**Trends & Applications**

**Frenectomy review: comparison of conventional techniques with diode laser**

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**Introduction**

The word frenum is derived from the Latin word “frænum”. Frenum is the triangle-shaped folds found in the maxillary and mandibular alveolar mucosa, and acts as the barrier between the central incisors and canine premolar area. Frenum may be classified depending on its morphology: **Long and thin**

**Short and broad.** Depending upon the attachment level, frenum has been classified as: (Pierce et al. 1974) **Mucoal**

**Gingival**

**Papillary**

**Papillary penetrating**

When the insertion point of the frenum is at the gingival margin it may pose a problem (Corn 1964). This kind of abnormal insertion of the frenum may cause marginal recession of the gingiva. Abnormal frenum insertion can distort and retract the marginal gingiva or pull away from the tooth when the lip is stretched. A frenum that encroaches on the margin of the gingiva may interfere with plaque removal, and tension on this frenum may tend to open the sulcus. This condition may be more conducive to plaque accumulation and promote poor oral hygiene. Alcerrent frenum can be treated by frenectomy or frenotomy procedure. Alcerrent frenum and frenotomy signify operations that differ in degree of surgical approach. Frenectomy is a complete removal of the frenum, including its attachment to the underlying bone, and may be required for correction of abnormal diastema between maxillary central incisors (Friedman 1977). Frenotomy is the incision and relocation of the frenal attachment.

**Indications**

- The indications for frenectomy procedure include:
  - Tension on the gingival margin (frenal-pull) concomitant with or without gingival recession
  - Facilitate orthodontic treatment
  - Facilitate home care. Techniques for frenectomy
  - Conventional technique
  - Using soft tissue lasers.

**Conventional technique**

Conventional technique utilizes traditional instruments like hand scalps and periostional knives. Different procedures have been mentioned under the conventional frenectomy technique. These include Dieffenbach, Schuchardt, & Mathis. The most common being Dieffenbach V-plasty & Schuchardt Z-plasty.

**Armentarium**

Bard-Parker handles no. 3, No. 15 blade, mosquito haemostat, sutures and needle.

**Procedure**

Dieffenbach V-plasty

Surgical steps: The area is anesthetized by giving local anaesthetic injection (2 % lignocaine with 1:20,000 adrenaline). After anaesthesia is achieved, the frenum is held with mosquito haemostats to its full depth. With the No. 15 blade mounted on a Bard-Parker handle, an incision is made along the upper surface of the haemostat till the entire depth of the frenum exposure is ensured. A similar incision is repeated on the under-surface of the haemostat so that the haemostat is detached along with the frenum tissue within its breaks. Once this is achieved, a rhomboid area exposing the deeper connective tissue fibers becomes visible. With the help of fine scissors, the deeper fibers are detached from the underlying periodontium. Periosteal scoring is done with the help of surgical blade so as to prevent the reattachment of fibers. The labial mucosa is undermined so as to permit the approximation of the edges. The bleeding is controlled by applying pressure pack.

Saturating: The diamond shaped wound is saturated using either a 4-0 or 5-0 silk sutures in simple interrupted fashion. Proper approximation of the margins is ensured. A periosteal dressing is placed to cover the surgical area.

Frenectomy by Y-plasty may result in scar formation that could prevent the mesial movement of the central incisors (West 1963). However, it is typically a safe surgical procedure with no notable complications.

**Carbon dioxide laser**

The carbon dioxide lasers have a wavelength of 10,600 nm. The beam of this laser falls in the infrared range and is thus invisible. This made the use of CO2 lasers awkward. Thus later on a quartz fiber incorporating a 650 nm coaxial He-Ne laser was used as an aiming beam in the handpiece. The CO2 laser received safety clearance from FDA in 1976 for use in soft tissue surgery. With the CO2 laser there is rapid intracellular rise of temperature and pressure leading to cellular rupture and resealing of ‘laser plume’ (vapour and cellular debris).

