Researchers bite into spinal cord injury rehab

Daniel Zimmermann

HONG KONG/LEIPZIG, Germany: In recent years, dental stem cells have increasingly been investigated for their use in medical applications, including the rehabilitation of lost or damaged biological function. Scientists from the Nagoya University in the Nagasaki Prefecture in Japan have reported that they could possibly help to repair injuries of the spinal cord, a leading cause of paralysis and disability.

Having transplanted human dental pulp stem cells into lab rats with severe spinal cord injury (SCI), they found that the animals regained significantly more limb function than through a transplant of human bone marrow stromal cells or skin-derived fibroblasts. According to the researchers, the cells not only inhibited the death of nerve cells, but also promoted the regeneration of severed nerves and replaced lost support cells with new ones, two main factors essential for functional rehabilitation.

"Spinal cord injury often leads to persistent functional deficits due to the loss of neurons and glia and to limited axonal regeneration," they stated in the study published in the Journal of Clinical Investigation last week.“Our data demonstrate that tooth-derived stem cells may provide therapeutic benefits for treating SCI through both cell-autonomous and paracrine neuroregenerative activities."

Investigating different types of stem cells for their potential in SCI rehabilitation has a long track record in science. This September, for example, researchers from the Medical College of Wisconsin reported that they had begun to implant foetal neural stem cells into SCI patients. The Nagoya study is the first to have shown a rehabilitation effect in SCI cases with stem cells derived from dental tissue.

Classified by the grade of impairment, SCI can have mild to severe effects on patients, including total loss of biological function. Common therapies include surgery, long-term physical therapy and other rehabilitation efforts. Korea sees new dental laser

Dental laser specialist Bionlase has announced to have gained regulatory approval for its Waterlase iPlus all-tissue dental laser system in South Korea. According to the US manufacturer, the system will be available beginning of December through the company’s dealer MD DMT in Seoul.

Scaling is good for you

A study from Taiwan has found that scaling teeth at least once a year can reduce the risks of suffering from a heart attack, by more than 20 per cent. Presented at the Scientific Session of the American Heart’s Association in the US, the study followed 100,000 people over the period of seven years.

Award given to Specialist Dental Group

Specialist Dental Group has won a “Promising Brands” award at this year’s Singapore Prestige Brand Award organised by the Association of Small and Medium Enterprises (ASME) and the country’s largest Chinese-language newspaper Lianhe Zaobao. The annually trophy recognises up and coming brands in the city-state that have been developed and managed effectively through various branding initiatives.

Prior to the winning the SPBA, Specialist Dental Group was already selected as one of three finalists for “Best Healthcare Experience” at the Singapore Experience Awards for the second year in a row.

Founded in 1979, the group has grown into one of the largest multi-speciality dental practices in Singapore employing dental specialist who offer treatment in areas such as prosthodontics, orthodontics, periodontics, oral maxillofacial surgery and parodontics. According to SDG, their signature treatments include dental implants, braces, Invisalign, gum treatment, oral surgery, crowns/veneers and dentistry for children.
Early osseointegration to hydrophilic and hydrophobic implant surfaces in humans

Prof. Niklaus P. Lang
Switzerland

The surface characteristics of titanium implants influence the rate and degree of osseointegration. Moderately rough surfaces such as SLA® have demonstrated superior bone-to-implant contact (BIC) than surfaces such as titanium plasma-sprayed (TPS), Al2O3-blasted or machined surfaces. Chemical modification, such as with the hydrophilic SLActive® surface, can further enhance the osseointegration process.

Investigations comparing osseointegration with various implant surfaces have been performed, but tend to be in vitro animal studies. No data are available from human studies, and the healing sequence of the early osseointegration process in man and how it compares to the process seen in other in vitro investigations is relatively unknown.

The aim of this investigation, therefore, was to evaluate the rate and degree of osseointegration at two different implant surfaces (SLA® and SLActive®) during the early phases of healing in a human model.

Materials and methods
A total of 49 specially designed titanium implants (length 4 mm, outer diameter 2.8 mm) with either a SLA® or SLActive® surface were placed in the regions of 28 healthy volunteers. A healing cap with an internal screw assembly was attached to the coronal part of the implant. After submerged healing periods of 7, 14, 28 and 42 days, the implants were removed using a specially designed trephine, which removed the implant and circumferential tissue of 1 mm thickness.

Histological sections were prepared and histometric analyses performed for amounts of new bone, old bone, bone debris, soft tissue and BIC.

Results
Healing was uneventful at all sites. Of the 49 implants placed, 56 were available for histologically/histometric analysis; difficulty in harvesting the biopsies resulted in the loss of some specimens. Artifacts were present on a number of specimens—these areas were excluded from analysis so that only artifact-free regions were evaluated. The percentages of new bone-to-implant contact after 7, 14, 28 and 42 days are shown in Table 1.

After seven days, no differences were observed between the SLA® and SLActive® specimens. BIC was approximately 6 %, and some early bone apposition was noted in places where existing bone was in close contact with the implant surface; bone therefore bridged a gap between old bone and implant in these situations. The majority of the space between bone and implant was filled with soft tissue comprising primitive matrix with various bone debris particles.

BIC increased to 12.2 % and 14.4 % for SLA® and SLActive®, respectively, after 14 days. Bone formation was noted on the existing bone, extending partly onto the implant surface. The beginning of new bone apposition was evident over large areas of the surface of the SLActive® implants. Larger bone particles were seen to be surrounded by osteoid, which helped trabecula formation.

