kept moist in ViSpan. We inserted trical-
cium phosphate in the apical 5 to 4 mm of the socket and reinserted the tooth with an 180° rotation to bring the deep fracture line into a more accessible labial side. The tooth was then splinted with fibre-reinforced composite for a period of three weeks. The root-canal treatment was completed at a later date, and the facial surface was built up with composite. We decided not to pro-
cceed with the crown immediately after stabilisation to prevent loading of the tooth. The patient was re-called periodically for follow-up.

Case III

A 25-year-old female patient presented with pain in her upper right anterior tooth. There was no history of trauma, and clinical ex-
imination revealed a deep palatal- gingival groove (PGG) with respect to tooth #12 (Fig. 2e–j). The intra-
oral peri-apical radiograph re-
vealed a peri-apical radiolucency. We decided to extract the tooth, seal the groove and then replant the tooth. After adequate anaesthe-
tic had been obtained, the tooth was extracted with all the necessary pre-
cautions and immersed in ViSpan. With help of the forceps, it was then held by its crown. The PGG was debrided with the tip of the ultra-
sonic scaler and sealed with glass-
ionomer cement (GIC). The socket was then gently curetted and the tooth reinserted. Sutures were placed in the inter-dental area and endodontic treatment was com-
pleted one week later. The apical 4 to 5 mm of the root were sealed with MTA, and the rest of the root canal was back-filled with thermo-plasti-
cised gutta-percha. The patient was re-
evaluated after seven days.

Discussion

Intentional replantation in den-
tinity has been performed for more than ten centuries and was used extensively to manage odontalgia. In 1561, Pare recommended its use when a healthy instead of a diseased tooth was mistakenly extracted. In 1712, Pierre Fauchard replanted a tooth and reported it to be stable on follow-up. Several steps in the replantation were debated, for in-
stance the need for amputation of root apices, immediate or delayed replantation, root-canal obturation before or after replantation, removal or preservation of periodontal ligament cells and the goal of ulti-
mate healing—bone ankylosis or ligament repair.

It was in 1881 that Thompson presented the technique on replan-
tation of teeth and emphasised the importance of preserving cementum for treatment success. Later, Evdedé in 1887 and Scheff in 1890 ad-
dressed the role of periodontal liga-
ment cells with regard to external root resorption after replantation. As the replantation technique be-
came increasingly refined, it was used as an easy alternative for fail-
ing root-canal treatment and hence evolved sharp criticism for the tech-
nique of replantation per se.

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Fig. 2a: Clinical photograph showing stabilization of the replanted tooth with slogging suture.— Fig. 2b: Six-month follow-up.— Fig. 2c: Clinical photograph (tooth #12) showing the PGG.— Fig. 2d: PGG sealed with GIC.— Fig. 2e: introradial X-ray showing obturated canal. The sealed PGG is superimposed on the root-canal obliteration.
The ninth WEC will help to elevate the technical and scientific standards of endodontic research, practice and teaching

An interview with IFEA congress president Prof. Hideaki Suda

The last World Endodontic Congress (WEC) in Athens, Greece, in 2010 was one of the most successful events the International Federation of Endodontic Associations (IFEA) has ever organised in its 27-year history. The next edition, to be held in Tokyo in Japan from 25 to 26 May 2015, has attracted even more interest from specialists around the world, according to the organisation. Endo Tribune had the opportunity to speak with congress president and Tokyo Medical and Dental University professor Hideaki Suda.

Endo Tribune: IFEA's ninth WEC is being held in Japan for the first time. What has the organisation been like, and what are your initial expectations for the event?

Prof. Hideaki Suda: The selection of the Japan Endodontic Association to host the congress in 2015 was a decision made by the IFEA general assembly in Vancouver, Canada, six years ago. Since then, the local organising committee and its five subcommittees have had over 50 meetings concerning the preparations for the congress. Each subcommittee has also held its own meetings. We expect that the ninth WEC will help to elevate the technical and scientific standards of endodontic research, practice and teaching, as well as disseminate them throughout the world in order to improve the dental care standards in many nations.

In what regard will this congress be different from that in Athens?

Looking back at the last congress, one has to admit that it was not only extremely well organised but also very successful both at an academic and social level. At this point, we can already say that the ninth WEC will be much larger in size and participation numbers, as we already have 1,100 preregistrations from 41 member and non-member countries. Almost 500 research papers have been accepted and will be presented in Tokyo. Furthermore, there will be nine symposia and 17 table clinic presentations, where the newest scientific methods and technologies will be on display.

Owing to Japan's unique hospitality, I am sure that participants will enjoy their stay throughout the event. Japan is the country where the apex locator was developed, among other things. How would you describe the level of endodontic treatment and research in the country?

