LASER Assisted Open Flap Debridement – A Case Series

Dr Sneha Gokhale discusses periodontal therapy

Periodontitis is the result of complex interrelationships between infectious agents such as bacteria and host factors. It is universally accepted that periodontal disease is the result of mixed bacterial infections that require the participation of a very limited number of the members of the anaerobic microbiota inhabiting the subgingival region and results in the destruction of supporting structures of the teeth.

The non-surgical periodontal therapy leads to resolution of inflammation, reduction in bacterial load and reduction in probing pocket depth. However, the complete removal of bacterial toxins from the root surfaces in the deep periodontal pockets is not always achieved with nonsurgical therapy. Instrumentation is not possible in inaccessible areas such as furcation, grooves and concavities.

Thus surgical therapy performed in cases with persistent inflammation, deeper pockets, class II and III furcation defects and intrabony defects provides better accessibility to root surfaces as well as osseous defects. However, periopathogens persist in the mixed species plaque biofilm on tooth surfaces, adhere to and enter the epithelial cells and are tissue invasive in nature. These are sources for re-colonisation and reinfection. The limitations of the conventional therapy have prompted us to implement the use of adjunctive anti-microbial measures.

Laser-assisted periodontal therapy has attracted attention recently as a potential alternative or adjunct to conventional mechanical debridement. Carbon dioxide (CO2) laser, Neodymium doped Yttrium-Aluminium-Garnet (Nd:YAG) laser, Diode and Erbium-doped Yttrium-Aluminium-Garnet (Er:YAG) lasers are used for debridement.
Lasers have been used as an adjunct to non-surgical periodontal therapy. Soft tissue lasers such as Diode and Nd:YAG have the potential for curettage of pocket wall and disinfection of periodontal pockets. Er:YAG laser can be used for both soft and hard tissue debridement. However, the scientific studies indicating positive clinical results and effective calculus removal in deep pockets with the use of different lasers are still lacking.

The use of Diode, CO2 and Er:YAG lasers as an adjunct in open flap debridement has been described in this case series. The mechanism of action, surgical technique, advantages and disadvantages of each laser have been discussed in detail.

**Therapy selection**

Patients within the age group of 50-50 years diagnosed as cases of Chronic Periodontitis were selected from the outpatient department of M.A. Rangoonwala College of Dental Sciences and Research Centre, India. Patients with probing pocket depth more than five mm after Phase I therapy were selected for the surgical therapy. Customised acrylic stents were prepared to record the probing depths pre and post-operatively. All the patients were followed up for three months post-surgery and probing depths were recorded with same stent.

The surgical area was anesthetised using Lignocaine 2% with 1:200000 Adrenaline. The procedure was done under proper aseptic precautions using continuous aspiration to keep the surgical site clean. A full thickness mucoperiosteal flap was raised to provide visibility and accessibility to the underlying bone and root surfaces. After the debridement, mucoperiosteal flaps were sutured back with 4-0 non-resorbable silk sutures.

The laser safety protocol was followed to avoid the adverse effects of lasers:

1. The operator, patient and the assistant wore glasses which are specifically designed to filter the laser beam of the specific wavelength.
2. Reflecting surfaces like mirrors were not used during the surgery as they are inflammable.
3. Alcohol based topical anaesthetic or alcohol moistened gauze were not used during the surgery as they are inflammable.
4. High speed evacuation was used to capture the laser plumes.
5. The lips were reflected using positive clinical results and effective calculus removal in deep pockets with the use of different lasers are still lacking.

**Soft tissue lasers such as Diode and Nd:YAG have the potential for curettage of pocket wall and disinfection of periodontal pockets**

Case 1: CO2 laser assisted open flap debridement

The CO2 laser is a gas laser with a wavelength of 10,600nm. It can be used in a continuous or pulsed mode. The laser shows high absorption by water and therefore it is an excellent soft tissue laser. It can easily cut and coagulate soft tissue, and has a shallow depth of penetration into the tissue, which is important while treating mucosal lesions. In addition, it is helpful in vaporising dense fibrous tissue. It can penetrate about 0.5mm deep into the tissue depending on the power intensity. It also has a strong bactericidal effect.