BIC increased in both sample types by day 28, but was significantly higher with SLActive® (48.5 %) than with SLA® (32.4 %). A bone coating was observed with both specimen types (Fig. 1 and Fig. 2), but almost complete BIC was observed within some threads of the SLActive® implants (Fig. 2), and new mineralized bone trabeculae were observed extending into the provisional matrix.

After 42 days, BIC increased further to 62 % for both SLA® and SLActive®. An advanced stage of bone maturation was observed with both surfaces, and the formation of Osteons was observed away from the implant surface. The osteocoating was noted to be thick and extensive, and was frequently connected via trabeculae, extending onto new bone.

Conclusions
Similar healing patterns were observed for both SLA® and SLActive® implants. Osseointegration (BIC) was greater after 14 days and significantly greater after 20 days for SLActive®. The rate of osseointegration was substantially slower (approximately double the healing time) in humans than that observed in animal studies. This is the first study to demonstrate histologically the osseointegration process with SLActive® in humans.

Table 1: Percentage of BIC after 7, 14, 28 and 42 days.

<table>
<thead>
<tr>
<th>Specimen</th>
<th>7 days</th>
<th>14 days</th>
<th>28 days</th>
<th>42 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLA®</td>
<td>0.14</td>
<td>14.82</td>
<td>48.34</td>
<td>01.02</td>
</tr>
<tr>
<td>SLActive®</td>
<td>0.47</td>
<td>12.19</td>
<td>32.58</td>
<td>01.53</td>
</tr>
</tbody>
</table>

This article first appeared in Clinical Oral Implants Research, 2011, 22, pages 349–356.

Prof. Niklaus P. Lang is working as professor at the Department of Periodontology and Implant Dentistry, Prince Philip Dental Hospital, The University of Hong Kong. He can be contacted at info@strau mann.com.
Philippines comes out tops in DENTSPLY Asia Student Clinician Competition

This is the first time that a Filipino dental student has won the annual competition. During a first attempt to win the trophy in 2009, representatives from the Southeast Asian country only finished third place. As the winner, Calbaquinto will become a member of the Student Clinician American Dental Association and receive travel funding to represent the International Association for Dental Research South-East Asia division at next year’s session of the American Dental Association in San Francisco, university officials said.

This year’s competition was held in conjunction with the 25th Convention of the International Association for Dental Research and 22nd Annual Meeting of the South East Asia Association for Dental Education in Singapore and joined by winners of national student clinicians competitions held in countries like Malaysia, Singapore, Vietnam and Indonesia.

Aussies spend more on dental services

Daniel Zimmermann

HONG KONG/LEIPZIG, Germany: Australians incurred more out-of-pocket expenses on dental services last year, a new report on oral health and dental care released by a government agency has found.

According to the paper, the overall dental expenditure in 2009–2010 increased by more than 10 per cent to AUS$7.6 billion (US$5.67 billion).

The report published by the Australian Institute of Health and Welfare (AIHW) in Canberra gathered information from surveys conducted and managed by the Australian Research Centre for Population Oral Health. It also found that over two-thirds of adults in the country had to pay for various dental treatments out-of-pocket, despite having insurance and nine per cent had to pay for their dental expenses fully.

The results could fuel demands for the creation of a universal Denticare scheme by the Green party, who made improved access to dental care a condition for a coalition with the Labor party in last year’s federal elections. Both parties have clashed repeatedly over the issue in the last twelve months.

As a basic commitment, the government recently announced that it would provide additional funding of AUS$55 million (US$56 million) for dental care next year and set up a National Advisory Council on Dental Health in order to develop recommendations on the reform of the deficient public dental health care system. Prior to that, Labor angered its coalition partner with plans of scrapping dental funding from its 2012 budget entirely.

According to the AIHW report, almost 50 per cent of adult Australians had untreated tooth decay in 2006. It also found that every second teenager had caries in their permanent teeth at the age of 15.
The single most important development that was a giant leap for endodontics is micro-computed tomography, by giving us a 3-D view of the area in which we have to work. Without this technology, the basis for many endodontic procedures was just empirical. For example, enlarging the root canal three sizes beyond the first fill that hinders, or arbitrarily deciding the final apical size with tapered rotary use during hand instrumentation does not have any scientific basis at all.

The work of Prof. Marco A. Versiani on the root canal anatomy project has provided us with new insight deriving from micro-CT, which has demystified many old concepts. Now we know that all root canals are curved, apical diameters are as small as perceived, and root canals do not have large lapers.

Regenerative endodontics, though in the infant stage, can hold significant implications for the management of necrotic immature teeth. This applies to the advances in tissue engineering and the regeneration of the pulp-dentine complex.

Multiple studies have shown that continued root development can be accomplished after disinfection of the root canal system, evoking bleeding inside the canal in the fundamental area of coronal seal. These treatment protocols can result in radiographic and clinical evidence of healing and subsequent root development that has been attributed to regeneration of tissue.

Until recently, the clinical presence of stem cells in the canal space after this procedure had not been proven. New findings by Tyler W. Loveless et al. demonstrated that the evoked bleeding step in regenerative procedures triggers the significant accumulation of undifferentiated stem cells in the canal space, where these cells might contribute to the regeneration of pulpal tissues. Future developments may see wider application of these tissue-engineering principles, which have the potential to revolutionise the field of endodontics.

