

Let's talk lasers part 3: Photobiomodulation (PBM)

Arun and Rita Darbar continue their series on laser dentistry and show the exceptional clinical results that can be achieved

The two previous articles have mentioned the many advantages of surgical laser treatment over conventional methods. We believe that it is the low level effect of the laser that is responsible for these benefits. As the photon density decreases at deeper levels due to scattering it could reach therapeutic levels (see Figure 1). The evidence for low level laser effects will be examined at cellular levels to attempt to relate it to clinical results. In the past 30 years over 2000 articles have

Education aims and objectives

The aim of this article is to demonstrate the healing effect of lasers through a series of case studies.

Expected outcomes

The reader will understand the positive results of the laser therapy and that the sooner the area is treated, the better the outcome.



Dr Arun Darbar has been using lasers in his dental practice for the past two decades. He has his private practice Smile Creations in Leighton Buzzard, Bedfordshire. He is

dedicated to providing cutting edge dentistry to his patients and is an examiner for the Academy of Laser Dentistry (ALD), holds a mastership and educator status and is a past Board member for the ALD and World Clinical Laser Institute (WCLI) and is a Fellow and diplomate of the World Congress of Minimally Invasive Dentistry (WCMID). Dr Darbar is an accredited member of the British Academy of Cosmetic Dentistry. A founder member of the WCLI, he continues to find newer applications for the lasers and lectures extensively on the subject. He also runs courses and trains dentists both in the UK and internationally.

Dr Rita Darbar runs her Specialist Orthodontic practice at Smile Creations in Leighton Buzzard and is also a Specialist Orthodontist at Bedford Hospital. She has had a varied career in dentistry spanning over 30 years, working in the community Dental services, General practice and Hospital services. She enjoys working in a multidisciplinary environment has been interested in laser dentistry for the past 10 years and has talked on the subject internationally.

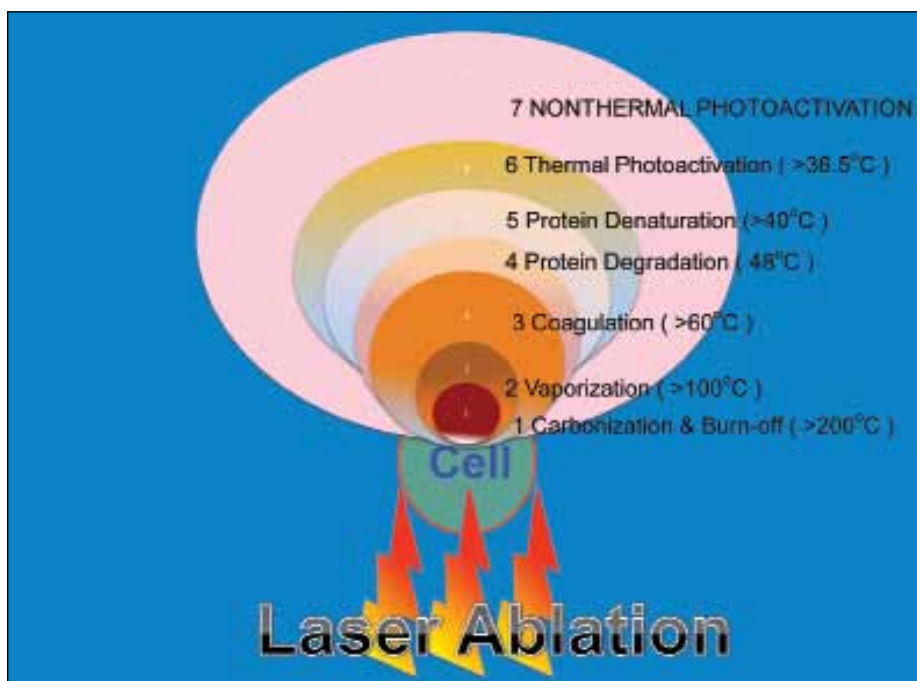


Figure 1: Tissue effects caused by thermal exposure

been published investigating and reporting the positive biological effects of non-thermal low level lasers. The interest in the subject has driven the research to a number of well-designed controlled trials which can quantify the effects. Even though many of the clinical benefits such as faster and better wound healing (Mester E et al, 1971; Iordanou P et al, 2009; Rochkind S et al, 2007) and restoration of function following nerve injury (Rochkind S et al, 2007) are well documented the precise mechanisms at cellular

