Physicists shed light on geographic tongue
Research provides new insights into dynamics of inexplicable condition

REHOVOT, Israel: Physicists at the Weizmann Institute of Science in Israel have clarified the intricate dynamics underpinning a tongue condition that has puzzled the medical community for decades. Known as benign migratory glossitis or geographic tongue (GT), the condition affects around 2 per cent of the global population and is characterised by evolving red patches on the surface of the tongue that may resemble a map.

The red patches appear due to loss of one of the four types of lingual papillae, tiny hair-like protrusions that cover the surface of the tongue. The affected type, called filiform papillae, is mainly distributed in the anterior two-thirds of the tongue. Despite extensive research, the exact cause of GT, a benign and mostly painless condition, remains unknown.

In their study, the researchers performed a number of numerical simulations to closely examine and visualise the development of GT, and devised a new way of identifying the severity of individual cases. “We hope these results can be used by physicians as a practical way of assessing the severity of the condition based on the characteristic patterns observed,” said lead author of the study Dr Gabriel Seiden, a researcher at the Weizmann Institute of Science in Rehovot in Israel.

Benign migratory glossitis affects around 2 per cent of the global population. (Photo: Angel Simon / shutterstock.com)
The scientists approached the problem of GT as if it were an excitable medium distributed, dynamic system with the ability to propagate signals without damping. A forest fire is a classic example of an excitable medium: it travels as a wave from its ignition point and regenerates with every tree it ignites.

This is in contrast to passive wave propagation, which is characterised by a gradual damping of the signal amplitude due to friction. However, after a wave has passed through, excitable media have to reconstitute before they can support the passing of another wave. In this way, a fire can spread through a forest, but it cannot return to a burnt spot until the vegetation has regrown.

The study found that GT can spread across the tongue in two different ways, each of which has distinguishing characteristics that could be used to diagnose severity. Researchers have directly observed the condition, which typically starts as small spots on the tongue, can continue to gradually expand in circular patterns until the whole tongue may have important consequences for the dynamics of GT, according to the researchers.

In their study, they give the example of GT observed in a 1-year-old boy who developed the characteristic lesions on multiple occasions along the tongue’s edge adjacent to the growing teeth, implying that the continuous rubbing of the tongue against the gingiva may trigger the condition.

“Going forward, we intend to collaborate with physicians and dentists who treat GT patients to establish valuable—and often scarce—empirical data regarding the dynamic evolution of the condition,” Seiden concluded. “This will allow for further, more quantitative explorations of GT and may eventually lead to a firmer understanding of what causes the condition.”

Wine wears down teeth quicker than previously thought

UIT Asia Pacific:

ADELAIDE, Australia: Wine lovers may seriously harm their teeth if they do not take preventative measures against erosion, new research from the University of Adelaide suggests. According to an article published in the latest edition of the Australian Dental Journal, demineralisation occurs as early as 10 minutes after enamel has been exposed to the organic acids of the beverage.

This places wine-tasters, for example, at increased risk of tooth wear, the researchers said. Previous research only found a softening effect in teeth exposed to wine after 1 hour.

Professional tasters usually test up to 150 wines per day, and wine judges even more. With wine tasting, the beverage is retained in the mouth for up to 60 seconds before it is spat out.

In order to assess the demineralisation during wine-tasting, the team simulated the conditions of the process in a laboratory, exposing extracted third molars repeatedly to white wine and artificial saliva. After 1 and 10 minutes, a nano-scratch test was conducted and the result was an increased scratch depth.

Surface roughness of the enamel also increased by almost 200 per cent. Reflecting on the findings, the researchers recommended that professionals take early preventative measures, including the application of remineralisation agents, such as calcium, phosphate and fluoride, to minimise the risks of erosion. Chewing gum and skipping toothbrushing the morning before the wine-tasting are additional measures that could lessen the occupational hazard, they said in the report.

“After a wine tasting, the teeth are likely to be much softer, so we recommend rinsing with water, and when it comes time to clean the teeth, just putting some toothpaste on your finger and cleaning with that,” remarked Associate Professor Sue Bastian from the university’s School of Agriculture, Food and Wine, which also teaches wine-making, about the results. “Cleaning with a brush when teeth are soft runs the risk of damaging the enamel.”

With pH values of 3 and 4, the acidity of wine is comparable to most soft drinks, which, owing to their high concentration of organic acids, are reported to be the main cause of the increase in tooth wear around the globe, particularly among children. Most professional wine organisations, however, currently do not recommend any special precautions for their members.
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One system for better restoration
DENTSPLY exhibits premium material collection at APDC congress in Singapore

SINGAPORE: At the sixth International Congress on Adhesive Dentistry (IAD), held recently in Bangkok in Thailand, dental consumables manufacturer DENTSPLY launched “one”, its collection of premium, high-performance restorative materials that were designed not only to be easy to use, but also to allow dentists to achieve outstanding clinical results.

According to the company, the “one” collection consists of ceram.x one, a composite available in different translucencies for everyday aesthetics (ceram.x one UNIVERSAL) and highly aesthetic restorations (ceram.x one DENTIN & ENAMEL). It also contains two bonding systems, one for total-etch applications (prime&bond one ETCH & RINSE) and one for self-etch, selective enamel etch and total-etch applications (prime&bond one SELECT).

Covering the full VITA (VITA Zahnfabrik) shade range with just seven shades, ceram.x one UNIVERSAL is extremely simple and easy to use, the company said. With intermediate translucency ranging between natural enamel and dentine, ceram.x one UNIVERSAL offers a powerful chameleon effect to facilitate natural, lifelike restorations and is ideal for everyday use. While many composite systems offer a myriad of shades and translucencies, making it difficult to match the colour of the natural teeth, ceram.x one DENTIN & ENAMEL replicates the structure of natural teeth utilizing just two translucencies: dentine shades that mimic natural dentine and enamel shades that mimic natural enamel. Also covering the full VITA shade range, it enables highly aesthetic, natural restorations with only four dentine and three enamel shades.

It is difficult to achieve an optimum level of dentine moisture prior to the application of an adhesive. Overwet or overly dry dentine can lead to insufficient sealing, resulting in microleakage and post-operative sensitivity. Prime&bond one ETCH & RINSE offers a technique-tolerant solution, providing high bond strength and reliable performance even on overwet or overly dry dentine, according to DENTSPLY.

The literature often recommends using a self-etch adhesive in cavities with a large proportion of exposed dentine in order to minimise the risk of post-operative sensitivity. However, etch-and-rinse adhesives have shown superior long-term results on enamel. Prime&bond one SELECT combines the advantages of both techniques. It provides high bond strength with all etching techniques (self-etch, etch and rinse, and selective enamel etch) and delivers reliable performance even on overly dry dentine, resulting in virtually no post-operative sensitivity.

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Difficulties mastered are opportunities won

These words from one of Britain’s most famous statesman Winston Churchill aptly describe the recent relaunch of Dental Tribune UK. The new edition is the result of months of reorientation and repositioning that will see the return of an active participant in the British dental publishing scene. At this opportunity, we would like to thank our former partners for their years of commitment and wish them best of luck for their future endeavours.