A 40-year-old male patient with a probing depth of six mm (Fig 1) after Phase I therapy was taken up for CO2 laser assisted open flap debridement. The CO2 laser (Fotona®) was used at the power of 5W in a continuous defocused mode for removal of the pocket lining. Defocussing increased the surface area and reduced the depth of penetration (Fig 2). The use of laser on the inner aspect produced a charred layer after ablation of the tissue (Fig 5). This laser had an articulating arm through which the laser beam was directed towards the granulation tissue. This laser is always used in a non-contact mode. The articulating arm is kept at a distance of one inch from the target tissue. A smoke evacuator was used to absorb the laser plumes formed as a result of ablation. An ‘Epithelial Exclusion’ technique described by Centy et al. in 1996 was used in this case. This technique includes de-epithelisation of the outer surface of the mucoperiosteal flap to prevent epithelial downgrowth (Fig 4). It was done at 5W, superpulse focused mode and the laser beam was directed at the band of epithelium which was ablated. Since the laser was
used in superpulse mode, the penetration was superficial and did not damage the underlying tissue.

The three-month follow up showed reduction in probing depth from six mm to three mm (Fig 5). The healing was uneventful. Patient did not experience pain or discomfort after the procedure.

The advantages of the CO2 laser are the excellent tissue coagulating and haemostatic properties. It also exhibits bactericidal effect against the tissue invasive perio-pathogens.

However, wavelength has the highest absorption in hydroxyapatite, where it is absorbed by the phosphate ion (-PO4), resulting in carbonisation when applied to hard tissues. It produces melting, cracking and carbonisation when applied to the hard tissue and therefore cannot be used for calculus removal. The laser energy is conducted through the waveguide and is focused to the surgical site in a non-contact fashion. The loss of tactile sensation poses a disadvantage to the surgeon, but the tissue ablation is precise with a careful technique.

Case 2: diode laser assisted open flap debridement

The diode laser is a solid-state semiconductor laser that typically uses a combination of Gallium (Ga), Arsenide (As), and other elements such as Aluminum(Al) and Indium (In) to change electrical energy into light energy. The wavelength range is about 800–980nm. The laser is emitted in continuous-wave and gated-pulsed modes, and is usually operated in a contact method using a flexible fibre optic delivery system. Laser light at 800–980nm is poorly absorbed in water, but highly absorbed in haemoglobin and other pigments. Since the diode basically does not interact with dental hard tissues, the laser is an excellent soft tissue surgical laser. The FDA approved oral soft tissue surgery in 1995 and sulcular debridement in 1998 by means of a diode laser.

A 45-year-old male patient with a probing depth of six mm after Phase I therapy was selected for diode laser assisted open flap debridement (Fig 6). Diode laser (Sunny Laser®) with a wavelength of 980nm and with a power setting 2.5W was used in continuous, contact mode with the help of a flexible fibre (400µm) optic delivery system. The fibre was used in a ‘brush stroke’ motion on the undersurface of the flap to remove the pocket lining (Fig 7). A layer of charred tissue was noticed after lasering the undersurface due to haemostatic and tissue coagulation effect of the diode laser (Fig 7-Diode laser for removal of granulation tissue).
Mechanical process, which ablates all living cells within the range of its penetration. Laser energy is absorbed by water molecules, and causes quick heating and vaporisation with massive volume expansion and explosion. The sequel of ‘Microexplosions’ creates high pressure on the surrounding cells that blast off. These dynamic effects cause mechanical tissues to collapse, resulting in Thermomechanical or Photo-mechanical ablation. This phenomenon has also been referred to as ‘Water Mediated Explosive Ablation’. Thus it is both a hard and soft tissue laser. The temperature increase is minimal in the presence of water irrigation, allowing hard and soft tissue removal without any carbomisation.

A 57-year-old male patient with probing depth of six mm was selected for Er:YAG laser assisted open flap debridement (Fig 10). In this case, delivery was a handpiece. The laser beam was directed towards the granulation tissue by holding the handpiece one inch away from target tissue. It was moved in a ‘brush stroke’ motion in a shaving manner till the granulation tissue was removed. The motion was continuous with overlap of the laser spots. The laser was used for calibration before use of laser (Fig 12).

There was reduction in probing depth from six mm to three mm after three months post-operatively (Fig 15). The healing was uneventful.

The use of Er:YAG laser has gained popularity in recent years due to its use in both soft and hard tissue procedures. The laser has an irrigation system which prevents overheating of the tissues thus causing minimal thermal damage. It also has an excellent bactericidal effect.