levels are not yet fully understood. However, many studies are emerging to explain the effects on viability of cells, enzymes (Sakurai Y, 2000; Bolognani L and Volpi N, 1992) and growth factors (Dourado DM et al 2011; Rocha Junior AM et al 2009), to name a few. All these studies help to piece together the evidence that is much needed to use low level laser therapy as a standard form of treatment. PBM is the application of electromagnetic radiation primarily in the red and infrared spectrum over



Figure 2: Site of pain markings



Figure 3:



Figure 4:

injuries and lesions to stimulate healing and render pain relief within those tissues.

Light has been used for centuries for its healing properties but the mechanisms by which it works has not been fully understood. In the plant kingdom the role of visible and near visible light in photosynthesis is a process that we are all familiar with. Essentially a photoacceptor, chlorophyll, absorbs photons and commences a chain of events that leads to oxidation and reduction to provide energy to the cells. In the animal cell photoacceptors have been identified which respond to certain wavelengths thereby inducing a variety of effects which are also dose dependant.

Earlier research has identified cytochrome c oxidase as a photoacceptor in the respiratory chain of the mitochondria. Laser energy is absorbed by the photoacceptor and the oxidative state is altered with an increased production of Adenosine Tri Phosphate (ATP) and Reactive Oxygen Species (ROS) which are involved in cell signalling. The energy can then be used for cellular proliferation and protein synthesis for tissue repair (Karu T, 1987). Some of the other effects that have been reported are enhanced blood flow (Kubota J, 2002), an analgesic effect by direct action on nerve fibres and modulation of inflammatory processes and enzymes.

Most of the studies report a therapeutic effect in the infrared and the near infrared regions of the electromagnetic spectrum. Even though the tissue is radiated superficially it is effective in deeper tissue structures making this treatment non invasive. As mentioned in previous articles laser light can be reflected, absorbed, transmitted or scattered. Scattering is usually caused by random spatial variations in tissue density and it is this property that enables the transfer of energy to deeper structures.

In general dental practice generally most procedures insult tissue and photobiomodulation can play a useful role in helping the patient by reducing pain (Kubota J and Oshiro, T, 1996; Kodoh C et al, 1989; Brännström M and Åström A,

1964; Berggren G and Brännström M, 1965; Charoenlarpa P et al 2007; Wanachantararak S, 2007; Chueh P et al, 2009; Greschman JA et al, 1994) accelerating inflammation, reduce complications and to promote quality repair. We also see conditions that do not respond well to conventional treatment such as cold sores, aphthous ulcers (Colvard M and Kuo P, 1991) and angular chelitis which respond to laser therapy by the action on the immune system and TMD pain management (Kim SY, Park JS, 1996; Kobayashi, M., Kubota, J, ?) These are some conditions that are commonly treated in our practice and the protocols we use for the enhanced comfort of our patients are demonstrated.

Clinical cases

The use of Low Level Laser Therapy (LLLT) for PhotoBioModulation (PBM) in daily general dental practice is a paradigm shift, and a state of mind or concept.

We are extremely fortunate, honoured and privileged to be able to use various modalities for the ultimate in patient care and comfort with several regular surgical lasers modified by us with the use of diffusers or beam expander handpieces and/ or fibres at optimum power densities with efficiency, along with several other dedicated low power lasers.