Our publishing group has come a long way since the first edition of Dental Tribune UK was launched in 2007. From a few publishers operating in key markets only, it has grown into a large-scale global operation with offices and representatives in almost every corner of the globe; to borrow a famous historical phrase, the sun never sets on the Dental Tribune International (DTI) network, as somewhere in the world a Dental Tribune publisher or partner is always working. And our expansion is still far from over; coinciding with the relaunch of the UK edition, Dental Tribune has introduced its first-ever Nordic edition at the SCANDEFA show in Copenhagen in Denmark to serve all markets in Scandinavia and Finland. Developed as a pan-regional title, the new edition will cover and analyse everything dentistry in the region, as well as internationally. With four editions per year and published in English only, it builds on the substantial knowledge and publishing expertise that has distinguished Dental Tribune partners in almost every corner of the world for the last two decades.

While remaining a print publisher at heart, DTI is constantly venturing forward in other areas, most notably continuing professional education and events. While the Dental Tribune Study Club has been providing free online education at an international and local level for the last seven years, the new Clinical Masters series will offer high-quality CE in selected areas, including implantology, endodontics and aesthetic dentistry. Moreover, last year saw the successful premiere of the Digital Dentistry Show, a show within a show expo format that will see further geographical and topical expansion in 2015.

For information and updates on all our exciting new projects, I invite you to visit our website at www.dental-tribune.com.

Sincerely,
Daniel Zimmerrmann
Group Editor
Dental Tribune International
Increasing number of European adolescents brush teeth twice a day

A international team of researchers has studied the daily frequency of toothbrushing in adolescents from 20 different countries and regions in Europe between 1994 and 2010. The researchers found that the prevalence of brushing more than once a day has increased in most of the surveyed countries and regions over time, with the highest increase observed in Estonia, Latvia, Russia, Finland and Flemish Belgium.

"From a public health perspective, improvement of toothbrushing habits is important in preventing the most common dental diseases, but even more so in reducing common risk factors for the main non-communicable diseases," the researchers stated in the study. According to them, brushing twice a day is one of the most important self-care methods and has become a universal recommendation worldwide in order to maintain good oral health.

For their study, the researchers from the University of Jyväskylä in Finland, Ghent University in Belgium and the National Institute of Public Health in Denmark used data from five consecutive Health Behaviour in School-aged Children (HBSC) surveys conducted between 1994 and 2010.

The HBSC research network is an international alliance of researchers that collaborate on the survey of schoolchildren. The HBSC collects data on 11-, 13- and 15-year-old boys’ and girls’ health and well-being, social environments and health behaviours. The researchers chose these age groups because they mark a period of increased autonomy that can influence how a person’s health and health-related behaviours develop.

The cross-national survey, initiated in 1982, is conducted every four years in 44 countries and regions across Europe and North America in collaboration with the World Health Organization’s Regional Office for Europe.

The scientists determined the frequency of toothbrushing by analysing the adolescents’ answers to the mandatory HBSC question in this regard, including study year, country, sex and age as variables. The 20 countries considered in the study included various central, eastern and northern European countries, as well as Russia and Canada.

In most of these countries, the prevalence of brushing twice a day has increased significantly, while the cross-national differences have diminished. In 1994, the rate of adolescents brushing their teeth twice a day ranged from 50 to 86 per cent. In 2010, between 50 and 81 per cent of the surveyed children said that they brushed twice every day.

In 1994, the countries with the lowest prevalence of brushing twice a day included Lithuania (50 per cent), Latvia (54 per cent), Russia (58 per cent), Finland (58 per cent), Estonia (42 per cent) and Flemish Belgium (45 per cent). By 2010, between 50 and 60 per cent of the children in all of these countries brushed twice a day.

The countries with the highest rate of adolescents brushing their teeth twice a day in 1994 were Sweden (86 per cent), Denmark (80 per cent), Norway (75 per cent) and Germany (75 per cent). By 2010, Sweden’s rate had decreased to 81 per cent and Denmark’s to 76 per cent, Norway’s rate remained at 75 per cent, while Germany’s increased to 80 per cent.
European dental markets trend towards group practices and consolidation

COLOGNE, Germany: Latest market figures released by the Federation of the European Dental Industry (FIDE), in cooperation with the Association of European Dental Dealers (ADDE), last month at the International Dental Show in Cologne, indicate rapid changes toward a digital dentistry manifesting in overall trends to a more global approach with group practices and consolidations throughout dental markets in Europe. The organisation’s 2015 market survey also revealed that the number of European dentists has slightly increased to a total of 276,090 in 2014 compared to 270,045 the year before.

A contrary trend showed in the number of dental offices and dental laboratories. While the numbers of the former remained flat on average, the total figures of labs in Europe has decreased in almost every surveyed country. According to ADDE President Dominique Deschietere, given the growing numbers of practicing dentists this development either indicates a trend to group practices or consolidation.

While the number of dental technicians has remained steady or slightly decreased in all countries except Hungary, the number of dental hygienists increased in all countries of the survey. This development is especially prominent in the UK, with the number of dental hygienists growing distinctively compared to 2013. As Deschietere has put it, this seems to be a result of the evermore “bending of the laws” in this area.

On the supply channels side, the percentage of direct sales from manufacturers remained steady in most countries, and the share of products purchased via e-mail or internet is constantly if only slightly, increasing compared to the previous year. Further, the figures indicate that the sales volume of equipment has dropped in 2014, while sales of sundries and consumables remained stable on average.

“Dentists continue to treat patients,” Deschietere pointed out. “Consumables and sundries, not new equipment like CAD/CAM units or intra-oral X-ray units, kept the figures up during the last years.”

To this date the gathering of information on new technologies seems to be the weak point of the survey. Although Germany shows a jump in the numbers of intra-oral scanners installed, most countries are not collecting data on the subject so far, explained Deschietere.

The annual ADDE/FIDE survey, which is conducted through its national associations since 1998 and represents the interests of more than 960 dental dealer organisations, covers the most relevant topics and trends for the European Dental Industry, such as the number of customers and end users, sales values for the main product categories, the use of computer and e-commerce, sales segments, distribution channels as well as VAT charges and their impact on the market.

DOMINIQUE DESCHIETERE

Photo: Kristine Hübner, DTI
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Google Mobile Armageddon and what it means

Naz Haque

Google has just released an update that will prioritise mobile-friendly websites. It is indeed widely known that online audiences are moving to smartphone and tablet computers. At Dental Focus, we have seen massive shifts in the online audience over the last few years to the point now where most clients see a minimum of 55 per cent of their organic audience visits from mobile devices.

Websites and marketing campaigns achieve higher conversions when they are mobile optimised. The diagram below shows a marketing campaign we are running at the moment. In this, we achieved 10,875 sessions over 30 days. The blue bar indicates the total sessions and the orange bar segments the mobile and tablet audience. In all traffic sources, mobile has the lion’s share of the market. In this project, we invested heavily in Google pay per click and 95 per cent of conversions were via mobile.