The difficulty in using this laser is the non-contact mode of laser delivery, which is difficult in inaccessible areas. This laser produces a typical ‘bullet noise’, which can be irritating to the patients. The use of irrigation produces aerosol containing blood which can contaminate the dental surgery. Also, the Er:YAG laser machine is expensive and comes as a big unit, unlike the diode laser.

Post-operative instructions
After completion of the procedure, flaps were sutured back with 4-0 non-resorbable silk sutures. No periodontal dressing was placed over the operated area in any of the treated sites. Post-operative instructions were followed back with 4-0 non-resorbable silk sutures. No periodontal dressing was placed over the operated area in any of the treated sites. Post-operative instructions were followed.

Conclusion
The use of lasers as an adjunct to mechanical debridement did not lead to post-operative complications nor delayed healing.

Three-month follow up showed reduction in probing pocket depth from six mm to three mm (Fig 9). The healing was uneventful.

The laser exhibited better operator control than the other two lasers since it is used in a contact mode. It is the most commonly used laser and is available in smaller cost effective units. Thus collateral damage with diode laser is less as compared to CO2 laser. The wavelength of diode laser is absorbed by the haemoglobin which leads to tissue coagulation and formation of charred layer. Diode leads to thermo-coagulation of the blood vessels which is responsible for its haemostatic effect. Thus diode laser is an excellent soft tissue laser because of its tissue coagulating and haemostatic properties. It selectively ablates the pigmented peri-pathogens due to its affinity for pigments and therefore exhibits excellent bactericidal effect.

Diode laser when applied to the hard tissues at power setting of more than 1.5W can lead to thermal damage. However, no effect is seen on dry or moistened surfaces. Since diode is absorbed by haemoglobin, only blood stained surfaces show evidence of thermal damage. It is ineffective in calculus removal.

Case 5: er:YAG laser assisted open flap debridement: The Er:YAG laser produces invisible light with a wave-length of 2,940nm that has high affinity to water in which it is maximally absorbed. The mechanism is similar to CO2 laser, but the absorption is about 10 times more. The soft tissue is removed by direct non-selective ablation, due to Water-mediated Photothermo-mechanical process, which ablates all living cells within the range of its penetration. Laser energy is absorbed by water molecules, and causes quick heating and vaporisation with massive volume expansion and explosion. The sequels of ‘Microexplosions’ creates high pressure on the surrounding cells that blast off. These dynamic effects cause mechanical tissues to collapse, resulting in Thermomechanical or Photomechanical ablation. This phenomenon has also been referred to as ‘Water Mediated Explosive Ablation’. Thus it is both a hard and soft tissue laser. The temperature increase is minimal in the presence of water irrigation, allowing hard and soft tissue removal without any carbomisation.

A 57-year-old male patient with probing depth of six mm was selected for Er:YAG laser assisted open flap debridement (Fig 10). In this case, the Er:YAG laser (Potona®) was used at a power setting of 1.5W (Energy 150mJ, Frequency 10Hz) in a short pulse, non-contact mode with air for degranulation and with air and water with the same power setting for calculus removal (Fig 11). The mode of laser application was directed towards the granulation tissue by holding the handpiece one inch away from target tissue. It was moved in a ‘brush stroke’ motion in a shaving manner till the granulation tissue was removed. The motion was continuous with overlap of the laser spots. The laser was used for calibration before use of laser (Fig 12).

There was reduction in probing depth from six mm to three mm after three months post-operatively (Fig 15). The healing was uneventful.

The use of Er:YAG laser has gained popularity in recent years due to its use in both soft and hard tissue procedures. The laser has an irrigation system which prevents overheating of the tissues thus causing minimal thermal damage. It also has an excellent bactericidal effect.

The difficulty in using this laser is the non-contact mode of laser delivery, which is difficult in inaccessible areas. This laser produces a typical ‘bullet noise’, which can be irritating to the patients. The use of irrigation produces aerosol containing blood which can contaminate the dental surgery. Also, the Er:YAG laser machine is expensive and comes as a big unit, unlike the diode laser.

Post-operative instructions
After completion of the procedure, flaps were sutured back with 4-0 non-resorbable silk sutures. No periodontal dressing was placed over the operated area in any of the treated sites. Post-operative instructions were followed.

Conclusion
The use of lasers as an adjunct to mechanical debridement did not lead to post-operative complications nor delayed healing.

However, further longitudinal studies are required to evaluate the long term effects of lasers on clinical as well as microbiological parameters. Further animal studies are required to provide an insight into the healing and a possible role of lasers in formation of a new attachment.