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 non-surgical 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 recolonisation 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-Aluminum-Garnet (Nd:YAG) laser, Diode and Erbium-doped:Yttrium-Aluminium-Garnet (Er:YAG) lasers have been used.

Laser-assisted periodontal therapy has attracted attention recently as a potential alternative or adjunct to conventional mechanical debridement.
Laser have been used in the therapy of periodontal pocket for hard tissue as well as soft tissue management. A part of the laser energy scatters and penetrates during irradiation into periodontal pockets. The attenuated laser at a low energy level might then stimulate the cells of surrounding tissue resulting in reduction of the inflammatory conditions (Shimizu et al 1995), in cell proliferation (Quadri et al 2005), and in increased flow of lymph (Shimotoyodome et al 2001), improving the periodontal tissue attachment and possibly reducing post-operative pain.

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.

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

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 mouth mirror were avoided in the area of interest.
3 The lips were reflected using positive clinical results and effective calculus removal in deep pockets with the use of different lasers are still lacking.
4 Moist gauze was used to prevent epithelial downgrowth (Fig 4).
5 Alcohol based topical anaesthetic or alcohol moistened gauze were not used during the surgery as they are inflammable.
6 High speed evacuation was used to capture the laser plumes.

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 3W 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 was described by Centry et al. in 1996 was used in this case. This technique includes de-epithelialisation of the outer surface of the mucoperiosteal flap to prevent epithelial downgrowth (Fig 4). It was done at 3W, 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 periopathogens.

However, wavelength has the highest absorption in hydroxyapatite, where it is absorbed by the phosphate ion (\( \text{PO}_4^2- \)), 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).
The Er:YAG laser produces invisible light with a wavelength of 2.940mm 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 Photothermolysis (Fig 11). The mode of laser 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 calculus removal in the same way. Since the laser does not have a hemostatic effect, some amount of bleeding was noticed after the 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 given to the patient. The patient was instructed to avoid spicy, hard, sour and hot food, avoid smoking and brushing on the treated area and was instructed to maintain oral hygiene by regular rinsing after meals and advised warm saline rinses from the next day. The patients were prescribed analgesics and Chlorhexidine mouthwash after the surgery.

Conclusion
The use of lasers as an adjunct to mechanical debridement did not lead to post-operative complications nor delayed healing. Lasers have been used in periodontal therapy due its bactericidal, haemostatic, cutting and coagulating properties. The use of lasers have been reported to cause less mechanical trauma, less swelling and scarring and less post-operative pain. Thus lasers can form an integral part of periodontal therapy in the future.

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.

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

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 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, open flap debridement: The Er:YAG laser produces invisible light with a wave-