Another Japanese development was the application of adhesive dentistry principles to endodontic treatment. As you may also know, Prof. Shinya Yamanaka from the Kyoto University was awarded the Nobel prize last year for inducing pluripotent stem cells. Tissue engineering of the dental pulp has become one of the hottest topics for research in Japan and we may see the regeneration of the pulp become a reality in the near future owing to this development.

Unfortunately, there are still only a few general practitioners who are specialised in endodontic procedures, most of which are performed under the Japanese health insurance service. There-
There are many reasons for an adverse outcome of a replantation: the tooth can fracture during extraction, and adjacent tissues can be damaged, reducing the likelihood of reattachment, infection, external root resorption, and ankylosis. Therefore, it is extremely important to understand that intentional replantation should be the last choice, selected only when all the other options of treatment—non-surgical and surgical—have been exhausted. Replantation can be a treatment of choice in cases in which a surgical approach can be difficult, for example on the lingual root of a mandibular molar, or in cases in which a surgical approach would be very invasive, such as the removal of thick bone from the buccal aspect of a second mandibular molar.

Intentional replantation has a better prognosis when the extra-oral time is kept as short as possible and trauma to the periodontal ligament and cementum is minimised. It is advisable to perform routine endodontic treatment intra-oral before the tooth is extracted to minimise the extra-oral time. It is also suggested that a team of two dentists work in tandem to prevent prolonged treatment time, thus improving the chances of success. The use of elevators should be avoided, and the breaks of the extraction forceps should not go beyond the CEJ. The cortical bone integrity should be maintained, and the tooth should be extracted as atraumatically as possible.

The medium in which the tooth is kept must play an important role. Saline, HBSS, milk, Viapax, to name a few, are widely used. Viapax is used for organ transplantation and preservation. Owing to its antioxidant activity, the solution keeps the periodontal ligament moist and reduces the likelihood of surface resorption.2

We generally use ultrasonic tips to prepare the root-end and the bedrilling of the PGG. It conserves the tooth structure and produces significantly less smear layer compared with burs.3 Commonly used root-end filling materials are amalgam, Intermediate Restorative Material (IRM), Super EBA, GIC, Diatek, composite and MTA. The sealing ability and marginal adaptation of MTA have been proven to be superior and not adversely affected by blood contamination. In addition, MTA promotes deposition of new cementum and stimulates osteoblastic adherence to the retro-filled surface.

In two of our cases, tricalcium phosphate was placed in the apical few millimetres of the socket. This was done in order to bring the defect supragingivally so that the integrity, aesthetics and prognosis of the case were improved. Tricalcium phosphate is an osteo-conductive material that acts as scaffold for bone growth and is gradually degraded and replaced by bone.4

A palato-lingual groove is a developmental anomaly that represents an infolding of enamel and Hertwig’s epithelial root sheath.5 PGG can vary in depth, length and complexity, causing varying degrees of periodontal defects. Mild grooves terminate at the CEJ, whereas moderate grooves continue apically along the root surface. A treatment option for a PGG terminating close to CEJ is to expose the groove surgically and to seal it thereafter. As presented, the groove extended beyond the apex in Case III. Here, the defect was sealed extra-orally and the tooth replanted. GIC was used to seal the PGG, as it chemically adheres to the tooth structure and has a good sealing ability and antibacterial effect.6

After replantation, the tooth was splinted for ten days. The splint enabled physiological movement of the tooth to prevent ankylosis. Endodontic treatment was completed one week after replantation in order to prevent inflammatory resorption and ankylosis and to allow splicing of periodontal fibres, which limits the sepa rage of potentially harmful root-filling materials into the traumatised periodontal ligament.7,8 Final restoration of the tooth was delayed to avoid loading and to ensure that proper healing of periodontal ligament took place.

In recent years, several bio-modulators, such as enamel matrix protein,9 hydroxyapatite and platelet-rich plasma,10 have been used in intentional replantation cases to improve the success rates. Guided tissue-regeneration techniques can also be employed along with these supplements to further improve the likelihood of success. We conclude that intentional replantation is a viable treatment option in carefully selected cases in which all other treatment options have been exhausted.

We would like to acknowledge the assistance of Dr Akanksha Gupta and Dr Nikhil Sinha.
Endodontic retreatment
Achieving success the second time around

Dr Brett E. Gilbert
USA

Root-canal treatment has been shown to have a success rate of 94%. However, as research methodologies move towards higher levels of substantiation, clinicians must rely on the best current evidence available to gain insight into the expected outcomes of their treatment. The highest level and best current evidence we have on the clinical success of endodontic treatment comes from a meta-analysis of the literature.

A meta-analysis done in 2007 by Ng et al. provides a thorough review of endodontic success rates from a variety of classical outcome studies. They found a weighted pooled success rate of 68 to 85%, with at least one year of follow-up.1 This review considers the strictest of criteria for determining that a tooth has healed, and includes many studies that were completed prior to the clinical use of dental operating microscopes and other advanced instrumentation.