To qualify this trend further, consider that desktop sales have started to decline significantly in recent data from the National Children’s Dental Health Foundation. One of the main factors promoting tooth decay in Singapore is more than twice that of the World Health Organization’s recommended annual intake of approximately 9 kg a year. Overall, the average sugar consumption in the country increased by 10 per cent from 2009 to 2012.

Colgate introduces new toothpaste for cavity prevention

SINGAPORE: Colgate has introduced a new toothpaste at the Asia Pacific Dental Conference in Singapore that contains Sugar Acid Neutralizer, which the company developed to combat sugar acids that arise when common oral bacteria react with food residue in the mouth. This reaction can cause the tooth enamel to weaken and leads to increasing risk of cavities.

The latest addition to the company’s oral care line promises to fight tooth decay in two clinically proven ways. Firstly, the patented Sugar Acid Neutralizer deactivates harmful sugar acids in the mouth. Secondly, fluoride and calcium additives, which have proven to prevent cavity formation by reducing demineralisation, are aimed at strengthening and restoring the tooth enamel.

Colgate introduces new toothpaste for cavity prevention

Dr Kuan Chee Keong, President of the Singapore Dental Association, welcomed the new toothpaste. “Sugar acids are the number one cause of cavities and we now have the ability to protect our teeth with this new technology. The landscape of dental technology is always changing for the better and it is always exciting to witness new breakthrough technologies that will help reduce the advent of caries. With these discoveries, our goal of a cavity-free future is in reach.”

Despite continuing education on the importance of good oral care habits to prevent cavities, cavities affects 60-90 per cent of schoolchildren and the majority of adults worldwide, according to data from the National Children’s Oral Health Foundation. One of the main factors promoting tooth decay and cavities is a high intake of sugary drinks and foods, and this appears to be a major problem in Singapore. According to the country’s Health Promotion Board, the sugar consumption in Singapore is more than twice that of the World Health Organization’s recommended annual intake of approximately 9 kg a year.

Overall, the average sugar consumption in the country increased by 10 per cent from 2009 to 2012.
Growing CAD/CAM abutment adoption vs increasingly popular discount implants

Opposing pricing trends to influence Asia Pacific dental implant market

Dr Kamran Zamani
& Celine Mashkoor
Canada

The various countries in the Asia Pacific region are all expected to demonstrate an increasing demand for dental implant treatments as a result of growing consumer awareness, the ageing population, growing accessibility (such as through the National Health Insurance Service coverage in South Korea), as well as greater product availability and other influencing factors. Traditionally, premium implant companies have dominated the dental implant market globally. However, in recent years, discounted implants have become increasingly popular, especially in the Asia Pacific region.

The growth of the discount implant segment will emerge at the expense of the premium segment and as a result is set to limit market growth for dental implant fixtures by lowering the market’s overall average selling price (ASP). In contrast, the final abutment market is set to experience an increasing ASP owing to the growing adoption of CAD/CAM abutments in the place of stock abutments. While commoditisation of stock abutments has greatly depressed the ASP of the final abutment market, growing adoption of CAD/CAM abutments is set to stimulate the final abutment market by pulling the ASP upwards. Therefore, the dental implant market is set to grow in all four countries included in the Asia Pacific region in this report, namely Australia, South Korea, Japan and China, despite varying pricing trends.

In the Asia Pacific dental implant market, consumer awareness, cultural tendencies and domestic regulations vary greatly. South Korea represents the most highly developed dental implant market as a result of being home to a number of global leading dental implant companies. This in turn has led to a high level of consumer awareness and early accessibility to a variety of different implant products. However, the dental implant market in South Korea is also highly discount dominant and led by domestic implant producer OSTEIM PLANT and as a result demonstrated the lowest regional dental implant ASP of US$86 in 2014.

In contrast, the Australian market remains highly dominated by leading premium implant companies, which collectively held over 70% of the domestic market. Consequently, Australia demonstrated the highest dental implant fixture ASPs in the region at US$156 in 2014. An increasing number of general practitioners are being trained in dental implant procedures in Australia, and general practitioners have been observed to be more cost sensitive relative to specialists. As a result of a growing number of general practitioners in the market, consumer preferences are shifting towards discounted solutions. Discount implant companies from the US and South Korea have recently been gaining market share in Australia. Throughout the forecast period, the premium segment of the market is expected to grow at far lower annual growth rates relative to the discount and value segments in Australia. By 2021, it is expected that discount implants will represent 45% of the overall units in the Australian market.

The Japanese and Chinese markets for dental implants are also dominated by premium companies. In recent years, OSTEIM PLANT has had a significant impact on the Chinese market, however, especially as a result of the training programme offered by the company’s Advanced Dental Implant Research and Education Center. All segments of the dental implant market in China are expected to demonstrate double-digit annual growth. However, the discount market is set to grow far more dramatically throughout the forecast period. By 2021, discount implant fixtures are set to represent over 50% of the overall units in the Chinese dental implant market.

The shift towards discount implants in Japan is expected to be far less dramatic, especially owing to cultural barriers that limit the success of Korean dental implant companies. The premium segment is expected to remain the dominant dental implant market throughout the forecast period. Unit representation of discount implants is expected to increase slightly from 12.5% currently to 14.6% by 2021.

The growing acceptance of discount implants has been driven by Korean companies. The regional market leader, OSTEIM PLANT, held a 21.9% share of the total dental implant market for the Asia Pacific region in 2014. The company has invested significantly in marketing efforts, which has led to the growing popularity of its products. Throughout the forecast period, OSTEIM PLANT and other discount implant companies, such as Megagen, Dentium and Neobiotech, are expected to capitalise on the growing popularity of discount implants. In contrast, premium implant companies, such as Straumann and Nobel Biocare, are expected to face increasing competitive pressures, especially in China and Australia.

Emphasis on CAD/CAM

In the dental implant market, the final abutment market is undergoing an opposing pricing trend relative to dental implant fixtures. CAD/CAM abutments are being increasingly utilised in the place of cheaply produced stock abutments. CAD/CAM development has been relatively rapid in the Asia Pacific region in recent years. A growing number of CAD/CAM milling centres have emerged to produce CAD/CAM abutments for the dental implant market. The overall region is set to demonstrate significant growth in the CAD/CAM segment for final abutments. In contrast to the dental implant fixture market, where discount products are gaining share, the overall final abutment market is set to demonstrate an increasing ASP. CAD/CAM final abutments are relatively more expensive than stock abutments, which have traditionally dominated the market. The shift towards CAD/CAM abutments is set to be the most significant in China. For the overall region, units of CAD/CAM abutments are set to grow at a compound annual growth rate of 22.1%. By 2021, CAD/CAM abutments are forecast to represent 51.6% of the overall unit growth in Asia Pacific.

Conclusion

Overall, the dental implant market, including fixtures and abutments, is set to grow at a compound annual growth rate of 11.5% for the Asia Pacific region. The unit growth will far outweigh the ASP effects, and the dental implant market will grow to reach a higher penetration ratio for the overall Asia Pacific region.