PBM is the most appropriate term used and accepted internationally by the likes of NASA, DARPA and other world authorities in laser and photo medicine. It is an umbrella term to include:

- LLLT, LILT, PDT, LT, PT
- Biostimulation
- Inhibition
- The wavelength is generally between 600-1000nm
- Dose in the region of 1-8 J/cm²

Here are a very small selection of cases to demonstrate implementation in everyday dentistry and some 'off label uses'. It is beyond the scope of this article to discuss clinical protocols and concepts for which one should attend training seminars dedicated to the subject, should you need any help in that

direction please do not hesitate to contact us.

TMD and facial pain management

These cases should be followed with proper established TMD protocols, extensive history etc., this topic by itself is a seminar. Depending on the type of pain, either acute or chronic and establishment of muscle or joint based pain is crucial to the success of the laser treatment provided, it is very important to understand that laser use is a pain management tool rather than cure. Muscle based cases are discussed here.

Patients are asked to point to or locate the exact site of pain or concern, as the site of pain is not always the source of pain and further investigation is justified. It would be prudent to be aware of trigger points and referred pain and differential diagnosis.

Case study 1

Management of TMD Pain using PBM Modality

- A 54-year-old patient was referred by his ENT surgeon for TMJ problems.
- Acute symptoms for six months.
- Severe pain in left TMJ area and ear.
- Complained about sensation of swelling in sub-mandibular / masseter region, and temporal area tender on the left side.
- On potent painkillers.
- His maximum allowance was six to eight a day, and he needed the maximum each day.
- The tablets were heavy doses of codeine and paracetamol.

Medical history

- Had a CT scan, all was normal except nasal septum deviated to the left
- Had IBS for past 20 years, and several operations for a fistula in the 1980's.
- Taking painkillers for three to four months at six to eight tablets a day.
- TMJ pain onset was sudden.
- His GP referred him to the ENT surgeon, who in turn referred him to us.

Diagnosis

- TMD problems along with joint and muscle

Case study 1



Figure 5: Pre treatment



Figure 6: Exam images



Figure 7: Exam Images



Figure 8: TMJ Lased



Figure 9: Temporal area



Figure 10: Styloid area



Figure 11: NTI made



Figure 12: Final view

problems

- On the left hand side of sudden offset,
- Pain was debilitating and affecting normal function on a daily basis.

Treatment plan

- Pain management with low level laser therapy (LLLT / PBM)
- Emergency NTI splint
- Regular occlusal splint therapy – lower flat plane.
- Diagnostic models, assessment and balancing of splint.
- Orthodontics and full scale equilibration and reconstruction to new occlusal scheme or rehabilitation if needed or necessary.
- The patient could also remain on long term splint therapy with regular maintenance, repair or replacements indefinitely

Possible alternatives

- LLLT and NTI
- Diagnostic models and splint.
- A surgical approach may be considered

- Equilibration and change of occlusal scheme
- Orthodontics to correct malocclusion

Laser indications

PBM modality works at cellular levels by promoting faster healing and return to norm, with a reduction in toxins via accelerated lymphatic flow, increase blood flow thereby helping to reduce pain etc.

Objectives

To provide pain relief and be non invasive.

Laser operating parameters

- A Diode 810 nm wavelength was used. Output calculated to 4-6J/cm²
- 15 seconds
- 3-4.5 J/cm²

Laser treatment sequence

Laser treatment provided over four sessions at 2, 4 and 7 day intervals.

Follow Ups

- Had 6-8 pain killers in 10 days
- Instead of 6-8 per day
- Pain Free in 2 months
- No medications taken
- 1 year follow up still pain free
- Wears orthotics as he needs it

Case study 2

15-year-old female

- Co-aching jaw and loud clicking
- Worst on left TMJ with click
- Bilateral pain on opening
- Masseters tender bilaterally
- Soreness in SCMs
- Arthralgia and Myofascial Pain
- Tx Provided-ST 0.7w x 15sec 4.8.04
- TMJ open and closed 15s each
- Masseter 15s
- SCM at Styloid area 15s
- Bilaterally
- TVO post op at ease and forced Images