When considering treatment for a tooth that has not healed successfully with root-canal therapy, there are significant challenges to address in order to attain complete healing of the diseased tooth. The armamentarium and techniques available today allow us the ability to disinfest the root-canal system properly after initial treatment has led to post-treatment disease.

The success rate of retreatment has been shown to be in the range of 80% healing. Phases III and IV of the Toronto Study showed such a healing rate four to six years after non-surgical retreatment.2 In a systematic review by Torabinejad et al.3 comparing non-surgical retreatment to endodontic surgery, it was demonstrated that non-surgical retreatment had a success rate of 85% versus 71.8% for endodontic surgery after four to six years.4

The presence of pretreatment apical periodontitis is one factor that has been shown to decrease the success rate. Without apical periodontitis, a ten-year success rate of 92 to 98% has been shown for both initial and retreatment root-canal therapy. With the preoperative presence of apical periodontitis, there is a decrease in the success rate to 74 to 90% over the ten years.5 From this, it is evident that endodontic healing is attainable through retreatment procedures, allowing us to maintain our patients’ natural teeth (Figs. 1–3). Although the alternative clinical treatment option of implant placement can provide an effective method for replacing a missing tooth, healthy maintenance of the natural tooth should remain the overall goal.

Post-treatment disease is, inevitably, a result of bacteria and the host response of the patient to the bacteria. These micro-organisms are the most critical etiology of post-treatment disease, as they are present within the root-canal system of a previously endodontically treated tooth owing to a combination of substandard endodontic techniques, iatrogenic treatment issues and restorative failure.

Intra-radicular bacteria are the primary etiology of post-treatment disease and eradication of these bacteria is the primary goal of retreatment procedures. The intra-radicular bacteria present in the previously treated tooth are persistent and resist removal methods. Bacteria are able to hide and survive in canal ramifications, deltas, irregularities (fins) and radicular deltas.

Figure 2 shows the complex root-canal anatomy preferentially (green areas) and the minimal amount of canal-wall cleansing that was accomplished during canal instrumentation (red areas). The remaining green areas illustrate the space that might be left untreated, thereby providing a source of bacteria and supporting substrate for intra-canal infection. The potential substrates that are found inside the canal and help the bacteria survive can include untreated pulpal tissue, debris and irregularities in the root-canal system.

The bacteria present in the initial infection of a root canal differ markedly from the bacteria infecting a previously treated tooth. Pre-treatment flora is polymicrobial with equal numbers of Gram-negative and -positive bacteria. Post-treatment bacteria are predominantly Gram-positive6 and they have been shown to be able to survive in harsh environments and to be resistant to many treatment methods.

There are high numbers of Enterococcus species.7 Enterococcus faecalis, for example, has been shown to be a common isolate in 27 to 77% of teeth with post-treatment disease.8 It is contaminated canal space may result from incomplete cleaning initially or subsequent leakage into root-canal spaces following root-canal treatment. Once present inside the canals, E. faecalis has a variety of characteristics that allow it to evade our best efforts to eradicate it from the root-canal system, including the ability to invade dentinal tubules and adhere to collagen.9 It is also resistant to calcium hydroxide application inside the canal system, which is an interappointment treatment technique used to help remove micro-organisms and their by-products, such as lipopolysaccharides, from the canal space.10 E. faecalis’s resistance of calcium hydroxide action arises from its ability to pump hydrogen ions from a proton pump. The hydrogen combines with the hydroxyls of calcium hydroxide and neutralises the high pH value.11

E. faecalis is also able to resist calcium hydroxide by being part of a biofilm. The protection of bacteria within a biofilm matrix prevents the contact of the bacteria to the treatment bacteria are predominantly and -positive bacteria. Post-treatment bacteria are predominately Gram-positive6 and they have been shown to be able to survive in harsh environments and to be resistant to many treatment methods.

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We love to create
with irrigants and medicaments, and allows communication between bacteria to aid in survival capabilities.\textsuperscript{15,16} The presence of \textit{E. faecalis} is well documented; however, it is in post-treatment disease has yet to be proven definitively.\textsuperscript{17} Survival mechanisms, however, shine a light on the persistent capabilities of these bacteria, and our clinical techniques must be focused on the challenge of eliminating them.

Iatrogenic issues encountered during the initial root-canal treatment may be the cause of intracanal bacterial infection. These issues may include perforation, incomplete-cleansing and shaping, inadequate canal enlargement, missed canals, ledging, canal transportation, over-instrumentation, as well as obstruction of the canal by debris or separation of instruments. Failure to use or using too small a volume of an appropriate irrigant solution, such as sodium hypochlorite, is an iatrogenic error. Full-strength 6% sodium hypochlorite has been shown to be highly antimicrobial and able to dissolve bacterial biofilms.\textsuperscript{18,19} These qualities in an irrigant are ideal for the debridement of residual bacteria and tissue debris. The use of a rubber dam to isolate the treatment field is the standard of care for endodontic treatment. Failure to use a rubber dam may be a fundamental contributor to post-treatment disease. The following case illustrates the ability to overcome prior incomplete treatment to achieve successful healing (Figs. 3a–e).