The use of lasers in endodontics may be a common procedure soon with a number of applications in access preparation, root-canal shaping, and decontamination of the root-canal system. The improved technology has introduced endodontic fibres and tips of a calibre and flexibility that permit treatment up to 1 mm from the apex. Laterally emitting conical fibre tips were found to be safe under defined conditions for intra-canal irrigation without harmful thermal effects on the periodontal apparatus. The EndoVac irrigation system (Discus Dental) is one of the best things that has happened to endodontics in recent years. While sodium hypochlorite is the only endodontic irrigant capable of significantly eliminating the biofilm associated with endodontic infections, it has the tendency to cause catastrophic tissue damage when extruded.

With EndoVac, fortunately, it can now be safely delivered to us a 3-D view of the area in which we have to work. Laser scanning, structure photo-imaging, and surface image analysis have almost superseded the stone model in the clinical environment. In addition, these technologies enable clinicians to achieve an intended treatment result through individual custom appliances made possible by robotics that allow sophisticated individual tooth positioning, a procedure that was not possible with conventional preformed appliances.

These diverse technologies bring the prospective adjustment in fundamental concepts of the conventional treatment, and consequently improve the accuracy of the orthodontic correction.

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Ban on HIV dentists in the UK could be lifted

According to latest news reports, HIV-positive dentists and doctors in the UK could soon be allowed to practise again, provided they are taking antiretroviral drugs and are being monitored. British media report. According to newspaper The Independent, the UK Department of Health is to announce that the automatic ban on dentists and doctors with HIV carrying out procedures that might potentially lead to blood contamination could soon be lifted.

The possible regulation change comes after a study of the evidence presented to the Chief Medical Officer Dame Sally Davies, which concluded that the risk of transfer during any medical procedure is now negligible and the likelihood of any infection to be as low as one case every 2,400 years.

The prohibition, which has been in place for 20 years, forbids practitioners who are infected with HIV to perform exposure-prone procedures. Hospitals and dental surgeries have long followed a “don’t ask, don’t tell” policy with regard to HIV positive practitioners, sources in the medical profession told the newspaper. They believe that—regardless of the emotive nature of HIV—the policy can no longer be justified on public health grounds and that it is therefore clearly discriminatory.

To the Editor

Re: “Editorial: Use of botox is a medical procedure” (Dental Tribune Asia Pacific Vol. 9, No. 11, page 4)

Pretty well everything about dentistry was covered at a basic level to enable graduation, just as medical practitioners graduate with very basic information. The test for medical and dental practitioners is how conscientiously they pursue CPD throughout their careers. If the dental or medical practitioner has attended approved courses in botox therapy, has taken the subject seriously, there should be no problem with him/her administering botox. I’m a dental practitioner, and choose not to administer botox for cosmetic purposes. Currently, I would regard myself as requiring further information and training before using it in any form. However, I feel confident that under the right tutors I would acquire the skills required quickly. My colleague is very experienced and is “only a general dentist”, but he has spent considerable time and money to acquire the necessary education, training and competence. Use of botox is a medical procedure. Dentistry is a medical specialty. Dentists are more than competent to administer botox if trained properly.

Dr Martin Edwards, 01 Dec. 2011

Secondly, the detailed anatomy of the mid-face, orbit, upper face and neck is not covered in dental training at a level sufficient for the safe use of botox—I don’t know where you went to dental school but I was trained. A LOT on head and neck anatomy. I completed a dermatology rotation in my residency. The pharmacology coursework taught me to evaluate new drugs, not just memorize the properties of existing drugs. Cosmetic dentistry and cosmetic medicine don’t overlap? Get a grip, your arguments are very weak.

Dan, 01 Dec. 2011
LEIPZIG/HEIDELBERG, Germany: The spirit of General Patton is greeting patients at the door. Only a few metres away from the hospital room where one of America’s most famous war heroes regrettably died in 1945, Lieutenant Colonel Cathleen Labate has just begun her daily shift. The dental provider from New Hampshire is one of almost 100 army dentists currently serving in the Europe Regional Dental Command (ERDC) at the Nachrichten Kaserne in Heidelberg, a small German town idyllically situated along the edge of the Odenwald forest. There she is jointly responsible for the oral health of several hundred soldiers and their family members in the surrounding Army communities.

Labate was recently assigned to another Army dental clinic in Vicenza in Italy. Prior to that, the descendant of German-Italian immigrants worked in private practice in the US for almost 20 years. The oral health of soldiers she sees at the base on a daily basis is often better that those of the patients she treated during her career as a dentist in rural America. Consequently, the most common procedures here are regular dental exams and emergency work like the removal of the periodontal abscess of a retired army officer who has just left her office. “Generally speaking, the oral health of people in the military is good,” she says. “Although I have to admit that missions like those in Iraq and Afghanistan can seriously take their toll on soldiers’ teeth.”

Colonel William R. Bachand could not agree more. The 58-year-old Commander of the ERDC has been with the Army Dental Corps for more than 32 years. In stressful situations like armed conflicts, he says, oral hygiene quickly declines with every single soldier. Along with the high intake of acid and sugar-rich fluids, especially in hot climates like Afghanistan, this negligence often leads to major dental problems, a phenomenon that Army dentists experienced in earlier conflicts like Korea or Vietnam. At the beginning of the last two Engagements in Iraq, for example, statistics showed a 30 per cent increase in returning soldiers with signs of rampant caries or gingivitis.

Bachand currently commands over 20 army dental clinics, spread over US bases in Germany, Italy and Belgium. Worldwide, the military employs over a thousand dental officers in three major regions—the US, Europe and the Pacific. Before he took command of the ERDC front Colonel Randall Ball last year, Bachand served as the commander of the Pacific Regional Dental Command in Hawaii, a post very different in many aspects to that in Europe.