Case study 3

Acute condition of short duration with limited

Case study 2



Figure 13: Left side trigger points marking



Figure 14: Right side markings



Figure 15: Restricted opening



Figure 16: Soft end feel (forced opening)

Case study 3



Figure 17: Location of pain by the patient



Figure 18: Pre treatment opening 22-31 mm



Figure 19: Improved opening in 10 mins to 37mm

opening and headaches in temporal region, earache, TMJ and muscles. The opening was at ease 21mm and forced (soft end feel) at 31mm. The areas treated were TMJ, masseter muscle, temporal and styloid regions and lymphatics. The pain reduced quite considerable in five minutes and the opening now was up to 37mm, notable feature was muscle relation.

Oral ulcers

Another common condition we notice is oral ulceration of various aetiology but most of them could be simply traumatic in nature, apthaea are a major concern for some patients.

- Most common lesion of the oral mucosa
- Can be due to local or systemic disorders
- For traumatic ulcers if the cause is removed they heal spontaneously

- Recurrent aphthous ulcers are idiopathic and characterised by frequent recurrences
- Symptoms-burning sensation, soreness, inflammation
- Prevalance-11-20% of the population

Case study 4

This patient was a frequent sufferer and was perhaps stress related. This lesion was very painful and been there for almost a week. Normally it takes few weeks to heal but the patient was constantly in pain with it. Hence pain management was the main goal, and due to the size and appearance and oral cancer screening with a 'veloscope' scanner was performed and recorded. No abnormal cell structure was observed. The patient was treated with various handpiece attachments

for different effects, firstly to stimulate repair and regeneration and secondly for pain management with slightly higher powers to inhibit pain response. This patient had multiple applications at each visit (three treatment sessions at three and eight day intervals). The VAS (Visual Analogue Score) 10 to five at the first session, and seven to four in five minutes at the second visit and third visit, eight to 10 then went down to two to three. The review appointment in four weeks showed complete healing.

Case study 5

This traumatic ulcer was treated once and patient had immediate pain relief and had reported it disappeared within the week uneventfully. A diode laser was used and

Case study 4



Figure 20: Large very painful ulceration

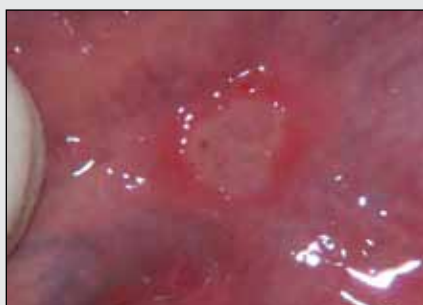


Figure 21: Close up view

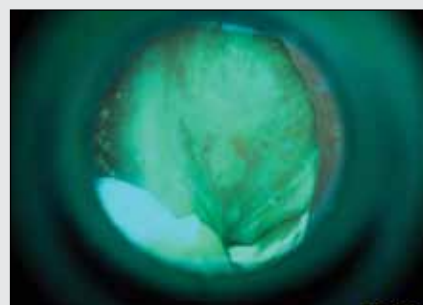


Figure 22: Veloscope screening



Figure 23: Laser in action



Figure 24: Healing at nine day post op



Figure 25: Total healing review six week post op

Case study 5



Figure 26: Pre-op



Figure 27: Post 15 minutes note the increase in vascularisation

immediate post operative image shows a marked change in vascularisation that explains the results achieved. To see and achieve such instant results is unbelievable, but observing cellular activity through heavy duty surgical microscope is even more stunning and frequently recorded.

Case study 6

As it occasionally happens, we are all guilty to some iatrogenic trauma. In this case, a gingival abrasion was caused, ulceration of sorts, while trying-in the crown stent where it was just a bit too close fitting. In this situation the patient was in for a long appointment so we used the laser to stimulate repair and the differences in

45 mins and two hours were recorded through a microscope indicating a very fast repair mechanism taking place. It is not uncommon to observe such rapid changes.