Clinical example

Restorative failure is a common cause of post-treatment disease. Failure to place an effective permanent access restoration in a timely manner can allow for bacterial entry into the root-canal system by coronal leakage. Submarginal leakage on a crowned tooth can also allow bacterial entry to occur. Decay in a previously treated tooth is another source of bacterial contamination. Structural damage to a tooth by trauma, cracking or fracture may provide an entry point for bacterial contamination of the canal. Our patients are responsible for their own oral health and must commit to effective oral hygiene techniques. Failure of the patient to perform effective oral hygiene can result in the failure of even the most well-executed endo- and root-canal and restorative treatments.

With the bacterial challenges clinicians have to face, retreatment techniques must be capable of effective elimination of bacteria and their substrates. The use of a dental operating microscope and ultrasonic irrigation allows clinicians to uncover all existing canal anatomy properly to ensure that they are able to cleanse the root-canal system completely. The following clinical case (Figs. 4a & b) illustrates the extent of the canal space left untreated in the initial root-canal therapy by not opening the mesiobuccal canal adequately and not locating and cleansing the hidden second mesiobuccal canal.

Endodontic ultrasonic tips are highly efficient at removing core build-up material, paste fills, posts and silver point fillings, as demonstrated in Figure 5. These instruments allow clinicians to conserve root dentine by providing excellent visibility under a dental operating microscope, thereby greatly improving the ability to retreat canals (Figs. 6a–c). A heat source such as a System B tip (Axia, SybronEndo) is efficient for the removal of gutta-percha and resin materials from the coronal third. Hand and rotary files can remove root fillings and shape canals to appropriate working lengths. Current NiTi rotary files are highly flexible and resistant to separation and allow us to mechanically enlarge the apical third of root canals safely and efficiently without alteration of the natural canal morphology, which allows effective irrigation to reach the complex apical root-canal anatomy where bacteria are able to hide and resist debridement.

Once the canals have been located and instrumented, the ability to irrigate becomes essential to successful treatment. The irrigant solutions target the bacteria we are trying to eliminate. While sodium hypochlorite is a potent and proven antimicrobial and tissue dissolver,\textsuperscript{20,21} 2% chlorhexidine has been shown to prevent the adherence of \textit{E. faecalis} to dentine.\textsuperscript{22} EDTA 17% is often used as an effective smear layer removal agent.\textsuperscript{23,24} Therefore, mechanical debridement and canal instrumentation provide a pathway for copious chemical irrigation deep into the canal.

Passive ultrasonic irrigation allows clinicians to place an irrigant solution into the pulp chamber and activate it as it is carried down to the apical end of the root canal. The IrriSafe tip from Satelec (Acteon, a member of the Acteon Group, France) is a non-cutting, ultrasonic file that is placed into each canal and is moved up and down in the canal for three cycles of 20 seconds. Passive ultrasonic irrigation has been shown to irrigate lateral canals better at 4.5 and 2 mm from the working length of canals as compared with needle irrigation.\textsuperscript{25} It has been demonstrated that passive ultrasonic irrigation can remove dentine debris in a canal up to 5 mm in front of where the tip extends apically in straight or curved canals.\textsuperscript{26} This evidence shows that an effective flow of irrigation can assist in the cleansing of teeth in which canal alteration occurred during the initial root-canal treatment.

The following silver-point case (Figs. 7a–e) with a large post and apical transportation in the mesial root, demonstrates the successful healing of post-treatment disease when proper disinfection has been accomplished. This case illustrates the reason that retreatment is the primary treatment option for post-treatment disease.

Once debridement and disinfection have been completed, appropriate obturation methods are used to seal the canal spaces. The warm vertical technique using gutta-percha or resin with an appropriate sealer provides a thorough seal of the well-cleaned and shaped canal spaces. The final restoration must provide a proper seal of the pulpal chamber to prevent coronal micro-leakage.

Current evidence has demonstrated that we can retreat previous endodontically treated teeth properly and successfully. The literature has also shown that specific bacteria, such as \textit{E. faecalis}, are able to survive inside a previously filled canal. The use of a dental operating microscope, ultrasonic instruments, irrigants, rotary NiTi files and appropriate obturation materials increases our ability to attain healing after retreatment. As we continue to strive to maintain healthy natural teeth for our patients, endodontic retreatment should be the primary treatment option for post-treatment disease.\textsuperscript{27} A complete list of references is available from the publisher.
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New tips for non-surgical endodontic retreatment

MÉRIGNAC CEDEX, France: The new EndoSuccess kit from Satelec was designed to address problems that commonly occur during non-surgical endodontic retreatment procedures. According to the French instrument manufacturer, which is part of the Acteon Group, the mini-tips of this product line are made of an alloy especially selected for this specific clinical application.