“In the Pacific you have a smaller population but huge distances to cross between each base and clinic,” he says. “In Europe, everything is conveniently reachable at a driving distance.”

Bachand’s scope of duty could soon become even smaller, as the US Army is in the process of significantly pulling back troops from Europe. According to the latest plans of the US Department of Defense, over 4,000 soldiers are to be relocated to the US mainland over the next two years. For the ERDC, this would mean the closure of several clinics and the relocation of dental personnel. In Germany, the clinics in Heidelberg and nearby Mannheim in particular will be closed by 2013, a process that comes with numerous challenges, says Bachand.

“This transformation will be complex, because owing to the closure of Army bases, large numbers of soldiers are moving within Europe. In addition, we’ll try to minimise job losses of our civilian
contractors like German dental technicians we usually hire from the nearby areas," he tells Dental Tribune.

Serving for more than 100 years

Dentists have always been part of US military forces. Before Congress signed the bill for the establishment of a commissioned Dental Corps in 1911, dentists and other health care professionals had been working for the Army on a contract basis since the Revolutionary Wars of the 18th century. Full financial and operating autonomy, however, was not achieved until 1977 when the dental command was finally separated from the medical service, a command structure that had previously led to low morale and retention rates amongst dental officers.

Nowadays, the dental service in Europe alone has an annual budget of US$18 million, of which the most part is spent on personnel and dental equipment. In terms of dental supplies, the Army rides the patriotic train, with all chairs being provided solely by US manufacturers like A-dec and Pelton & Crane. Long-term contractor Henry Schein also just closed another exclusive US$172 million contract with the service for 2012.

Most army dentists enter the service through the Health Professions Scholarship Program, a competitive one- to four-year paid educational programme available for several medical-related posts throughout the military forces. Others are directly recruited by the Army, including many older dentists who often want to do a last service for their country.

According to Bachand, the Corps is currently short a few hundred officers worldwide, despite the fact that Army dentists are much on par with their civilian counterparts and enjoy several advantages like paid education or a comprehensive career development plan. Each year, for example, the Army provides them with 30 hours of continuing education and even sends specialists back to the States for conferences like the recent annual congress of the American Dental Association in Las Vegas.

Most CE courses in Europe, however, are organised with local providers such as the Kopf clinic at the Heidelberg University’s Faculty of Medicine, which has collaborated with the ERDC for many years.

“Even more like our civilian colleagues, Army dentists have to stay in touch with the latest technology-driven changes like CAD/CAM or cone-beam computed tomography," Bachand comments. “Compared to when I started in the service over 50 years ago, almost every aspect of our field has now become computerised, beginning from the workload reporting in the scheduling system, diagnosis or treatment."

Despite the more stable lifestyle, switching places with dentists in the civil world does not seem to be an option for Bachand anymore.

“What I like especially about military dentistry is the group practice approach and the possibility to really focus on the clinical needs of every individual patient. Even though we have to be responsible financial stewards, we do not have to worry so much about the business aspects in regard to specific treatment for patients,” he concludes. “I would never trade that experience.”

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According to the LAI technique, the tip must be localised in the middle third of the canal, approximately 5 mm from the apex (on the right).—
of a smear layer. Note the typical pattern of laser ablation, both on the organic and inorganic dentine.—
of smear layer and thermal damage.—

Figs. 9 & 10: the international literature today

Er,Cr:YSGG laser.—

Fig. 7:
Preparation of the access cavity

Laser in endodontics (Part II)
are useful in the removal of pulp
faces, the second part of this ar-
chitecture and clinical results.21–23 However, the Erbium, Chromium: YSGG (Er,Cr:YSGG) and

Fig. 16

Figs. 13 & 14:
SEM images of irradiated dentine with Er,Cr:YSGG laser (1.0 W, 20 Hz, 1 mm to the apex), spray off and canal irrigated with physiological solution, showing evidence
for decontamination and the absence of smear layer. Note the typical pattern of laser ablation, both on the organic and inorganic dentine. —

Figs. 25 & 26:
SEM images of irradiated dentine with Er:YAG laser (1.75 W, 20 Hz, 1 mm to the apex), with water spray.35,27

The surfaces prepared with the Er:YAG laser are well cleaned and without smear layer, but often con-
tains tangles, irregularities and char-
ning with the risk of perforations or apical transportation. In effect, canal shaping performed by Er-
bium laser is still a complicated pro-
tocol that should not be underestimated.

Preparation and shaping of canals

Preparation of the canals

Preparation of the access cavity

The preparation of the access cavity can be performed directly with Erbium lasers, which can ablate enamel and dentine. In this case, the use of a short tip is recom-
ended (from 4 to 6 mm), with di-
meters between 600 and 800 µm, made of quartz to allow the use of higher energy and power. The im-
portance of this technique should not be underestimated.

Owing to its affinity to tissues richest in water (pulp and carious tissue), the laser allows for a min-
imally invasive access (because it is selective) into the pulp cham-
ber and, at the same time, allows for the decontamination and rem-
oval of bacterial debris and pulp tissue. Access to the canal orifices can be accomplished effectively after the number of bacteria has been minimised, thereby avoid-
ing the transposition of bacteria, toxins and debris in the apical di-
rection during the procedure. Chen et al. demonstrated that Erbium lasers are killed during cavity preparation up to a depth of 500 to 400 µm below the radiated sur-
fFace.20 Moreover, Erbium lasers are useful in the removal of pulp stones and in the search for calcified canals.