Herpetic lesions

- 20% of population affected
- If left untreated will resolve
- Recurrence rates usually quite frequent
- Symptoms- oedema, blisters, pain, unsightly
- Conventional treatment - Anti virals to attenuate the virus and contain it in the area
- Antibiotics to treat secondary infection
- Laser smile diode laser (LxSm) 3 watts 15 second scan along the nerve pathways as the virus is found in clusters around the neural

tissues.

- Most effective day 1
- Others options creams, waterlase, bare fibre
- Safety consideration-Plume!!

Case study 7

This patient had been suffering from cold sores for a long time which is stress-related. Exposure to the sun can also cause coldsores. She had them every six weeks and could be anywhere on the lips, usually the corners and angle of the mouth. Pain levels are usually high and the patient would probably would go through a full cycle despite taking anti viral and other medications. Since we started treating her for it, after the first or second treatment episodes,

Case study 6



Figure 28: Fresh injury 12.45



Figure 29: Fresh injury 12.53



Figure 30: Fresh injury 12.53



Figure 31: Fresh injury 12.53



Figure 32: Immediate post laser PBM 12.55



Figure 33: Wound at 13.29



Figure 34: Close up at 13.30



Figure 35: Healing at 14.52



Figure 36: Healing at 14.53

her frequency and intensity has changed and she has longer periods of relief from herpetic attacks which again are a common observation as it also works with immune responses. If we can see the patient at the prodromal stage it is possible to fast track the whole episode with less discomfort and in certain cases actually totally bypass or abort the attack. A dramatic change is also noticed in two hours (see Figures 41 and 43).

Case study 8

This was a young male undergoing orthodontics and his mother was aware of our work with lasers and requested treatment if it would help him. The patient was seen at an earlier stage of the herpetic lesion and it can be noticed that the cycle is fast tracked and an acne spot also improves dramatically within the week. There is a difference within the first 40 minutes and

24 hours. The patient did not go through any pain during the whole time.

Angular Cheilitis

- Multifactorial disease of infectious origin
- Symptoms: soreness, erythema, and fissuring at the corners of the mouth.
- Usually of fungal origin (candidosis)
- Predisposing factors- iron, riboflavin, B12 deficiency

Case study 9

This patient's mother informed us at one of his orthodontic appointments how this young patient was never without any discomfort from 'cracked lips' and always had something going on. We offered laser treatment as a possibility but it was initially declined. The patient got back to us later to consider it. So at the next episode when he would be in pain and discomfort,

we suggested he contact us. To our surprise the mother mentioned it had not gone away since the last time we saw him, hence started the treatment. The patient was out of pain in a short time almost immediately. He was treated twice for this episode and a further subsequent couple more episodes. We were then contacted by the mother informing us how much better he was and had not had anymore problems. He was reviewed two years later and that was the first time, as he was unwell and had slight irritation around the lips. Other than that, he was totally symptomless.

Case study 10

Nerve Injury Post surgery– paraesthesia

- Nerve injury – the nature and type of trauma or injury can help if regeneration is possible
- Crush, bruise, compression with some

Case study 7



Figure 37: Start of treatment



Figure 38: Close up view of herpetic vesicle just started



Figure 39: Second treatment 3 days later



Figure 40: Close up view



Figure 41: Third treatment at 10.20



Figure 42: Close up 10.20



Figure 43: Close up on same day at 12.30



Figure 44: Patient returned for trauma to lip head butted but no cold sore so far



Figure 45: Close up

Case study 8



Figure 46: Pre op



Figure 47: Close up



Figure 48: Acne spot



Figure 49: Post op 45mins later note reduction of tissue swelling.