A major innovation, the use of Niobium-titanium an alpha-beta microcrystalline structure alloy, is claimed to allow optimal handling with ultrasound in even the most challenging circumstances and with the best mechanical and clinical performance. Under intensive usage, it provides good stability/time ratios, the company said. With only a diameter of 3 µ, three to four times smaller than that of standard steel, the grain of the alloy has excellent ultrasound transmission, allowing practitioners to work efficiently with the required resistance at high power.

The Newton technology in Satelec piezoelectric generators furthermore gives the tips unbeatable efficiency, as the instruments are driven with great precision and respond specifically to the power settings chosen by the practitioner.

According to Satelec, EndoSuccess tips are compatible with all Suprasson generators.

Obturators entirely made of gutta-percha

MUNICH, Germany: VDW’s latest innovation makes use of the advantages commonly associated with gutta-percha, as the new GUTTAFUSION carriers for the thermoplastic obturation of root canals are now made entirely of this material. These obturators now feature a core made of cross-linked gutta-percha that remains stable even when heated and therefore simplifies post space preparation procedures, according to the German specialist company.

In addition, they are coated with gutta-percha, which flows evenly when heated in the GUTTAFUSION oven, for example, filling the whole root-canal system, including ramifications, isthmuses and the apex.

Root canal fillings done with GUTTAFUSION can be removed easily for retreatment, the company said. Specially designed for use with tweezers and fingers, the obturator handle allows for easy application of the obturators in molars. According to VDW, no other instruments are required for separation.

GUTTAFUSION has a high radiopacity and is compatible with most rotary NiTi systems. The three obturator sizes correspond to the R25, R40 and R50 instruments. The correct obturator size can also be determined with a NiTi size verifier, which is available in sizes 20 to 55. GUTTAFUSION obturators for RECIPROC are particularly convenient.
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Endodontic irrigants and irrigant delivery systems

Dr Gary Glassman
Canada

Endodontic treatment is a predictable procedure with high success rates. Success depends on a number of factors, including appropriate instrumentation, successful irrigation and decontamination of the root-canal space to the apices and in areas such as isthmuses. These steps must be followed by complete obturation of the root canals, and placement of a coronal seal, prior to restorative treatment.

Several irrigants and irrigant delivery systems are available, all of which behave differently and have relative advantages and disadvantages. Common root-canal irrigants include sodium hypochlorite (NaOCl), chlorhexidine gluconate, alcohol, hydrogen peroxide, and ethylenediaminetetraacetic acid (EDTA). In selecting an irrigant and technique, consideration must be given to their efficacy and safety.

With the introduction of modern techniques, success rates of up to 98% are being achieved.1 The ultimate goal of endodontic treatment per se is the prevention or treatment of apical periodontitis,17 for which there is complete healing or treatment of apical periodontitis.2 Treatment per se is the prevention or treatment of apical periodontitis,2 while such that there is complete healing or treatment of apical periodontitis.

In addition, EndoVac set-up.—Micro cannula

Fig. 2: Root-canal complex (DTI/Photo courtesy of Dr Ronald Ordinala Zapata, Brazil, www.facebook.com/TheInternalAnatomyOfTheHumanTooth).

The challenge for successful endodontic treatment has always been the removal of vital and necrotic remnants of pulp tissue, debris generated during instrumentation, the dentine smear layer, micro-organisms, and micro-tubules from the root-canal system.4

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.4 In addition, Enterococcus faecalis and Actinomyces prevention or treatment of apical periodontitis as Actinomyces viscosus, which are both implicated in endodontic infections and in endodontic failure.5–7 Penetration deep into dental tubules, making their removal through mechanical instrumentation impossible, is a key factor for the development of periapical lesions.2,8,9 Additionally, the root-canal system has a complex anatomy that consists of arborisations, isthmuses and cul-de-sacs that harbour organic tissue and bacterial contaminants (Fig. 1).10

Therefore, a suitable irrigant and irrigant delivery system are essential for efficient irrigation and patibility and lack of toxicity, the ability to dissolve organic material and remove the smear layer, ease of use, and moderate cost.2

As mentioned above, root-canal irrigants currently in use include hydrogen peroxide, NaOCl, EDTA, alcohol and chlorhexidine gluconate. Chlorhexidine gluconate offers a wide antimicrobial spectrum, the main bacteria associated with endodontic infections (E. faecalis and S. sanguinis) are sensitive to it, and it is biocompatible, with no tissue toxicity to the peripheral or surrounding tissue. Chlorhexidine gluconate, however, lacks the ability to dissolve necrotic tissue, which limits its usefulness. Hydrogen peroxide as a canal irrigant helps to remove debris from the physical aspect of irrigation, as well as through eviscerating of the solution. However, while an effective anti-bacterial irrigant, hydrogen peroxide does not dissolve necrotic intra-canal tissue and exhibits toxicity to the surrounding tissue. Cases of tissue damage and facial nerve damage have been reported following use of hydrogen peroxide as a root-canal irrigant.8,9 Alcohol-based canal irrigants have antimicrobial activity too, but do not dissolve necrotic tissue.