Fig. 3: Unit analysis of dental implant fixtures in Australia. By 2021, units of premium implants are expected to dominate the overall abutment market, including fixtures and abutments. (Source: iData Research Inc.)

Fig. 2: China’s dental implant market. The adoption of CAD/CAM final abutments, which are more expensive, and a growing discount implant segment are set to result in the final abutment market representing a larger portion of the dental implant market throughout the forecast period.

Fig. 1: OSTEIM PLANT, a Korean discount dental implant company, led the Asian Pacific dental implant market for final implant fixtures and final abutments in 2014. The company is expected to continue to capitalise on the growing popularity of discount implants.
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It is very difficult to escape from your professional status

An interview with practice manager Gary Smith, Australia

Gary Smith is well aware of the shifting demands practitioners are facing today. Increasing service levels, changing expectations of patients, and achieving a competitive edge through up-to-date technology and procedures place increasing pressure on health care professionals in terms of both their time and sources, he said. At the recent Australian Dental Congress in Brisbane, Dental Tribune Asia Pacific had the opportunity to talk to him about this subject, and why new technology might not necessarily help reduce the burden.

“Are the main challenges of today compared with the past?”

Gary Smith: The changing expectations of patients are one of the greatest challenges the industry has faced over the years. Patients’ demands are increasing, along with their expectations of the level of service to be provided. The acceptance of the level provided by dental practitioners at times may differ from the level of service the patient actually expects, however.

The intrusion of government’s and health insurers’ requirements has changed over the years, and believe that the provision of services will become more complicated as a result of further involvement of these two groups. Of course, one of the greatest challenges remains the running of a small to medium enterprise. This, as well as the increasing red tape and making a profit, will always pose a challenge.

Are practitioners today more likely to neglect their work-life balance in favour of patients?

This depends on the age group of the practitioners and whether they are owners or contractors. Veterans, baby boomers and Generation X practitioners generally struggle with work-life balance and have a tendency to put their patient first. Generation Y practitioners in contrast are very much aware of their work-lifestyle balance.

Many developed countries continue to see an increase in the demand for dental care; what about Australia? And is there a disparity regarding the coverage of dental care between rural and urban areas?

There appears to be a shortage of qualified dentists, but it is all about the distribution of the professionals. There is indeed a disparity between the urban and the remote rural areas, and it usually needs a very special person to set up a private business in remote places. This can be a substantial financial and time commitment.

Is daily practice more stressful for practitioners working in rural areas compared with those in the cities?

Yes, it is. In most rural areas, the reality is that you are available either in the middle of the night or on weekends. It is very difficult to escape from your professional status, and there is an expectation—whether right or wrong—that you are available even when you are shopping or out to dinner.

The challenge we have is to continue to provide a level of service to our patients with a workforce that places work-lifestyle balance at the forefront of their working career.

According to the Australian Work and Life Index, it is not only about how much you work, but also when it is during unsocial hours. What are the first warning signs?

There are certain areas of the working life of a practitioner that, if not checked, may lead to a poor work-life balance. These stressors include managing a solo practice, missed appointments, patient dissatisfaction with treatment, insurance problems, non-competitive, as well as regulations of governmental agencies.

Lack of quiet time, such as not having breaks from your work, is also a sign that something is not right. Of course, the first warning sign is burn-out as a result of the level of demands placed on the practitioner.

How can technology influence the work of clinicians? Are they actually time-saving tools as advertised or do they add even more stress, since practitioners have to constantly keep up and engage with the latest developments?

I once read the following: “We work harder and longer to save to purchase labour-saving devices”. How true this is. The competitive edge you have over another nowadays is up-to-date technology and procedures. It is patients that drive this prominence of technology in our business. We have to be seen to have the equipment that allows us to perform the latest procedures.

Of course, this increases the practice’s overheads, not only in the purchase of the technology, but also in the running costs to use the technology, including the costs to increase the skill sets of staff through learning and the maintenance of the technology.

Could you list some strategies to achieve healthy work routines?

The most effective strategy in the first instance is to recognise and accept that there is a work-life balance problem. Once it can be identified, it is then a matter of putting a series of strategies in place to manage the problem. These strategies may include the employment of a practice manager, mentoring other staff to take over certain aspects of the business, and increasing clinical staff to relieve work overload.

Certainly, all these come at a cost to the business, but the practitioner has to determine what he or she wants out of the business. For those in the health care profession have we allowed the tail to wag the dog? It is time for practitioners to take control of their own strategy and destiny.

Thank you very much for this interview.
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Pain is one of the most complex health conditions encountered, as it affects not only the sufferers, but also the community in which they live. It is often associated with other co-morbidities, especially anxiety, depression and chronic pain elsewhere. In the orofacial region, the most commonly reported pain is dental, and this inevitably requires a visit to a dentist, who in most instances can provide a cure. However, there are other pains encountered in the orofacial region that can become chronic, defined as pain that has been present for over three months. These pains need to be diagnosed correctly, as their management is different.

At present, we have no biomarkers for chronic pain, and the only way we can make a diagnosis is to listen carefully to the history the patient gives. We need to elicit the key features of pain, for example onset, duration, location, severity, character, provoking and relieving factors, as well as the impact on quality of life and activities of daily living. It is essential to determine the presence of other illnesses, especially other chronic pain. Chronic orofacial pain has a significant psychological impact, as the face used to express pain from other parts of the body is now in pain itself. Patients with chronic orofacial pain are also confused as to whom they should consult, a dentist or a doctor. Their choice of health care provider will significantly affect both first-line treatment and subsequent referral.

Pain is notoriously difficult to communicate and poor communication of pain is cited as the main barrier to treatment and management. This “unsharability” of pain can be correlated with its resistance to language. This results in an intense burden of suffering and isolation for the individual. It is further compounded when patients do not have the requisite language skills. Yet we know that words may help a clinician in the differential diagnosis; for example, patients with musculoskeletal pain will use words such as “heavy”, “aching” and “nagging”, whereas those with neurological causes will describe their pain as “burning”, “pins and needles”, “shooting” and “stabbing”.

We also try to measure pain using a scale of 1 to 10, but do these verbal measures really capture the experiences of those with facial pain? This question recently led to a project with a visual artist to create photographic images of pain. Thus images were co-created by the artist Deborah Padfield and facial pain sufferers, aiming to reflect the individual experiences of pain. A selection of these images were then made into pain cards, which are now being used with other pain patients to help improve mutual understanding and communication between doctors and patients. They appear to be helpful in describing the characteristics of the pain, as well as initiating discussions about its impact.

Once a dental or oral mucosal cause of pain has been excluded, the most common cause of pain in the lower part of the face is temporomandibular disorders (TMD). TMD can present as clicking or locking of the jaw and can come on suddenly. It can present on only one side or both. Pain in the muscles of mastication with or without pain in the joint itself is the commonest form of this group of disorders. It is very common and up to 20 per cent of cases can become chronic.

