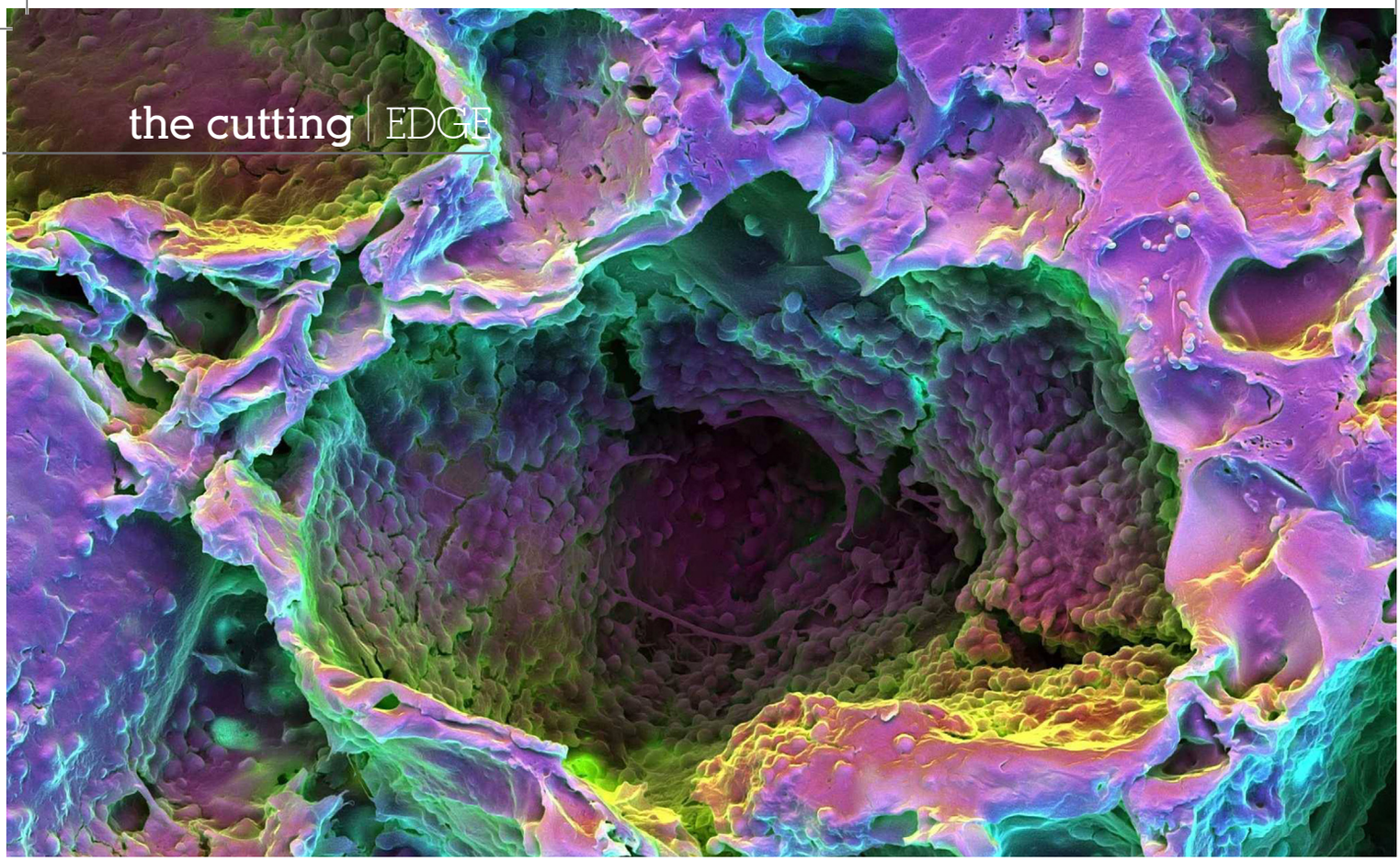

Clinical applications of low level laser therapy: Current use and future potential

By Laurence J. Walsh

"There are now a broad range of areas in clinical practice where LLLT has already been proven to offer benefits in patient care..."

Low level laser therapy (LLLT), also known as biostimulation or photobiomodulation, is a well accepted part of modern medical, physiotherapy and veterinary practice. The potential benefits of biostimulation that have been demonstrated in many healthcare fields include improved healing, reduced inflammation and pain control, which suggest considerable potential for its use in oral tissues.[1] Biostimulation speeds up blood flow, boosts metabolic activities at the level of mitochondria within cells and accelerates the healing of the damaged tissue. There is an extensive literature supporting LLLT in health care settings, with over 2000 publications in the past 20 years. Despite almost 50 years of experience with LLLT, concerns remain as to its effectiveness as a treatment modality. Controlled clinical studies have demonstrated that while LLLT is effective for some specific applications, it is not a panacea. This article summarizes key findings around the use of LLLT for specific soft tissue applications to provide an evidence-based assessment of LLLT in dentistry today.