The irrigant that satisfies most of the requirements for a root-canal irrigant is NaOCl.11,12 It has the unique ability to dissolve necrotic tissue and the organic components of the dentine layer.13 Also kills sessile endodontic pathogens organised in biofilms.14 There is no other root-canal irrigant that can meet all these requirements, even with the use of methods such as lowering the pH,15 increasing the temperature,16 or adding surfactants to increase the wetting efficacy of the irrigant.17 However, although NaOCl appears to be the most desirable single endodontic irrigant, it cannot dissolve inorganic dentine particles and thus cannot prevent the formation of a smear layer during instrumentation.18

Calculations hindering mechanical preparation are frequently encountered in the root-canal system, further complicating treatment. Demineralising agents such as EDTA have therefore been recommended as adjuvants in root-canal therapy.19,20 Thus, in contemporary endodontic practice, dual irrigants such as NaOCl with EDTA are often used as initial and final rinses to circumvent the shortcomings of a single irrigant.21,22 These irrigants must be brought into direct contact with the entire canal-wall surfaces for effective action.23,24 particularly in the apical portions of small root canals.9

The combination of NaOCl and EDTA has been used worldwide for antiseptic of root-canal systems. The concentration of NaOCl used for root-canal irrigation ranges from 2.5 to 6%, depending on the country and local regulations. It has been shown, however, that tissue hydrolysis is greater at the higher end of this range, as demonstrated in a study by Hand et al. comparing 2.5 and 5.25% NaOCl. The higher concentration may also favour superior microbial outcome compared with a 2.5% endodontic irrigant spectrum, including but not limited to E. faecalis. NaOCl is superior among irrigating agents that dissolve organic matter. EDTA is a chelating agent that aids in smear layer removal and increases dentine permeability,25,26 which will allow further irrigation with NaOCl to penetrate deep into the dentinal tubules.27

General safety precautions

Regardless of which irrigant and irrigation system is used, and particularly if an irrigant with tissue toxicity is used, there are several general guidelines that must be followed. A rubber dam must be used and a good seal obtained to ensure that no irrigant can spill from the pulp chamber into the oral cavity. If deep caries or a fracture is present adjacent to the rubber dam on the tooth being isolated, a temporary sealing material must be used prior to performing the procedure to ensure a good rubber dam seal. It is also important to protect the patient’s eyes with safety glasses and protect clothing from irrigant splatter or spill.

It is very important to note that while NaOCl has unique properties that satisfy most requirements for a root-canal irrigant, it also exhibits tissue toxicity that can result in damage to the adjacent tissue, including nerve damage should NaOCl inadvertently occur during canal irrigation. Furthermore, Nahgaber reported in the 1970s that apical extrusion of an endodontic irrigant routinely occurred in vivo.28 This highlights the importance of using devices and techniques that minimise or prevent this. NaOCl incidents are discussed later in this article.
Irrigant delivery systems

Root-canal irrigation systems can be divided into two categories: manual agitation techniques and machine-assisted agitation techniques. Manual irrigation includes positive-pressure irrigation, which is commonly performed with a syringe and a side-vented needle. Machine-assisted irrigation techniques include sonic and ultrasonic systems, as well as newer systems such as the EndoVac (SybronEndo), which delivers apical negative-pressure irrigation, the plastic rotary F File (Plastic Endo), the VibeRinger (VibeRinger), the RaSendro (Air Techniques), and the EndoActivator (DENTSPLY Tulsa Dental Specialties). Two important factors that should be considered during the process of irrigation are whether the irrigation system can deliver the irrigant to the whole extent of the root-canal system, particularly to the apical third, and whether the irrigant is capable of debriding areas that could not be reached with mechanical instrumentation, such as lateral canals and isthmuses. When evaluating irrigation of the apical third, the phenomenon of apical vapour lock should be considered.

Apical vapour lock

Since roots are surrounded by the periodontium, and unless the root-canal orifices are open, the root canal behaves like a close-ended channel. This produces an apical vapour lock that resists displacement during instrumentation and final irrigation, thus preventing the flow of irrigant into the apical region and adequate debridement of the root-canal system. Apical vapour lock also results in gas entrapment at the apical third. During irrigation, NaOCl reacts with organic tissue in the canal system, and the resulting hydrolysis liberates abundant quantities of ammonia and carbon dioxide. This gaseous mixture is trapped in the apical region and quickly forms a column of gas into which further fluid penetration is impossible. Extension of instruments into this vapour lock does not reduce or remove the gas bubble, just as it does not enable adequate flow of irrigant.