The CO2 laser is readily absorbed by water. Soft tissue consists of 75 % to 90 % water; 98 % of the incident energy is converted into heat and absorbed at the tissue surface with very little scatter or penetration. Thus moist surface is essential for maximal effect. With CO2 laser no contact is made with the tissue, and no tactile feedback occurs.

**Neodymium:YAG laser**

The Nd:YAG laser has a wavelength of 1,064 nm and lies in the infrared zone like the CO2 laser. The Nd:YAG laser penetrates water up to 60 mm after which it is attenuated 10 % of its original strength. Nd:YAG lasers are most effective in soft tissue rather than being absorbed onto the surface. The wavelength of Nd:YAG laser is a solid-state laser that generates a light with a wavelength of 2,940 nm. Of all lasers emitting in the near- and mid-infrared spectral range, the Nd:YAG laser in water is the greatest because its 2,940 nm wavelength coincides with the large absorption band for water.

The absorption coefficient of water of the Er:YAG laser is theoretically 10,000 and 15,000–20,000 times higher than that of the CO2 and the Nd:YAG lasers, respectively. Since the Er:YAG laser is well absorbed by all biological tissues that contain water molecules, this laser is indicated not only for the treatment of soft tissues but also for ablation of hard tissues. The FDA approved the pulsed Er:YAG laser for hard tissue treatment such as caries removal and cavity preparation in 1997, unchanged for soft tissue surgery and subdermal debridement in 1999 and for osseous surgery in 2004.

**Figure 1: Abnormal Frenal Attachment.**

**Figure 2: Hemostat in place & incision made.**

**Figure 3: Submucosal placement.**

**Figure 4: Post-operative view.**

**Figure 5: Ptychoparyplasty Frenal Attachment.**

**Figure 6: Periosteal incision made.**

**Figure 7: Incision coincides with the large absorption band for water.**

**Figure 8: Coagulation (65°C to 90°C).**

**Figure 9: Protein denaturation (90°C to 100°C).**

**Figure 10: Drying (100°C).**

**Figure 11: Carbonization (above 100°C).**

**Table 1: Comparison of Laser Type and Characteristics of Target Tissue.**

<table>
<thead>
<tr>
<th>Laser Type</th>
<th>Wavelength</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excimer laser</td>
<td>337 nm</td>
<td>Violet</td>
</tr>
<tr>
<td>Gas laser</td>
<td>637 nm</td>
<td>Red</td>
</tr>
<tr>
<td>Dye laser</td>
<td>655 nm</td>
<td>Green</td>
</tr>
<tr>
<td>Solid state</td>
<td>1,064 nm</td>
<td>Silver</td>
</tr>
<tr>
<td>Er:YAG laser</td>
<td>2,940 nm</td>
<td>Red</td>
</tr>
<tr>
<td>Nd:YAG laser</td>
<td>1,064 nm</td>
<td>Red</td>
</tr>
<tr>
<td>Er,Cr:YSGG</td>
<td>2,940 nm</td>
<td>Red</td>
</tr>
<tr>
<td>Er:YSGG</td>
<td>2,940 nm</td>
<td>Red</td>
</tr>
<tr>
<td>KTP</td>
<td>1,342 nm</td>
<td>Green</td>
</tr>
<tr>
<td>InGaAs</td>
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<td>Green</td>
</tr>
<tr>
<td>GaAlAs</td>
<td>1,342 nm</td>
<td>Green</td>
</tr>
<tr>
<td>HeNe</td>
<td>633 nm</td>
<td>Yellow</td>
</tr>
<tr>
<td>CO2</td>
<td>10,600 nm</td>
<td>Black</td>
</tr>
</tbody>
</table>

**Figure 12: Coagulation on the applied laser.**

**Figure 13: Coagulation on the applied laser.**

**Figure 14: Coagulation on the applied laser.**

**Figure 15: Coagulation on the applied laser.**

**Figure 16: Post-operative view.**
Diode Lasers

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 800–980 nm. The laser is treated in continuouswave and gated-pulse modes, and usually operated in a contact method using a flexible fiber optic delivery system. Laser light at 800–980 nm is poorly absorbed in water, but highly absorbed in hemoglobin and other pigments (ALD 2000). Since the diode basically does not interact with dental hard tissues, the laser is an excellent soft tissue surgical laser (Romonos G, 1999), indicated for cutting and coagulating gingiva and oral mucosa, and for soft tissue curettage or sulcular debridement.