Shabahat et al. presented posi-
tive results of treatment performed entirely using a Er:YAG laser and endodontic lateral emission micro-
probes.20,21 Ali et al., Matsuura et al. and Iwamoto et al. used Er:Cr:YSGG laser to prepare straight and curved canals, but in these cases, the re-

The surfaces prepared with the Er:YAG laser are well cleaned and without smear layer, but often con-
tains tangles, irregularities and char-
ning with the risk of perforations or apical transportation. In effect, canal shaping performed by Er-
bium laser is still a complicated pro-
tocol that should not be underestimated.

Decontamination of the endodontic system

Studies on canal decontamina-
tion refer to the action of chemical irradiants (NaOCl) commonly used in endodontics, in combination with chelating substances for better cleaning of the dentinal tubules (uti-
lised in EDTA). One such study is that of Forti et al., who reported the decontaminating power of NaOCl up to a depth of 130 µm on the radicular wall.21 Lasers were initially introduced in endodontics in an attempt to increase the decon-
tamination of the endodontic sys-
tem.22 All the wavebands have a high bactericidal power because of their thermal effect, which, at dif-
fers powers and with differing ability to penetrate the dentinal walls, generates important struc-
tural modifications in bacteria cells. The initial damage takes place in the cell wall, causing an alteration of the osmotic gate and consequent swelling and cellular death.23,24

Decontamination with near infrared laser

Laser-assisted canal decontamina-
tion performed with the near in-
frared laser requires the canals to be prepared in enamel (spa-
cial preparation with ISO 25/30, as—

the Erbium(YAG) (Er:YAG) lasers have received FDA approval for cleaning, shaping and enlarging can-
als. Few studies have reported posi-
tive results for the efficacy of these systems in shaping and enlarging radicular canals. Shen et al. used an Er:YAG laser system with a conical tip with 80 % lateral emission and 20 % emission at the tip to enlarge and clean the canal using 0.9% sodium

Figs. 21–23: SEM images of radiated dentine with radial firing tip, at 20 and 50 mJ, 10 Hz for 20 and 40 seconds, respec-
tively, in a canal irrigated with EDTA, showing noticeable cleaning of debris and smear layer from the dentine and ex-
pansion of the collagen structure. (Figures courtesy of Den Engelsman, USA.) —

Figs. 24 & 25: SEM images of radially fired dentine with a conical tip, at 50 and 100 Hz for 0.2 seconds, showing canals of different diameters and lengths. (Figures courtesy of Dr Enrico DiVito, USA.) —

The surfaces prepared with the Er:YAG laser are well cleaned and without smear layer, but often con-
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this wavelength has no affinity and therefore no ablative effect on hard tissue.26 Decontamination is performed at the end of the traditional endodontic preparation as a final means of de-contaminating the endodontic system before obturation. An optical fiber of 200 µm diameter is placed 1 mm from the apex and retracted with a helical movement, moving centrally in five to ten second intervals (according to the different procedures). Today, it is advisable to perform this procedure in a canal filled with endodontic irrigant (preferably, EDTA or citric acid; alternatively, NaOCl) to reduce the undesirable thermal morphological effects.27–30

Using an experimental model, Schoop et al. demonstrated the manner in which lasers spread their walls.8 The Neodymium:YAG (Nd:YAG; 1,064 nm) laser demonstrated a near zero bacterial reduction of 88% at 1 mm, compared with the diode laser (810 nm) which obtained 95% at 1 mm or less. This marked difference in penetration is due to the low and varying affinity of these wavelengths for hard tissue. The diffusion capacity, which is not uniform, allows the light to reach and destroy bacteria by penetration via the thermal effects (Fig. 3). Many other microbiological studies have confirmed the strong bactericidal action of the diode and Nd:YAG lasers, with up to 100% decontamination of the bacterial load in the principal canal.31–35 An in vitro study by Benedicenti et al. reported that the use of the diode 810 nm laser in combination with chemical chelating irrigants, such as citric acid and EDTA, brought about a more or less absolute reduction of the bacterial load (99.9%) of E. faecalis in the endodontic system.36

Decontamination with medium infrared lasers

Considering its low efficacy in canal preparation and shaping, using the Er,Cr:YSGG laser for decontamination in endodontics requires the use of traditional techniques in canal preparation, with the canals prepared at the apex with ISO 25/30 instruments. The final passage with the laser is possible thanks to the use of long, thin tips (200 and 250 µm), available with various Erbium instruments, allowing for easier reach to the working length (1 mm from apex). In this methodology, the traditional technique is to use a helical movement when retracting the tip (over a five- to ten-second interval), repeating three to four times depending on the procedure and alternating radiation with irrigation using common chemical irrigants, keeping the canal wet, while performing the procedure (NaOCl and/or EDTA) with the integrated spray closed.