The phenomenon of apical vapour lock has been confirmed in studies in which roots were embedded in a polyvinylalcohol impression material to restrict fluid flow through the apical foramen, simulating a close-ended channel. The result in these studies was incomplete debridement of the apical part of the canal walls with the use of a positive-pressure syringe delivery technique. Micro-CT scanning and histological tests conducted by Tay et al. have also confirmed the presence of apical vapour lock.

In fact, studies conducted without ensuring a close-ended channel cannot be regarded as conclusive on the efficacy of irrigants and the irrigation system. The apical vapour lock may also explain why in a number of studies investigators were unable to demonstrate a clean apical third in sealed root canals.

In a paper published in 1985, based on research Chow determined that traditional positive-pressure irrigation had virtually no effect apical to the orifice of the irrigation needle in a closed root-canal system. Fluid exchange and debris displacement were minimal. Equally important to his primary findings, Chow set forth an infallible paradigm for endodontic irrigation: “For the solution to be mechanically effective in removing all the particles, it has to: (a) reach the apex; (b) create a current (force); and (c) carry the particles away.” The apical vapour lock and consideration for the patient’s safety have always prevented the thorough cleaning of the apical 5 mm. It is critically important to determine which irrigation system will effectively irrigate the apical third, as well as isthmuses and lateral canals, and in a safe manner that prevents the extrusion of irrigant.

Manual agitation techniques

By far the most common and conventional set of irrigation techniques, manual irrigation involves dispensing of an irrigant into a canal through needles/cannulas of variable gauges, either passively or with agitation by moving the needle up and down the canal space without binding it on the canal walls. This allows good control of needle depth and the volume of irrigant that is flushed through the canal. However, the closer the needle tip is positioned to the apical tissue, the greater the chance of apical extrusion of the irrigant. This must be avoided; were NaOCl to extrude past the apex, a catastrophic accident could occur.

Manual-dynamic irrigation

Manual-dynamic irrigation involves gently moving a well-fitting gutta-percha master cone up and down in short 2 to 5 mm strokes within an instrumented canal, thereby producing a hydrodynamic effect and significant irrigant exchange.

Recent studies have shown that this irrigation technique is significantly more effective than constant-pressure dynamic and static irrigation.

Machine-assisted agitation systems

Sonic irrigation

Sonic activation has been shown to be an effective method for...
disinfecting root canals, operating at frequencies of 1–6 kHz. There are several sonic irrigation devices on the market. The Varios allows delivery and sonic activation of the irrigating solution in one step. It employs a two-piece syringe with a rechargeable battery. The Irrigator is sonically activated at the needle that attaches to the syringe. The EndoActivator is a more recently introduced sonically driven canal irrigation system. It consists of a portable handpiece and three types of disposable polymer tips of different sizes. The EndoActivator has been reported to effectively clean debris from lateral canals, remove the smear layer, and dislodge clumps of biofilm within the curved canals of molar teeth.

Ultrasonics

Ultrasonic energy produces higher frequencies than sonic energy but low amplitudes, oscillating at frequencies of 25–50 kHz. Two types of ultrasonic irrigation are available. The first type is simultaneous ultrasonic instrumentation and irrigation, and the second type is referred to as passive ultrasonic irrigation operating without simultaneous irrigation (PUI). The literature indicates that it is more advantageous to apply ultrasonics after completion of canal preparation rather than as an alternative to conventional instrumentation. PUI allows energy to be transmitted from an oscillating file or syringe to the irrigant in the root canal by means of ultrasonic waves. There is consensus that PUI is more effective than sonic irrigation at removing pulpal tissue remnants and dentine debris. This may be due to the much higher velocity and volume of irrigant flow that are possible to reach and clean the isthmus area with instruments, it is not impossible to reach and thoroughly clean the isthmus area. The use of the method of irrigation is safe and efficacious. In studies comparing the EndoVac, the Signi-denti, the F-File, the monomaxic Flow-i-Probe (DENTSPLY Endo), the Ultrasonic Irrigator and the EndoVac, only the EndoVac was able to successfully clean 100 % of the isthmus area.

Apart from being able to avoid air entrapment, the EndoVac system is also advantageous in its ability to deliver irrigants safely to working length without causing their undue extrusion into the periapical tissues. Therefore avoiding NaOCl incidents. It is important to note that it is possible to create positive pressure in the pulpal canal if the Master Delivery Tip is misused, which would create the risk of a NaOCl incident. The manufacturer’s instructions must be followed for correct use of the Master Delivery Tip.