The pain is centred in the preauricular area and can spread down the mandible and neck, as well as up to the forehead. It can be associated with clicks on opening or closing and rarely with reduced opening. The pain is described as dull, aching, sore and occasionally sharp. When the main muscles are palpated, the same character pain is elicited.

A careful history is essential in order to identify any potential red flags. It is important to check for possible temporal arteritis in anyone over the age of 50 having his or her first episode, as prompt treatment with steroids is required to prevent blindness. Any history of malignancy, neurological deficits, weight loss or severe trismus will require prompt investigation.

Orofacial pain can have many non-dental causes.
Traditional TMD has been managed largely by the provision of a variety of intra-oral appliances. They do provide pain relief, but this may be due to the natural history of the condition. Current data from the world’s largest study on TMD in the US has highlighted that the most common provoking factors are psychological. There is increasing evidence that patients with TMD also experience pain in other parts of the body and are more likely to be headache and migraine sufferers. This data therefore suggests that our approach to management of these conditions needs to be radically changed to include a more holistic approach as described below.

A condition with increasing incidence is persistent dental and/or facial pain, also known as atypical facial pain. This is pain in the region of the teeth and/or tooth-bearing area in which a dental cause cannot be identified. In some cases, the pain is related to nerve injury. This can occur after extraction of teeth, especially third molars, as well as after root canal work, implants or facial trauma.

This pain is often not identified and leads to extensive irreversible, unnecessary dental treatment. It is probably a neuropathic pain and so needs to be managed in the same manner as other reported neuropathic pains according to guidelines. Drugs such as anti-depressants and anti-convulsants are helpful; opioids are of no help in these conditions. However, management with medications alone is insufficient. Patients need to be given an explanation about pain and how it is influenced by past experiences, mood, attention, significant life events, as well as genetic variability.

Evidence shows that chronic pain outcomes are improved when a biopsychosocial approach is used. Cognitive behaviour therapy needs to be delivered by multidisciplinary teams that include clinical psychologists and physical therapists.

Pain that remains intra-oral and does not radiate externally is burning mouth syndrome. This is defined as a burning pain or discomfort often present continuously on the tongue and other parts of the oral mucosa. There are no local or systematic factors to account for this pain, and often it is associated with altered taste and changes in salivary flow. Its highest incidence is in perimenopausal women, and so it had for many years been labelled as a psychological pain; however, recent research has now shown that this is also a neuropathic pain with abnormalities especially in perception of warmth and cold.

There have been a number of randomised controlled trials performed, but the evidence of any efficacy is low. Cognitive behaviour therapy is effective, especially if it includes a careful explanation of the potential causes of this condition and a reassurance that it is not cancerous.

Another rare pain that dentists often see is trigeminal neuralgia. It is defined as a “sudden, usually unilateral, severe, brief, stabbing, recurrent pain in the distribution of one or more branches of the fifth cranial nerve” that is provoked by light touch activities. It has a highly significant impact on quality of life and if poorly managed leads to depression. In some rare cases, it is caused by multiple sclerosis or tumours, but its cause is unknown in the majority of patients. Many patients will have compression of the nerve inside the skull. The pain often presents in the mouth, leading patients to believe that the cause is dental and to ask dentists to investigate.

Again, many patients will undergo unnecessary irreversible treatment until patient or dentist realises that it is non-dental. In the early stages, the pain is highly responsive to anti-convulsants, either carbamazepine or oxcarbazepine, and all guidelines suggest this as the first-line drug type. However, for trigeminal neuralgia, there is a wide range of treatments, both medical and surgical, and so patients need to be seen not only by neurologists or oral physicians, but also by neurosurgeons. In correctly diagnosed patients, surgical outcomes can give the longest pain relief periods.

It is increasingly important that dentists recognise that there are many non-dental causes of orofacial pain. Time needs to be spent in eliciting a careful history, and irreversible dental treatment must be avoided. Chronic orofacial pain patients will have better outcomes if managed by specialist teams with multidisciplinary staff.
IPS e.max CAD and Zenostar: Monolithic brothers

Fabricating individualised monolithic restorations

Dr Petr Hajný
Czech Republic

Aesthetic and functional rehabilitation of the anterior dental arch and occlusal height can be completed in a single day using IPS e.max CAD (Ivoclar Vivadent) lithium disilicate ceramics in combination with CAD/CAM technology. In this case, the CEREC system (Sirona) was used. The articulation was assessed with the help of T-Scan technology (Tekscan), which provided excellent results.

Until recently, closing lateral gaps in patients who refuse implant treatment posed a problem with timescales for us. For these cases, zirconia bridges proved to be a valuable solution. In order to achieve this effect, zirconia bridges proved to be a valuable solution. In order to achieve this effect, we were looking for solutions which could be implemented within a few hours, 48 hours at the latest. For this reason, we decided to use all-ceramic bridges with metal–ceramic crowns in the posterior region. The plan was to manufacture a bridge spanning from tooth #23 to 26, a cantilever bridge from tooth #33 to 35 with a pontic at tooth #34 and a bridge from tooth #45 to 47.

Unfortunately, the gingival tissue was in a poor condition, which was mainly attributed to the impact of the metal–ceramic restorations. Figure 4 shows the need to increase the vertical dimension. With the help of a bleaching shade guide, the patient decided to use BL2. She did not want this shade to be toned down with materials of a darker hue. We therefore decided to use the unstained, or pure, shade variant for the fabrication of the Zenostar bridges (Ivoclar Vivadent) and IPS e.max CAD LT blocks in the BL2 bleaching shade (Fig. 3). Under normal circumstances, we use IPS e.max CAD for the fabrication of three-unit bridges up to the second premolar. In this case, however, required four-unit bridges and a cantilever bridge in the posterior region. IPS e.max CAD does not cover these indications.

Clinical procedure

After removing the existing restorations, we inserted FRC Postec (Ivoclar Vivadent) glass-fibre-reinforced composite root canal posts into teeth #23, 25, 35, 44 and 45. This was followed by the placement of MultiCore Flow (Ivoclar Vivadent) core build-up composite. As the next step, we replaced all existing single restorations with zirconia made of IPS e.max CAD milled with the CEREC MC XL CAD/CAM system and IPS e.max CAD LT blocks in shade BL2 (staining technique). The occlusal height was raised on the same day and temporarily stabilised with Telio CAD (Ivoclar Vivadent) bridges.

The anterior mandibular teeth were restored with laminate veneers made of IPS e.max CAD (staining technique). Prior to placing the Telio CAD bridges (Ivoclar Vivadent), impressions were taken using Virtual 390 (Ivoclar Vivadent). A bite record of the new vertical dimension was taken with Virtual CADHite (Ivoclar Vivadent) silicone material. The bridges were manufactured using a Wieland scanner and a Zenotec mini-milling unit.
justments were not required. The restorations were then cleaned with Ivoclean and silanised with Monobond Plus (both Ivoclar Vivadent). The preparations were pretreated with Multilink Primer A and B and then seated using Multilink Automix luting composite (yellow shade; both Ivoclar Vivadent). After the luting composite had been cured with a Bluephase (Ivoclar Vivadent) curing light and the excess material had been removed, the restorations were permanently cemented in place by activating the Turbo mode of the curing light a number of times. Articulation and occlusal contact points were assessed with a T-Scan device and then the occlusal surfaces were polished (Figs. 10 & 11).