Figure 50: 24 hours post op



Figure 51: Close up 24 hours post op



Figure 52: Acne close up 24 hours post op



Figure 53: 4-day post op



Figure 54: 4-day post op

Case study 9



Figure 55: start of treatment



Figure 56: Close up view right side fissures



Figure 57: Left side fissures



Figure 58: Three days later



Figure 59



Figure 60



Figure 61: Review 2 months later



Figure 62: Review 2 months later



Figure 63: Review 2 months later



Figure 64: 2 year recall and review



Figure 65: 2 year recall and review



Figure 66: 2 year recall and review

intact fibres can recover it's a matter of time regeneration environment

- Cut nerve fibres in close approximation can regenerate too
- Treatment should be as close to site of injury
- 2-5W 15-60 sec scan defocused
- 1-2 50/50 15 -30 -7mm defocused
- 1-2 W 50/50 bare fibre 15 sec

This patient, a rather unlucky individual had a large kerato cyst in the left mandibular

area posterior to the first molar area, which was surgically removed. However, two years later it reoccurred and she went through another major surgery where she even lost part of her coronoid process. This eventually left her with paraesthesia in the left sub mental area. She was told she would have to accept it as permanent and live with it. Our initial research did indicate some laser work could be effective in that direction so we offered

to try it for her as our pilot case study and she agreed. She showed some changes almost immediately and the progress was slow and the type of nerve injury was unknown. Eventually we were informed of compression type etc. The treatment lasted for almost a year at six-week treatment phases and the rest for the same amount, at the end of the year she started getting her sensation back not totally and today she can cope with it and is

Case Study 10



Figure 67: Measurement of affected area



Figure 68: Measurement of affected area



Figure 69: Black area of original affected area. Red current area affected change with in the first week



Figure 70: Patient at end of first week

not too aware of the paraesthesia, although when she is tired or stressed her lip may feel strange to her, but in all she is happy with the result. Image markings indicate original area of paraesthesia in black, an area of roughly 3cm by 3cm and later red indicates new area of main numbness in a matter of days. To be able to help patients like this makes all these efforts really worth it.

Case study 11

This patient was referred to us for the remake of existing crowns with black triangles by a periodontist at end of their healing and stabilisation stages of surgical periodontics. The patient had concerns about her smile, however just replacing crowns would not solve her problems as there was no bone to hold or support an interdental papillae.

The options were to reconsider further second stage perio surgery with soft and hard tissue grafting, or try orthodontics and PBM laser stimulation and regeneration over a long period after completion of orthodontics. The patient opted to try the non-invasive option to start with, then should need arise, consider other options such as re-grafting and/or implants etc.

PBM is the application of electromagnetic radiation primarily in the red and infrared spectrum over injuries and lesions to stimulate healing and render pain relief within those tissues.

Treatment modalities used

- Laser curettage: a continued maintenance phase
- Orthodontics
- Considering bone and soft tissue grafting
- Replacing old crowns with long-term provisionals
- LLLT/PBM complex protocol combination using different wavelengths over at least six to eight months and further six months healing and refinement stages
- Once a week for six weeks post orthodontics and at regular maintenance hygiene appointments, a minimally invasive surgical concept adhered to, as the patient had already had surgical periodontics.
- The treatment took several sessions, crowns changed and replaced as long-term interim restorations and upon favourable conditions with the bone and gingival architectures to replace with definitive restorations, which are now being considered. This experience

has given us the confidence of setting specific protocols for similar cases and some are being reviewed in due course. Patients compliance and oral hygiene maintenance have been nothing short of excellent. It was a very rewarding case study for us.

With post surgical complications, the most common situation we encounter is third molar extractions and its related issues and problems that we and our patients face frequently.

- Trismus and limited opening
- Swelling
- Pain
- Partial or complete Paraesthesia (transient or long term)

All these are also similar to non-surgical complications such as pericoronitis. In all these circumstances it is a vicious circle of events. The patient cannot open their mouth wide, so are unable to clean or maintain adequate oral hygiene, hence food and debris impaction. This predisposes to inflammation and infection flourishes. Therefore, in these cases it would be better to do something to help patients open their mouth wider, establish better oral hygiene and reduce complications. Using lasers to modulate the tissues can help do exactly that.

Pericoronitis treated with LLLT - vertical opening is improved, enabling better access for oral hygiene as food debris that collects is a focus of infection.