With the advent of compact diode lasers and their increasing use for minor oral surgery in general practice and in orthodontic specialist practice, the question arises around effective utilization of this technology for purposes other than surgical dentistry, namely LLLT. In recent times, numerous clinical trials and systematic reviews have been undertaken on specific dental applications (Table 1).

Most studies have used diode lasers ranging in wavelength from 810-1000 nm in the near infrared spectrum, although many of the older studies used the shorter wavelengths from 630-700 nm in the visible red spectrum. Both show similar penetration and comparable effects at the cellular level, in terms of activation of key metabolic pathways such as electron transport on the inner mitochondrial membrane, so the subtle differences are more of academic interest. Practices which have already acquired a diode laser for minor oral surgery will have chosen a wavelength in the 810-980 nm range, so it is best to concentrate on that portion of the spectrum.

Table 1. Clinical applications of LLLT

General
- Desensitizing teeth[15-17]
- Enhancing healing after pulpotomy[19,20]

Orthodontics
- Reducing pain during orthodontics[12]
- Accelerating orthodontic tooth movement[13,14]
- Enhancing the stability of orthodontic mini screws (TADs)[21]

Oral and periodontal surgery
- Accelerating wound healing[1,2]
- Accelerating wound healing on the palate after harvesting connective tissue for grafts[8]
- Reducing post-extraction pain[6,22,23]
- Reducing pain after orthognathic surgery[7]
- Enhancing nerve healing after inferior alveolar or lingual nerve iatrogenic injury[1]
- Attenuating the effects of bisphosphonates on bone healing & improving outcomes after surgical treatment of MRONJ lesions[3,4]

Periodontal and implant surgery
- Enhancing bone formation around newly placed implants[24,25]
- Enhancing bone formation in periodontal defects when used as an adjunct to GTR[26]
- Reducing pain and swelling after sinus lifts[27]

TMJ
- As an adjunct in the treatment of TMJ disorders[9-11]
- Deactivation of myofascial trigger points[11]

Oral medicine
- Reducing pain from recurrent herpes simplex infection and burning mouth syndrome[28,29]
- Reducing pain in trigeminal neuralgia[30]
- Reducing pain from mucositis and reducing xerostomia during chemo and radiotherapy[31,32]
- Phototherapy treatment of oral lichen planus lesions[33]

Accelerating wound healing

Accelerating soft tissue wound healing is the oldest LLLT application, having been developed 50 years ago. The dosimetry is important, since too low a fluence (measured in Joules per square centimetre) will not activate the normal functions of cells and too high a fluence will cause thermal effects and an increased likelihood of cellular injury. The optimal "light dose" is around 2 to 4 J/cm^2, as seen in both human clinical trials and numerous animal models of wound healing.[1,2] A recent study nicely illustrated the problems with incorrect dose which can occur when LLLT is used to treat oral ulcers. In this investigation, 3 mm diameter wounds on the dorsum of the tongue were created in rats using a skin biopsy punch. Daily irradiation with 4 J/cm^2 significantly accelerated the healing process, with a striking reduction over time in ulcer area, degree of re-epithelialization and collagen deposition. Using a high fluence (20 J/cm^2) did not give a substantial benefit to the healing process.

Accelerated wound healing is particularly important in patients with medication related osteonecrosis of the jaws (MRONJ). The non-healing nature of MRONJ lesions makes their management problematic. There is emerging evidence that LLLT could improve the outcomes from medical-surgical treatment. In a recent (2014) study,[3] 11 patients diagnosed with advanced MRONJ lesions received LLLT applications during the postoperative period in addition to medical and surgical treatment. Laser irradiation covering the entirety of the surgical site was undertaken using a GaAlAs diode laser at 808 nm with a fluence of 5 J/cm^2 per point. Clinically, the symptoms resolved and the MRONJ lesions healed, with a stable mucosal closure in all patients. Of note, primary healing was achieved in seven patients and secondary healing course was observed in four patients. The conclusion from this admittedly small study was that LLLT could be combined with antibiotic therapy and surgical debridement to give favourable outcomes. This aligns with a recent report that LLLT enhances bone regeneration in bone defects in rats in the presence of alendronate,[4] and with over 20 previous studies outside the context of MRONJ showing that LLLT exerts a biostimulatory effect on bone tissue, enhancing osteoblast proliferation and differentiation.[5]