Conclusion
A slight difference in brightness between the Zenostar zirconia bridges and the IPS e.max CAD crowns was noticeable. With hindsight, we would adjust the shade of the Zenostar framework with Zenostar Color Zr (Ivoclar Vivadent) colouring solution before conducting the sintering process to adapt the brightness level in such cases. As an alternative, a pre-shaded block could be used instead of adjusting the shade later by means of the staining technique.

For the patient, her new bright smile was simply a wish came true (Figs. 12 & 13). From our point of view, the SShape software was very efficient in completing the rehabilitation. Tooth shapes were easy to copy. An initial proposal for the design of the occlusal surface of the posterior teeth was immediately available and could be adjusted quickly and predictably. The restorations showed a smooth surface and clearly contoured fissures both on the screen and after milling in the four-axis milling unit.

As further adjustments were not necessary, we were able to seat the restorations straightaway. Monolithic zirconia restorations have shown similar, if not lower, levels of enamel wear on antagonists to other ceramic restorations in clinical applications. By using monolithic restorations, we are able to complete certain cases in a single day.

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**Fig. 10:** The monolithic restorations after 11 months: IPS e.max CAD restorations and Zenostar. — **Fig. 11:** Anterior view of the rehabilitation. — **Fig. 12:** Post-treatment view of the lips: the outcome fulfilled the patient’s wishes. — **Fig. 13:** Close-up of the monolithic IPS e.max CAD crowns fabricated using the staining technique.

**Fig. 10**

**Fig. 11**

**Fig. 12**

**Fig. 13**

**References**

**COMPLETE LINE OF MTA**

Bioceramic materials
Clinical laser application

Dentistry has historically been a leading clinical specialty in adoption of new technologies. Light has been a central part of clinical dentistry from evolutions of operating lights and fibre optic illuminations to light cured materials. With much excitement, these initial observations spurred many investigations for the use of low powered lasers and other light devices (including filter-based broad light sources and LEDs) in many clinical and lab research studies.

Barriers in application

Unfortunately, a combination of the complexity of the early technology and a lack of understanding of its biological mechanisms has resulted in significant discrepancies in their reported therapeutic benefits. Hence, the lack of robust clinical efficacy has largely relegated the field to being side-lined as a pseudo-scientific and alternative medicine field. Current problems in the field from its basic terminology that prevents accurate indexing of the literature, to appropriate disease or biological response-specific clinical dose recommendations appear to be major barriers. Nonetheless, development of low power laser applications has also shown significant progress specifically in the areas of traumatic brain injury, post-traumatic stress disorders, reversal of methanol toxicity and wound healing. 7, 8 In more recent years, mechanistic insights into light-biological tissue interactions have contributed to our better understanding for the therapeutic applications of laser therapies. 9-11

Defining photobiomodulation

Our operational definition for Photobiomodulation (PBM) is a form of phototherapy that utilises non-ionising sources (including broad light, LEDs and Lasers) in the visible and infrared spectrum that result in therapeutic benefits such as alleviation of pain or inflammation, immunomodulation and promotion of wound healing and tissue regeneration. PBM is a non-surgical process involving photophysical and photochemical events at various length scales resulting in beneficial photobiological responses. Its clinical applications could be applied as PBM therapy.

Study 1: Activating TGF-β1

Based on prior reports, we began studies to establish the parameters of the near infrared laser to effectively promote seal wound healing at low doses (5 J/cm², 10 mW/cm², 5 minutes). We performed a thorough literature search to evaluate possible biological pathways involved in promoting cutaneous healing. There appeared to be distinct correlations with reported use of exogenous TGF-β1 and laser treatments in wound healing. Based on these observations, we assessed the laser-treated healing response of oral tissues for TGF-β1 expression and noted increased expression immediately post treatment and at 14 days.12 The increase at 14 days correlated well with an increase in monocyte-macrophage influx, well-known cellular sources of TGF-1. We next looked into the increased early expression of active TGF-1 in these wounds. TGF-β1 is secreted as a latent growth factor complex when associated with a Latency Associated Peptide (LAP). The activation process involves dissociation of LAP from active TGF-β1 dimer that is well-documented with a wide range of physio-chemical modalities such as proteases, extreme pH, heat, ionizing radiation and inorganic binding among others. The early wound has also shown latent TGF-β1 from degranulating platelets present in the early wounds.

We observed low power laser treatments were capable of activating the latent TGF-β1 complex. To further pursue this observation mechanistically, we noted that near infra-red laser was capable of generating reactive oxygen species (ROS). This highly reactive, transient chemical intermediate was sensed by a key metalloproteinase on the latent TGF-β1 complex that resulted in a change in its conformation, resulting in its activation. 13

Study 2: Dentin regeneration

Having noted the effects of low power lasers on promoting oral mucosal wound healing in the prior study, we extended our clinical applications to dentin regeneration where TGF-β1 has been shown to play a pivotal role in dentin physiology. 14-16 We noted the ability of low power lasers to promote dentin regeneration using human dental stem cells. To validate these observations, rodent pre-odontoblasts (MDPC-23) cells grown in a polymeric scaffold, simulating a 3-D niche were treated with low power lasers.

Laser treatments were able to induce dentin differentiation as evident by increased dentin-specific markers of mineralisation. To confirm the role of TGF-β1 in vivo, transgenic mice with lack of TGF-β1 receptor in all cells capable of inducing dentin (utilizing a Dental Naihalophosphoprotein specific transgene) were generated. Experiments in these mice did not demonstrate any significant induction following laser treatment validating the critical role of TGF-β1 activation in mediating its effects.

Previous studies have shown the therapeutic benefits of supplementing exogenous (recombinant) TGF-β for reparative

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Fig. 1: The use of various wavelengths at different doses can be used for various clinical applications. The following wavelengths are used in PBM. Photobiomodulation, ePDT—Photodynamic therapy with endogenous chromophores and exPDT—Photodynamic therapy with exogenous chromophores (606).

Fig. 2: Therapeutic outline utilizing laser-generated ROS activated TGF-β1 in direct differentiation of dental stem cells and pre-odontoblasts to induce dentin matrix and subsequent mineralisation with a Latency Associated Peptide (LAP). The activation process involves dissociation of LAP from active TGF-β1 dimer that is well-documented with a wide range of physio-chemical modalities such as proteases, extreme pH, heat, ionizing radiation and inorganic binding among others. The early wound has also shown latent TGF-β1 from degranulating platelets present in the early wounds.

Fig. 3: Potential routes to move the field of PBM towards mainstream clinical dentistry. The wavy path from lab research to clinics is meant to reflect the multistep, intricate path from lab research to clinics.