Pre-surgical treatment prior to the surgical removal of impacted teeth improves outcomes as access is better. The muscles are relaxed and it is therefore less traumatic. Post surgical treatment manages pain and improves healing and regeneration.

Case study 12

This patient had lower third molar extraction surgically in the oral surgery department of the local hospital. Post operatively the patient had limited opening. The maximum was 20mm and we used a customised intraoral diffuser handpiece and lasered the site of extraction for 15 seconds on each side both lingually and buccally (intraoral approach). The patient was allowed to relax for 5-10 minutes and was able to open their mouth to 32mm and had reduced pain. In the days following treatment, the swelling was under control and we had a happier patient.

We follow a general rule of thumb in pain management. To avoid complications:

- Treat immediate post op
- Precondition
- Be preventive and non invasive. Make it a positive treatment protocol and avoid other post surgical complications and reduce

Case study 11



Figure 71: Patient as referred from periodontist to replace crowns



Figure 72: Close up view



Figure 73: Interim restorations



Figure 74: Interim modified



Figure 75: Pre op x-rays



Figure 76: post op x-rays

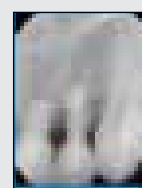


Figure 77: Most recent x-ray

Case study 12



Figure 78: Right Surgical site



Figure 79: Left surgical sit



Figure 80: Pre-laser treatment limited opening 20mm



Figure 81: 10 mins post opening to 32 mm

trauma

- Helps healing, pain management
- Patients will love for it

Case Study 13

This case demonstrates the sooner we get to the trauma site with PBM lasers the better the healing and comfort and the ultimate outcome for the patients. This patient crushed her thumb very badly when closing the car door. Her main concern was pain, swelling and if she loose the nail and will it go black? etc. We treated this thumb within 15 minutes of the accident and two to three times in the next week. Pain was reduced immediately and increased bleed from the nail bed was noticed with minutes of the first application. This avoided pooling of blood in the nail bed and an eventual black nail, which did not happen.

Case Study 14

Another case of immediate application of PBM laser after one of our team members fell over in the icy condition, in this case as the hand was full of road debris chances of infection was higher but healing was uneventful.

Clinical discussion

Having the opportunity to use a variety of different wavelengths and models, we are very fortunate to be able to develop different uses and protocols. Some will change the way we work and accept healing and regeneration. We now have a publication devoted to our latest PBM protocols called preconditioning and can be used on a daily basis for everything we do clinically.

Other situations where PBM has been applied successfully in combination with other modalities or by itself is for implantitis, and failing and /or mobile implants, mucocitis, periodontics, orthodontics, endodontics, long appointments and muscle fatigue, anaesthesia reversal and virtually everything we do in some way or the other, just a mind set change with a paradigm shift.

Conclusion

The clinical cases presented in this article require further analysis through wider clinical assessment. The positive feedback from patients and clinical results dovetail with existing literature, and support the suggested mechanisms of action that cause, and reduce, pain encountered through dental procedures. No doubt more double blind Randomised Controlled Trials are needed to become a standard form of treatment in all dental practices.

Case Study 13



Figure 82: Day of injury



Figure 83: Laser in action



Figure 84: Three hour post op note fresh bleeding point after second laser session on same day



Figure 85: Review at almost two weeks post trauma

Case Study 14



Figure 86: Hand cleansed with laser within 10 minutes of fall



Figure 87: Close up of injury



Figure 88: One-week post PBM



Figure 89: One week post PBM

Closing comment

'Patients do not care how much you know till they know how much you care for them' and using lasers lets them know you care. **A**

Dr. Arun and Rita Darbar hold bespoke 'Let's Talk Lasers' seminars for dentists and their staff. These laser seminars are tailored to each practice

depending on their need, this can be from a first time laser user to the more experienced wanting to further enhance their laser knowledge. If you are interested in booking one of these seminars or want further information please contact them at Smile Creations Dental Innovations © Tel: 01525 383065 or visit www.smilecreations.co.uk

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