Pain reduction

There is considerable interest around how LLLT can reduce post-surgical pain as well as accelerate wound healing. A particular focus of recent work has been how LLLT can simultaneously promote wound healing as well as lower pain intensity, swelling problems, halitosis and post-op usage of analgesics after surgical removal of lower third molars. In a recent study with 150 patients, 100 having LLLT had the least post-op problems after third molar removal, showing wound healing without any complications and reduced use of analgesics.[6] The similar benefits of reduced pain, faster mucosal healing and reduced need for analgesics were reported in a recent study of LLLT after orthognathic surgery (bilateral sagittal split with Le Fort I osteotomy in the maxilla),[7] or after connective tissue graft harvesting from the palate.[8]

TMJ therapy

For patients affected by temporomandibular joint disorders, LLLT has been demonstrated to exert analgesic, anti-inflammatory and biostimulating effects. As a treatment modality which can be repeated over time, it is non-invasive, quick and safe and limits the need for patients to take prescription or over-the-counter analgesics. A 2013 systematic review drew on 13 clinical trials and concluded that there is evidence in favour of using LLLT for treatment of TMJ dysfunction.[9] The most recent (April 2015) study of LLT in TMJ treatment compared it to occlusal splint therapy in 30 patients with TMJ disorders and myofascial pain. LLLT was used daily for 10 days, applied onto on the trigger points. Control patients were sham irradiated while conventional treatment patients wore occlusal splints for 12 hours per day for 3 weeks. The positive benefits seen in LLLT and occlusal splint groups were identical, demonstrating that LLLT is as effective as occlusal splint therapy for pain relief.[10] LLLT has also been shown to be as effective as injections of local anaesthetic solution in deactivating myofascial trigger points (MTPs) and reducing pain, when used at a fluence of 4 J/cm^2.[11]

Orthodontic tooth movement

There is growing interest in how LLLT can be used to accelerate orthodontic tooth movement and reduce pain during treatment. A recent systematic review included 14 clinical trials, with a total of 659 participants from 11 countries. LLLT significantly reduced the intensity of orthodontic pain by 39% in comparison with placebo treatment.[12]

At present, there is weak to moderate positive evidence around the questions of whether LLLT can enhance orthodontic tooth movement. A 2014 systematic review[13] included eight studies and assessed the changes in canine retraction rate, which was enhanced by some 0.42mm/month; 95% CI: 0.26-0.57. It was concluded that there is some evidence that LLLT accelerates orthodontic tooth movement, but the quality of evidence was not high and further investigations are required before routine application can be recommended. In particular, it is necessary to optimize the fluence and the duration of treatment to achieve the highest success rate.[14]

Conclusions

There are now a broad range of areas in clinical practice where LLLT has already been proven to offer benefits in patient care, or where positive results have been shown and protocols are being refined. Achieving the correct fluence and repeating the treatment at the appropriate interval are key considerations for maximizing the benefits which can be gained from LLLT, when it is administered in the dental office setting.

The recent development of consumer-level LLLT devices designed for at-home use is likely to lead to greater utilization of LLLT as a painless and non-invasive therapy and open up further possible enhancement to existing dental treatment protocols, as well as new treatments. Domestic devices have lower outputs and correspondingly reduced requirements in terms of protective eyewear. In the future, it is quite conceivable that such devices could be loaned to patients from the dental practice, or purchased directly by patients from the practice or a web-based vendor as a personal care device, in much the same way as sophisticated electric toothbrushes are today. The first such consumer level device (known as the EasyCure™) was registered with TGA in late 2013 and this is a powerful example of how the technology of LLLT can be taken from the clinical setting to the patient for their at home use.

Already there has been work in combining LLLT with home oral care devices. LLLT devices combined with toothbrushes have been tested for their possible benefits in treating dentine hypersensitivity, a condition for which there is considerable existing evidence around the benefits of LLLT administered in the dental office setting.[15-17] A recent (2014) clinical trial of a low-level laser-emitting toothbrush involving 96 individuals with hypersensitive teeth without caries or fracture used a brush which had an integral 635 nm 6 mW laser or a 635 nm 12.9 µW light-emitting diode (LED). Both gave a useful reduction in discomfort after 4 weeks of use, with the higher benefits for the laser versus the LED. There were no significant adverse events or side effects. The finding that a low-level laser emitting toothbrush is a safe and effective treatment option for the management of hypersensitive sensitive dentine opens the door for exploring yet other options for this type of approach.

About the author

Professor Laurence J. Walsh is the technology editor of Australasian Dental Practice. He is also a noted commentator on and user of new technologies and the former Head of The University of Queensland School of Dentistry.

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