Innovations with lasers could lead regenerative dentistry

With this year, 2015, being designated as the year of light, the acknowledgment for the key role of light in multitude areas of our very existence and more specifically, in areas of human health are being widely promulgated. 1 Many references to the beneficial effects of light and specifically sunlight are re-
dentin, this study suggests the use of low power lasers can activate endogenous latent TGF-β1 present naturally in the pulp-dentin complex to drive differentiation of resident dental stem cells (Fig. 2). Thus, this therapy can utilise the inherent repair-regenerative responses naturally present in native tissues.

Clinical Applications of Laser-Dentin induction

These observations have potential clinical implications where dentin would need to be therapeutically generated. The two directly relevant clinical scenarios are for pulp capping following deep carious lesions and for dentin desensitisation. In the former case, removal of decayed or damaged tooth structure approximating the pulp (close to or clear exposure) that would be potentially replaced with low power laser treatments.

In the second scenario, the use of low power laser treatments on exposed dentinal tubules could potentially generate an intrinsic dentin barrier that would relieve tooth sensitivity. This would be more effective than our current approach to extrinsically occlude exposed tubules modes.

The two major limitations of the current study were that we noted calcifications interspersed throughout the pulp chamber, spatially distinct from the laser-biological tissue interface. We believe this is perhaps a combination of the inherent near-infrared laser wavelength that readily permeates throughout biological tissue as well as the soluble nature of the activated molecules. This could be potentially addressed by better optical focusing technique and use of specific reagents that absorb the radiant energy and spatially restrict the biological inter-phase.

A second limitation in this study was the observation that laser-generated dentin was a tertiary or reparative form that lacks pristine tubular structure. It appears that additional cues (biophysical, architectural) and biochemical (soluble, organisational), are likely necessary to promote morphodifferentiation of the newly induced dentin.

In attempts to further explore these molecular mechanisms, we have more recently extended developed a polymeric scaffold system with precise morphogen fields. Using this model, we were able to extend our observations with dental stem cells and laser-activated TGF-β1 mediated dentin differentiation to mesenchymal stem cells suggesting this approach could have significant potential with other stem cell types as well.

Conclusion

Both ROS and TGF-β1 are central biological mediators in a wide range of biological responses. Further, the ability to effectively move this therapy into mainstream clinical dentistry will require more basic research, development of robust clinical standards and education at various levels (basic dental training and continued education) (Fig. 3).

In the current era of personalised medicine and strategies to utilise sophisticated technologies and pharmaceuticals to individualise health care, the significant promise of lasers in clinical dentistry may indeed be the leading, pivotal technology that usherers in the new era of regenerative dentistry.

Acknowledgement

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Virtual reality simulation

Indications and perspectives for the technology in the field of dental education

Dr Susan Bridges, Suzanne Perry & Prof. Michael Burrow
Hong Kong & Australia

Virtual reality (VR) simulation inevitably conjures up images of futuristic technology, imaginary worlds or complex robotic devices. What if haptic simulators are now able to create an environment in which users can practise clinical procedures, such as restorative dentistry, endodontics, periodontal assessment, implant placement and even dental extractions.

These systems are a far cry from the first phantom head simulator created in the early 1900s that attempted to represent the oral cavity with a relatively primitive set of upper and lower dental casts mounted on a metal pole (Fig. 1). Although phantom head systems are now the mainstay for undergraduate training, educationalists are becoming more aware of the additional benefits of VR simulation, such as the need to repeat the same task many times, providing real-time feedback leading to a reduction in supervision, and the benefits of students being able to practise in their free time without laboratory supervisors. Other benefits of VR simulators include the reduction of consumable costs incurred with plastic teeth and the elimination of water system management issues, reducing the possibility of water-borne infections such as Legionella.

Undoubtedly, the initial cost of the VR simulator is a major deterrent and, with additional concerns regarding possible lack of realism to the clinical situation, it is natural that many suggest the need for more evidence-based research prior to committing to such an investment. In the limited literature on VR dental simulation, studies have been mixed but, in general, are positive about the use of the technology for dental training. Research has shown that procedural learning on VR simulators may be more effective than with the traditional phantom head and may reduce the number of staff–student interactions without a reduction in the quality of the practical work.

In contrast, other research has shown that dental performance may be no better using VR simulation and that some students prefer their training to be on phantom heads. Naturally, further research will be needed to establish the effectiveness of the technology.

What are haptics?

The addition of haptics to VR technology creates a dimension of sensory feedback for the user. The word itself originates from the Greek work haptikos, which means “to touch or grasp.” There are many examples of haptic simulation in modern-day technology, such as in gaming and the vibration component of a mobile phone. The aim of haptics in many cases, especially in surgery, is to improve the realism of the virtual experience. In dentistry, for example, when carrying out a cavity preparation on a haptic VR simulator, there is a difference in hardness felt when cutting from enamel to dentine, and if the pulp is damaged an instant loss of resistance occurs, producing a realistic sensation of drilling through the roof of the pulp chamber (Figs. 2 & 3).

Naturally, the important question is: does the addition of haptic technology really make a difference when learning using VR simulation? To answer this, we have to delve into surgical research for which a stronger evidence base exists, specifically in the area of laparoscopy. A review of the use of haptics in surgery suggested that the addition of haptics to simulation can reduce surgical errors and is especially beneficial in the early stages of learning a new skill task. Other studies have shown that the addition of haptics may improve overall performance of surgical skills and may be beneficial when a trainee is first exposed to a clinical situation. In dentistry, small-scale studies of haptic VR simulators suggest that they are at least as good as phantom heads in training undergraduates.

The future of VR simulation in dentistry

Currently, exciting research involving the universities of Hong Kong and Melbourne is looking into gaining solid evidence concerning the use of haptic VR simulation in the dental undergraduate curriculum. By utilising neuroimaging techniques, identification of the traits an expert usually displays can occur, which in turn can be built into training pathways to enhance the effectiveness of procedural learning.

Initial findings have suggested that distinct differences may be apparent in the brains of dental experts and novices during a simulated clinical task when using a dental haptic VR simulator. Further work in this area is to be carried out, with additional investigation into the positioning of haptic VR simulation within a curriculum and considering its effectiveness compared with traditional phantom head training techniques.

Already it can be seen that the area of VR in dentistry and especially that of haptic VR simulation is proving an interesting development, offering encouraging prospects for the future skills-based training of dentists. The evidence is limited, however, so, prior to committing this technology as the mainstay of training in dental undergraduate curricula, there is a compelling need to expand the current research base.
Going (unintentionally) green: The unexpected bonus of switching to CAD/CAM and same-day dentistry

De Joel Shum
USA

With dentistry as innovative and dynamic as it is, the progress made and the exciting new trends that result are often judged in terms of the technological or financial. We can update our equipment to have a listry to their patients; that is, they condense the restorative process of multiple appointments over several weeks down to one appointment lasting a few short hours. Clinicians can digitally scan the patient's teeth and design the restoration(s) right then and there. Once approved, the restoration(s) can be milled and while remaining chairside, pro- viding patients with that "wow" factor as they see what digital technology is allowing dentists to do. Once designed, the restorations can be immediately milled in the office and tried in the patient's mouth, so a perfect fit and high-quality aesthetics are affirmed at the same appointment.