The 3-D decontamination of the endodontic system with Erbium lasers is not yet comparable to that of medium infrared lasers. The thermal energy created by these lasers is in fact absorbed primarily on the surface (high affinity to dentinal tissue rich in water), where they have the highest bactericidal effect on E. coli (Gram-negative bacteria) and E. faecalis (Gram-positive bacteria). At 1.5 W, Montez et al. obtained an almost total eradication (99.64%) of these bacteria.31 However, these systems do not have a bactericidal effect at depth in the lateral canals, as they only reach 500 µm in depth when tested in the width of the radicular wall.9 Further studies have investigated the ability of the Er,Cr:YSGG laser in the decontamination of traditionally prepared canals. Using low power (0.5 W, 10 Hz, 50 mJ with 20% air/water spray), complete eradication of bacteria was not obtained. However, better results for the Er,Cr:YSGG laser were obtained with a 77% reduction at 2 mW and 95% at 1.5 W.32

A new area of research has investigated the Erbium laser’s ability to remove bacterial biofilm from the apical third,41 and a recent in vitro study has further validated the ability of the Nd:YAG laser to remove endodontic biofilm of numerous bacterial species (e.g. A. naeslundii, R. sphaeroides, L. casei, P. acnes et P. na- cleatum), with considerable reduction of bacterial cells and disintegration of biofilm. The exception to this is the biofilm formed by L. casei.37

Ongoing studies are evaluating the efficacy of a new laser technique that uses a newly designed radial and tapered strip tip for removal of not only the smear layer, but also bacterial biofilm.33 The results are very promising. The Erbium lasers with “end fires” tips—frontal emission at the end of the tip—have little lateral penetration of the dentinal wall. The radial tip was proposed in 2007 for the Er,Cr:YSGG, and Gordon et al. and Schoop et al. have studied the morphological and decontaminating effects of this laser system (Fig. 6).34,35 The first study used a tip of 200 µm with radial emission at 10 Hz with air/water spray (54 and 28%) and dry at 10 and 20 mJ and 20 Hz (0.2 and 0.4 W, respectively). The radiation times varied from 15 seconds to two minutes. The maximum bactericidal power was reached at maximum power (0.4 W), with a longer exposure time, without water in dry mode and with a 99.71% bacterial eradication. The minimum time of radiation (15 seconds) with minimum power (0.2 W) and water obtained 94.7% bacterial reduction.36

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The second study used a tip of 300 μm diameter with two different parameters of emission (1 and 1.5 W, 20 Hz, with an endodontic tip). The effect was significantly high, with important thermal effects. With 1.5 W, thermal effects increased between 2.7 and 3.2 °C.49 The other parameters (0.6 and 0.9 W) produced very heated conditions of the smear layer, in which the thermal rise of 1.3 and 1.6 °C, respectively, showed a high bactericidal effect in E. coli and E. faecalis.44

The need to take advantage of the thermal effect to destroy bacterial cells, however, results in changes at the dentinal and peritubular level. Its importance to evaluate the best parameters and explore new techniques that reduce the undesirable thermal effects so that lasers have hard- and soft-tissue structures to a minimum. Morphological effects on the dentinal surface Numerous studies have investigated the morphological effects of laser radiation on the root canal walls as collateral effects of root canal decontamination and cleaning performed with different lasers. When they are used dry, both the near and medium infrared lasers produce characteristic effects (Figs. 7 & 8).65 Near infrared laser radiation causes characteristic morphological changes to the dentinal wall: the smear layer is partially removed and the dentinal tubules are primarily closed as a result of melting the inorganic dentin-dentin structures. Re-crystallisation bubbles and cracks are evident (Figs. 8-12).66–68

Water present in the irrigation solutions limits the thermal interaction of the laser beam on the dentinal wall and, at the same time, works therapeutically on a smear layer that is infrared dry or directly vaporised by a medium infrared laser (target chromophores) with its specific action (disinfecting or chelating). The radiation in the near infrared laser (diode 2.5 W, 15 Hz) and NaOCl 1.5 W, 800 m, 15 Hz) —performing a three-minute treatment, this solution, produces a better dentinal pattern, similar to that obtained with only an irrigant. Radiation with NaOCl or chlorhexidine produces a morphology with closed dentinal tubules and used, there is evidence of ledge cracks, areas of superficial melting and vaporisation of the smear layer.

A typical pattern arises when dentine is irradiated with the Er:YAG laser in the presence of water. The thermal damage is reduced and the dentinal tubules are open at the top of the peritubular more calcified and less ablated areas. The inter-tubular dentine, which is richer in water however, is more ablated. The smear layer is vaporised by radiation with Er:YAG lasers and is mostly ablated.56–58 Shoop et al., investigating the variations of temperature on the radiographic surface in vitro, found that the standardised energies (100, 150, 15 W) produced an increase in temperature over 5 °C on the peritubular surface. Mortiz proposed these parameters as the international standard of use for the Er:YAG laser in endodontics, claiming it as an efficient means of canal cleaning and decontamination (Figs. 11-16).69–74 Even with Er:YAG lasers, is disadvantageous to use irrigating solutions. Alternatively, NaOCl and hydrogen peroxide can be utilised during the terminal phase of laser-assisted endodontic therapy with a resulting dentinal pattern, with fewer thermal effects. This represents a new area of research, in search of a laser-assisted endodontic therapy. Various techniques have been proposed, such as laser-activated irrigation (LAI) and photon-initiated photo-acoustic streaming (PIPS).