Sodium hypochlorite irrigation

Although a devastating endodontic NaOCl incident is rare, the literature indicates that all vital tissue are well established. The associated sequelae of NaOCl exposure have been reported to include life-threatening airway obstructions, facial disfigurement requiring multiple corrective surgical procedures, permanent paraesthesia to the facial nerve, and—in the least significant consequence—loss of taste. Although the exact aetiology of the NaOCl incident is still uncertain, based on the evidence from actual incidents and the location of the associated tissue trauma, it would appear that an intracanal injection may be the cause. The patient shown in Figure 3 demonstrates a widespread chemical dermatitis that is in contrast to the characteristics of NaOCl incident trauma reported by Fausk & Brescian. This extensive trauma, particularly involving the cervical skin around the eye, could only have occurred if the NaOCl had been introduced into the pulpal canal, not to the root apex through which ex- traction of the irrigated root occurred and the irrigant then found its way into the venous complex. This would require positive pressure apically that exceeded venous pressure (10 mg Hg). In one in vitro study, which used a positive-pressure irrigation technique to mimic clinical conditions and techniques, the apical pressure generated was found to be eight times higher than the normal venous pressure.

Safety first

In order to compare the safety of six different intra-canal irrigation delivery devices, experiments were conducted using the worst-case scenario of apical extrusion, with EndoVac and the Signi-denti using an open apex. The study concluded that the EndoVac did not extrude irrigating solution during delivery and suctioning of the irrigating tip.
ant from the chamber to full working length, whereas other devices did. The EndoActivator extruded only a very small volume of irrigant, the clinical significance of which is not known.

Mitchell and Baumgartner tested irrigant (NaOCl) extrusion from a root canal sealed with a permeable agarose gel. Significantly less extrusion occurred using the EndoVac system compared with positive-pressure needle irrigation. A well-controlled study by Gondim et al. found that patients experienced less post-operative pain, measured objectively and subjectively, when apical negative-pressure irrigation was performed (EndoVac) than with apical positive-pressure irrigation.110

Efficacy

In vitro and in vivo studies have demonstrated greater removal of debris from the apical walls and a statistically cleaner result using apical negative-pressure irritation in closed root-canal systems with sealed apices. A study involving 22 teeth by Shin and Baumgartner, less debris remained at 1 mm from working length using apical negative pressure compared to use of traditional needle irrigation, while Shin et al. found in an in vitro study of 69 teeth comparing traditional needle irrigation with apical negative pressure that these methods both resulted in clean root canals, but that apical negative pressure resulted in less debris remaining at 1.5 and 3.5 mm from working length.110,111 When comparing root-canal debridement using manual-dynamic agitation or the EndoVac for final irrigation in a closed system and an open system, it was found that the presence of a sealed apical foramen adversely affected debridement efficacy when manual-dynamic agitation was used, but did not adversely affect results when the EndoVac was used. Apical negative-pressure irrigation is an effective method to overcome the fluid-dynamic challenges inherent in closed root-canal systems.112

Microbial control

Hockett et al. tested the ability of apical negative pressure to remove a thick biofilm of E. faecalis, finding that these specimens rendered negative cultures obtained within 48 hours, while those irrigated using traditional positive-pressure irrigation were positive at 48 hours. One study found that apical negative-pressure irrigation resulted in similar bacterial reduction to use of apical positive-pressure irrigation and a triple antibiotic in immature teeth.115 In a study comparing the use of apical positive-pressure irrigation and a triple antibiotic that has been utilised for pulpal regeneration/revascularisation in teeth with incompletely formed apices (Trimix = Cipro, Minocin, Flagyl) versus use of apical negative-pressure irrigation with NaOCl, it was found that the results were statistically equivalent for mineralised tissue formation and the repair process.116 Using apical negative pressure and NaOCl also avoids the risk of drug resistance, tooth discoloration, and allergic reactions.117,118

Conclusion

Since the dawn of contemporary endodontics, dentists have been striving NaOCl into the root-canal space and then proceeding to place endodontic instruments down the canal in the belief that they were carrying the irrigant to the apical termination. Biological, scanning electron microscopy, light microscopy, and other studies have proven this belief to be in error. NaOCl reacts with organic material in the root canal and quickly forms microbubbles at the apical termination that coalesce into a single large apical vapour bubble with subsequent instrumentation. Since the apical vapour lock cannot be displaced via mechanical means, it prevents further NaOCl flow into the apical area.

The safest method yet discovered to provide fresh NaOCl safely to the apical terminus is via apical negative pressure. This method has also been proven to be safe because it always draws irrigant to the source via suction—down the canal and simultaneously away from the apical tissue in abundant quantities.119 When the proper irrigating agents are delivered safely to the full extent of the root-canal terminus, thereby removing 100 % of organic tissue and 100 % of the microbial contaminants, success in endodontic treatment may be taken to levels never seen before.120

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

This article has been reprinted in part from D. Glassman, Safety and Efficacy Considerations in Endodontic Irrigation (PenWell, January 2011).

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