Digital practice equal green practices

Since CAD/CAM technology was first introduced decades ago, early adopters and technology enthusiasts have encouraged integration of these systems for various practical and financial reasons. Though generally a substantial initial investment, practices that upgrade to digital technology find that streamlined procedures and happier patients lead to a significant return on investment.

But switching to a CAD/CAM system provides an unanticipated bonus, one with a far broader impact. Using an in-office CAD/CAM system is one of the most environmentally conscious upgrades a practice can make, offering both concrete and intangible benefits for dental practices, their patients, and the greater community.

CAD/CAM systems add to a practice's green image with the many small changes they allow the office to implement. For example, now that impressions are taken with a digital scanner (PlanScan), traditional impressions—and all their associated materials, such as disposable impression trays, impression material, and water—with which it is mixed—are no longer necessary. Clinicians who thought they were only saving money (and storage space) can rest easy at night knowing they’re no longer contributing to the toxic, dis-posable culture in many health-care offices.

Additionally, because digital impressions can be viewed instantly with software that allows users to see potential errors, any mistakes are quickly averted with a second digital scan that requires no extra materials or waste. It is not uncommon for dentists to take a second traditional impression because of errors caused by saliva or air pockets in the impression material or to have a backup on hand in case there are problems down the road. Over time, material waste created using traditional impression methods adds up. Using digital technology not only streamlines the process but ensures that materials, time, and money aren’t wasted.

Moreover, because traditional impressions aren’t needed with a digital workflow, equip- ment previously used to perform these procedures, such as a mixing gun for impression material, are also no longer necessary. While clinicians may think they are only saving themselves hassle or time by purchasing an easier-to-use piece of equipment, they’re also saving energy—literally. With digital technology, impression-taking instruments no longer need to be run through a wash cycle and sterilized. This saves time, energy, and water.

While it seems like saving re- sources, particularly water, isn’t possible in digital practices, small steps such as these really add up. The Eco-Dentistry Association (EDA) (www.ecodentistry.org) estimates that dental practices use 560 gallons of water per day. This totals 57,000 gallons of water per year, per practice. In the United States alone, dental prac- tice water usage totals approxi-mately 570 million gallons per year. This does not even in- clude dental laboratories, which must use substantial amounts of water when mixing and pouring models in stone and cleaning their equipment.

In addition to the above in-of- fice water issues, amalgam lab- oratories and their respective procedures that will always re- quire water; these staggering sta- tistics spell out the clear need for water conservation whenever possible. Luckily, CAD/CAM supports this effort.

Greener materials: Using all ceramics instead of amalgam

Amalgam restorations had been the standard of care in restorative dentistry for decades. With material science advance- ments, however, there are new contenders for that top spot. One partic- ular, the use of all-ceramic mate- rials has significantly increased in recent years. When com- pared with in-office CAD/CAM sys- tems, their advantages are eco- nomical and ecological, in addition to aesthetic, biocompatible and functional.

The majority of the materials for same day CAD/CAM dental practice are all-ceramic com- posite or all-ceramic blocks, so there is no metal involved. These metal-free restorations can even be used without reservation for patients with a history of amalgam sensitivity, or for those who want the aesthetic benefits that metal-free restorations can offer. Metal-free restorations can often be used without reservation for same day CAD/CAM dental practice. There are new possibilities that were previously room for and that can be used with higher restorations, such as those that use same day CAD/CAM dental practice.

Furthermore, the longevity of all-ceramic restorations such as in-office CAD/CAM designed inlays is well documented. In addition to a highly aesthetic restoration, patients receive restorations that will last for many years, without the concerns associated with amalgam, such as cracks, failures or potential mercury toxicity. This potentially saves patients and clinicians time, money and wasted resources that would be spent traveling to and from the dental practice, taking more impres- sions and fabricating new restorations.

Perhaps of greater conse- quence is removing toxic metal from this equation. All-ceramic and metal-free restorations mean that dental patients no longer have to worry about amalgam disposal and its accompanying mercury toxicity.

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Perhaps of greater consequence is removing toxic metal from this equation. All-ceramic and metal-free restorations mean that dental patients no longer have to worry about amalgam disposal and its accompanying mercury toxicity.
The Environmental Protection Agency (EPA) estimates that nearly 50 per cent of all mercury entering local wastewater treatment facilities originates in dental offices.

Using CAD/CAM compatible materials such as all-ceramics lessens or eliminates the contribution of your dental office to environmental mercury. It also means that dental practices needn't worry about using an amalgam separator.

Currently, the American Dental Association (ADA) does not have national regulations in place for amalgam separators, so many dental practices and laboratories aren't compelled to use them. Although designing and milling all-ceramic materials still requires energy and results in some waste materials, can they really compare with the toxic by-products of metal-based restorations?

Crunching the numbers: CAD/CAM math

In-office CAD/CAM systems provide more than just a clear conscience about saving the environment. There are real, tangible benefits and savings that can easily be estimated to demonstrate the immense value of this digital technology.

Because same-day in-office CAD/CAM dentistry reduces the number of appointments from two (or possibly more, if the restoration does not fit) to one, it stands to reason that every dentist who incorporates these procedures would positively impact the environment by reducing the number of automobile trips patients make to the practice. This would result in a 50 per cent reduction in gasoline and oil product use.

With a carbon content of 2,421 grams, one gallon of gasoline produces approximately 19.4 pounds per gallon of carbon dioxide emissions. This is calculated by multiplying the carbon content (2.241) by the amount of carbon that remains unoxidized (0.99) by the ratio of the molecular weight of CO₂ (44) to the molecular weight of carbon (12).

Using the state of California as an example, where approximately 10 per cent of the 100 million laboratory dental restorations are completed in the United States every year, we can calculate an approximate savings. If four gallons of gasoline are used for a round trip to the dentist, a restoration needing two appointments to complete would require eight gallons of gasoline. But if these dental practices adopted same-day in-office CAD/CAM dentistry, that number could be cut in half, saving four gallons of gasoline per restoration. Four gallons of gasoline multiplied by 10 million restorations would equal a savings of 40 million gallons of gasoline for restorative procedures in the state of California alone. This, in turn, would equal a reduction of carbon dioxide emissions by 776 million pounds per gallon each year (assuming the previously calculated 19.4 pounds per gallon measurement).

If we extrapolate to the United States as a whole, we can calculate that this would equal 400 million gallons of gasoline saved and 7,760 million pounds of carbon dioxide emissions eliminated, per year. This would all be due solely to a reduction in patient automobile trips to and from the dentist for restorative procedures. While same-day dental procedures may not save the world, their potential impact, even estimated, is undeniable.

**Conclusion**

In-office CAD/CAM systems' advantages are limitless. In addition to the clear financial and practical benefits they bring, their positive impact on the environment makes the decision to upgrade even better. They remove toxic, wasteful and disposable materials and practices from the equation, replacing them with greener practices that have a tangible influence. While the clinical advantages of CAD/CAM systems and same-day dentistry continue to be rightfully celebrated, their ecological advantages should not be overlooked.

**References**

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