Photothermal and photochemical phenomena for the removal of smear layer

George et al. published the first study that examined the ability of lasers to activate the irrigating liquid inside the root canal to increase its action. In his study, the tip of a Er:YAG and Endo YGSGG (480 μm diameter, both flat and conical tips) with the external coating chemically removed —were used to irradiate the lateral wall of the root canal. The best results were obtained when radiation followed the irrigating solution, with surface cleaned of the smear layer, with open dentinal tubules and less evidences of charring and ablation.43,44,45 In the conclusion of their studies on the photothermal activation, Kimura et al. and Kimura et al. affirmed that water is necessary to avoid the undesirable morphological changes that merit when radiation with the Er:YAG lasers is performed.43,44 The Erbium lasers used in this way result in signs of ablation and thermal damage as a result of the power and conical tips with the external coating chemically removed —were used to irrigate the lateral wall, with 1 and 0.75 W, produces an increase in temperature of only 2.5 °C with lasers (400 and 980 nm) with 200 μm fibre to activate the irrigants at a power of 20 W and 25 Hz, respectively. Consider- ing the lack of affinity between these wavelengths and water, higher powers were needed, via thermal effect and cavitation, producing a reduction in the root canal, leading to an increased ability to remove debris and the smear layer.13 In a later study, the authors also verified the safety of using these tips with the Er:YAG laser on a root cause a rise in temperature of 50 °C in the intra-canal irrigant solution but of only 4 °C on the external radiographic surface. The study concluded that irrigation activated near infrared lasers is highly effective in minimising the thermal effects on the dentine and the radiculodontic area.

In a recent study, Macedo et al. referred to the main role of activation as a strong modulator of the reaction of NaClO. During a rest interval of three minutes, the consumption of available chlorine increased significantly after LAI compared with PUI or CI.70

Photoinitiated photo-acoustic streaming

The PIPS technique presupposes the use of a pulsed Er:YAG laser (Powerlase XT/HT and Light Walker AT, both Fotona) and its interaction with irrigating solutions (EDTA or distilled water).71 The technique uses a different mechanism from the preceding LAI. It exploits the photoacoustic and photomechanical phenomena exclusively, which result from the use of subablative energy of 20 ml at 15 Hz, with impulses of only 95 μJ. With an average power of only 0.5 W, each impulse interacts with the water molecule at a peak power of 400 W, creating expansion and successive “shock waves” and leading to the formation of a powerful fluid stream inside the canal, without generating the undesirable thermal effects seen with other methodologies.72

The study with thermocouples applied to the radioular apical third revealed only a 1.2 °C thermal rise after 20 seconds and 1.5 °C after 40 seconds of continuous radiation. Another considerable advantage derived from the insertion of the tip into the root canal after the entrance to the root canal only, without the problematic insertion of the tip into the canal or 1 mm from the apex required by the other techniques (LAI and CI). Newly designed tips (12 mm in length, 500 to 400 μm in diameter and with the “radial and stripped” terminals) are used. The final 5 mm are withdrawn out of the canal to achieve a correct emission of energy compared with the frontal tip. This mode of energy emission is of greater interest of the laser energy when, at subablation levels, delivery with very high peak powers is required. The power of 480 (400 W) produces powerful “shock waves” with a remarkable and demonstrable and significant mechanical effect on the dentinal wall (Figs. 18-20).

The studies show the removal of the smear layer to be superior in the control groups with only EDTA or distilled water. The samples treated with laser and EDTA for 20 and 40 seconds show a complete remo-val of the smear layer with open dentinal tubules (score 1, according to Hulsmann) and the absence of undesirable thermal phenomena, which is characteristic in the dentinal walls treated with traditional laser techniques. With high magnification, the collagen structure remains intact, suggesting the hypothesis of a minimal mechanical or endothodontic treatment (Figs. 21-23). The Medical Dental Advanced Technologies Group in collabora- tion with the Arizona School of Dentistry and Oral Health (A. T. Still University), the Arthur A. Dugoni School of Dentistry (University of the Pacific), the University of Genova School of Dental School, Universidad de America School of Dentistry, is currently in- vestigating the effects of the use of root canal decontamination technique and the removal of bacterial biofilm in dentine. A recent report, which are forthcoming, are very promising (Figs. 24-29).

Discussion and conclusion

Laser technology used in end-odontics in the last 20 years has undergone an important development. The improved technology has reduced endodontic instrumentation and tips and a calibre and flexibility that permit insertion up to 1 mm from the apex.61 The use of lasers has been directed towards improving the clinical outcome of reduced length, “radial firing and stripped” tips) and techniques (LAI and PIPS) to simplify the use of laser in endo-dontics and minimise the undesirable thermal effects on the dentinal walls, using lower power in the presence of chemical irrigant. EDTA has proved to be the best solution for the LAI technique that activates the liquid and increments its chelating capacity and cleaning of the smear layer. The use of EDTA for 20 seconds and a demonstrable and significant mechanical activity. Finally, the PIPS tech-nique reduces the thermal effects of the Er:YAG laser and bactericidal action thanks to its streaming of fluids initiated by the photon interaction of the Erbium laser. Further studies are necessary to validate these techniques (LAI and PIPS) and compare them with other strategies for modern endodontics.73

Contact Info

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Laboratory-fabricated ceramic in- and onlays and table tops offer dental technicians the possibility to design a detailed morphology and create a life-like shade design. In this sense, they are a good alternative to direct restorations of posterior teeth with composite resin.

The entire processing therefore needed to prevent them from breaking. Thin restoration margins in order to leave some room for OE4 material, which is capable of reflecting light to some extent and, therefore, used often to imitate the whistie effect seen on the cusps (Figs. 3a–d). The layering diagram applied after stain firing was fairly straightforward: dentine (R2) for the cusps, some Opal Effect 2 (OE2) between the cusps towards the central fossae (depth effect) and some Transpa Incisal (TI1) to imitate the anatomy of the posterior tooth. This layer, however, was restricted to 0.2 mm below the final restoration outline in order to leave some room for OE4 material, which is capable of reflecting light to some extent.