The FDA approved oral soft tissue surgery in 1995 and sulcular debridement in 1998 by means of a diode laser (GaAlAs 810 nm). The diode laser exhibits thermal effects using the ‘hot-tip’ effect caused by heat accumulation at the end of the fiber, and produces a relatively thick coagulation layer on the treated surface (ALD 2000). The usage is quite similar to electrocauterization. Tissue penetration of a diode laser is less than that of the Nd:YAG laser, while the rate of heat generation is higher (Rastegar S 1992), resulting in deeper coagulation and more charring on the surface compared to the Nd:YAG laser. The width of the coagulation layer was reported to be in excess of 1.0 mm in an incision of bovine oral soft tissue in vitro (White JM 2002). The advantages of diode lasers are the smaller size of the units as well as the lower financial costs.

Argon Laser

The argon laser uses argon ion gas as an active medium and is fiber optically delivered in continuous wave and gated pulsed modes. This laser has two wavelengths, 488 nm (blue) and 514 nm (blue-green), in the spectrum of visible light. The argon laser is poorly absorbed in water and therefore does not interact with dental hard tissues. However, it is well absorbed in pigmented tissues, including hemoglobin and melanin, and in pigmented bacteria.

The argon laser was approved by the FDA for oral soft tissue surgery and curing of composite materials in 1991 and for tooth whitening in 1995. Considering the advantages of eradication of pigmented bacteria, this laser may be useful for the treatment of periodontal pockets.

Alexandrite Laser

The Alexandrite laser is a solid-state laser employing a gemstone called Alexandrite, which is chromium-doped: Beryllium-Aluminum-Oxide cryoharvyr (Cr:5; ReAl2O4) and is one of the few trichromatic minerals. Rechmann & Henning first reported that the frequency-doubled Alexandrite laser (wavelength 532 nm, pulse duration 100 ns, double spikes, q-switched) could remove dental calculus in a completely selective mode without ablating the underlying enamel or cementum. The development of this laser for clinical use is widely expected due to its excellent ability for selective calculus removal from the tooth or root surface without ablating the tooth structure.

Excimer Laser

Excimer lasers are lasers that use a noble-gas halide, which is unstable, to generate radiation, usually in the ultraviolet region of the spectrum. Frenitzer et al. demonstrated that the ArF excimer laser, wavelength 193 nm, could effectively remove dental calculus without causing any damage to the underlying surface. The cementum surface was clean, and only a slight roughness could be observed after irradiation, supporting the use of excimer lasers for laser scaling. Fölüzczey et al. have reported that the 308 nm wavelength XeCl excimer laser could effectively ablate dental calculus without thermal damages or smear layer production.

Frenectomy procedure using diode lasers Diode laser (A.R.C. Fox®) with wavelength of 810 nm was selected for the procedure. No local anaesthesia was given to the patient. The frenum was stretched to visualize its extent. The diode laser was applied in a contact mode with focused beam for excision of the tissue. The ablated tissue was continuously mopped using wet gauze piece. This takes care of the charred tissue and prevents excessive thermal damage to underlying soft tissue. The tissue was lasered until all the underlying muscle fibers were dissected. No sutures were placed at the end of this procedure. Patients were asked to take analgesics only if needed. Advantages of Laser over Conventional technique:

No need of local anaesthesia.
Hence it’s a painless procedure.
As a result there is less patient apprehension.
Bloodless operative field, thus better visibility.
No need of periodontal dressing, therefore no patient discomfort.