Shade determination
Shade determination is crucial in the fabrication of ceramic restorations. I usually take the canine as a reference, as this tooth shows a very high dentine portion. In this clinical case, an LT ingot in the shade B3 was selected owing to the size and depth of the lesion (Figs. 1 & 2).

The shade of the cervical area of the tooth was B5, and a brighter shade was selected for the cusps (R2). I wanted the restoration to show a shade saturation from the inside. Owing to the depth of the defect, an LT ingot with lower translucency and a life-like brightness value and chroma was selected instead of an HT ingot. An inlay of this size might have shown a greyish shade effect if an HT ingot had been used.

After the shade group had been determined on the basis of the canine, all following work steps were completed within this shade group, in this case shade group B. To illustrate this the canine in this case had the shade B5; consequently, all the work was planned to lighten up or darken this shade according to the specific requirements.

To document this patient case, two different approaches were pursued. On the one hand, a cut-back IPS e.maxPress framework was layered with IPS e.max Ceram, and on the other hand, a fully anatomical inlay was pressed and characterised during the glaze firing.

The layering technique
At the beginning, residues of the investment material were removed from the framework with aluminium oxide (110 µm, 2 bar/29 psi). Subsequently, the surface of the framework was sand-blasted with glass polishing beads. Owing to the excellent strength of the LS material, the risk of restorations breaking at the margins is extremely low.

After the sand-blasting, glaze liquid was applied in a thin layer and dentine powder in the same shade as the ingot was sprinkled onto the framework. This procedure improves the bond between the layering ceramic and the LS material and additionally creates a “diamond effect” under incident light (Figs. 3a–d).

After the initial firing cycle at 750 °C, I focused on the design of the surface textures, which I...
The staining technique
All morphological properties of this molar, including the surface texture, were already designed in the wax-up. After the ceramic inlay had been pressed and divested, the surface was slightly ground and the contact points and the occlusion were checked (Fig. 7).

The same stains as the ones used in the layering technique were applied and subsequently fired in a stain and characterisation firing (Figs. 8a & b).

It is advised not to apply the stains too excessively in order to prevent a mirror effect. If too much material is applied, the light is reflected from the restoration surface and cannot penetrate it. As a result, the desired translucency cannot be achieved.

The shape and the marginal adaptation were checked with silver powder before and after the glaze firing. Finally, the restoration was polished to a high gloss with a rubber polisher and diamond paste (Fig. 9).

Comparison
Both restorations were tried intra-orally and showed a nearly perfect marginal fit. As a consequence, the restoration that was actually to be cemented into place had to be selected on aesthetic criteria. The monolithic structure and the fact that only pressed LS2, the strongest pressable ceramic tested to date, was used would have been a reason to use the stained restoration (Fig. 10).

With regard to mechanical and functional properties, this restoration would have been first choice; however, it did not show the desired translucency. When the two restorations were compared, the layered restoration clearly showed a superior shade effect (Fig. 11), and thus was permanently seated (Fig. 12).

Conclusion
IPS e.max Press and Ceram in combination with an adhesive cementation protocol represent a valuable asset for dental technicians. The system allows the fabrication of highly aesthetic inlays with an excellent strength and many advantages for patients and clinicians alike, thus providing a highly attractive alternative to direct inlay restorations.
The problem of white spot lesions
A new method for remineralisation post-orthodontic treatment

Dr Derek Mahony
Australia

Demineralised white spot lesions occur frequently after orthodontic treatment. Some teeth are more prone to demineralisation, typically the maxillary lateral incisors and the mandibular canine teeth. The disto-gingival area of the labial enamel surface is the area most commonly affected (Fig. 1). In the first few weeks after removal of the fixed appliances, there is a reduction in white spot lesion size and appearance, possibly due to the action of saliva (Fig. 2).

Various treatment methods have been proposed to assist the process of remineralisation. It is important to note that fluoride should not be used in high concentration, as it tends to prevent demineralisation and can lead to further unsightly staining. Low concentrations of fluoride, however, may assist remineralisation, such as those found in casen calcium phosphatas materials. Additionally, stimulation of salivary flow by chewing sugar-free gum is helpful.

This article will describe a revolutionary new approach to the cosmetic treatment of white spot lesions (Figs. 3). With Icon, a microinvasive technology from German manufacturer DMG, demineralised enamel can be filled and reinforced without drilling or anaesthesia (Figs. 4 & 5).

One of the reasons that earlier approaches to the treatment of white spot lesions have fallen short is that fluoride therapy is not always effective in the advanced stages, and the use of restorative fillings usually sacrifices significant amounts of healthy tooth structure. Instead of adopting a wait and see approach, Icon has been shown to arrest the progress of early enamel lesions up to the first third of enamel in one simple procedure (Fig. 6), without unnecessary loss of healthy tooth structure.

In the procedure described here, the surface area of the white spot lesion is eroded with a 15% HCl gel, which opens the pore system of the lesion. This is then dried with ethanol, followed by the application of Icon onto the lesion with the application aid. The extremely high penetration coefficient enables it to penetrate into the lesion pores. Excess material is then removed, and the material is light-cured. The total treatment time should be about 15 minutes (Fig. 7).

The cosmetic treatment of cariogenic white spots in one visit can be very appealing, especially to young patients and their parents (Figs. 8a & b). No drilling or anaesthesia is required and those patients who have already demonstrated poor compliance with their brushing can be treated earlier. I would recommend that clinicians try the Icon product when attempting to remineralise white spot lesions post-orthodontic treatment. This is not just minimally invasive dentistry; it is microinvasive dentistry.

The cosmetic treatment

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