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Clinical applications of lasers during removable prosthetic reconstruction

Gabi Kesler, DMD

Dental Laser Center, Post Office Box 8121, Petah Tikva, 49651, Israel

During the past 10 years, lasers have been used as an alternative to conventional surgical techniques. Laser treatment in periodontal and oral surgery and in other disciplines in dentistry [1] has replaced many traditional electrosurgical and scalpel procedures and is beginning to replace the dental handpiece. The successful construction of removable full and partial dentures mainly depends on the preoperative evaluation of the supporting hard and soft tissue structures and their proper preparation [2,3]. Lasers may now be used to perform most preprosthetic surgeries. These procedures include hard and soft tissue tuberosity reduction, torus removal, treatment of unsuitable residual ridges including undercut and irregularly resorbed ridges, treatment of unsupported soft tissues, and other hard and soft tissue abnormalities. Stability, retention, function, and esthetics of removable prostheses may be enhanced by proper laser manipulation of the soft tissues and underlying osseous structure. Compared with conventional techniques, laser treatment has many advantages [3–6]. These advantages include

Reduced overall treatment time due to less mechanical trauma and edema
Decreased bacterial contamination of the surgical site
Reduced swelling, scarring, and wound contraction at the surgical site
Excellent hemostasis, leading to superior visualization of the surgical site

Lasers also may be used to treat the problems of hyperplastic tissue and nicotinic stomatitis under the palate of a full or partial denture and ease the discomfort of epuli, denture stomatitis, and other problems associated with long-term wear of ill-fitting dentures. This article discusses the proper use of various laser wavelengths to enhance the successful construction of removable prosthetic devices. Other articles in this issue have discussed in detail the various wavelengths available to dentists. Rather than repeat that information here, a very brief explanation of the various wavelengths seems appropriate

E-mail address: drkeslerg@012.net.il

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before discussing laser use in removable prosthetic care. Each wavelength has a different absorption coefficient, based on the composition of oral structures. Water, which is a universally present molecule in dental tissues, is most interactive with the erbium and carbon dioxide (CO_2) wavelengths. Oral mucosa, which has an extremely high water content, will absorb these wavelengths; therefore, these wavelengths can be used for dental soft tissue surgery. Shorter wavelengths such as argon, diode, and Nd:YAG are less well absorbed by water; however, they are well absorbed by blood components (such as hemoglobin) and tissue pigments (such as melanin). These shorter wavelengths, therefore, also may be used for soft tissue surgery. Erbium laser wavelengths are highly absorbed by the apetite crystal that forms the structure of enamel, dentin, cementum, and bone. Due to this unique interaction, the erbium family of lasers is ideally suited for dental hard tissue surgery.

Surgical procedures

Treatment of unsuitable alveolar ridges

Alveolar resorption usually is uniform in vertical and lateral dimensions. On occasion, irregular or excessive resorption occurs in one of the dimensions, producing an unsuitable ridge. As the available denture-bearing area is reduced, the load on the remaining tissue increases, which leads to an ill-fitting prosthesis, with discomfort that is not alleviated by soft linings [7]. Conventional surgical techniques include the use of scalpels to incise the soft tissue to obtain access to the underlying structures. Ronguers, bone files, and round burs in high-speed handpieces have been the treatment of choice to remove sharp bony projections and to smooth the residual ridge. Today, soft tissue laser surgery to expose the bone may be performed with any number of soft tissue wavelengths (CO_2, diode, Nd:YAG). Hard tissue surgery may be performed with the erbium family of wavelengths.

Treatment of irregular and undercut alveolar ridges

There are many causes of irregularly shaped alveolar ridges. Two of the most common causes are dilated tooth sockets that result from insufficient compression of the alveolar plates after an extraction and nonreplacement of a fractured alveolar plate. Naturally occurring undercuts such as those found in the lower anterior alveolus or where a prominent premaxilla is present may be the cause of soft tissue trauma, ulceration, and pain when a prosthesis is placed on such a ridge. Soft tissue surgery may be performed with any of the soft tissue lasers. Osseous surgery may be performed with the erbium family of lasers.

Surgical treatment of unsupported soft tissues

Unsupported soft tissue frequently is found in the anterior maxilla opposite mandibular anterior teeth with an edentulous posterior mandible.

During mastication, the upper denture oscillates, causing disproportionate resorption in the maxilla. The soft tissues are compressed, thus causing the denture to become increasingly unstable. Pain is not felt until the anterior nasal spine is nearly exposed and subject to trauma from the denture base. Unsupported maxillary alveolar soft tissues are bulkier than those in the lower jaw that tend to prolapse in the lingual direction. Traditional surgery consists of removing wedges of soft tissue from the alveolar crest until the wound edges are closed easily. Any of the soft tissue lasers are able to perform this procedure [4,8–10].

The enlarged tuberosity

Invasion of the intraalveolar space in the tuberosity area may prevent the posterior extension of the upper and lower dentures, thereby reducing their efficiency for mastication and their stability. Although enlarged tuberosities sometimes result from alveolar hyperplasia accompanying the overeruption of unopposed maxillary molar teeth, the most common reason for enlarged tuberosities usually is soft tissue hyperplasia. The bulk of the hyperplastic tuberosity may lie toward the palate. If undercuts are present, then osseous reduction may be required. Surplus soft tissue should be excised, allowing room for the denture bases. The soft tissue reduction may be performed with any of the soft tissue lasers. An erbium laser is the laser of choice for the osseous reduction [11–14].

Surgical treatment of tori and exostoses

Prosthetic problems may arise if maxillary tori or exostoses are large or irregular in shape or the mucosal covering becomes ulcerated. These bony protuberances also may interfere with lingual bars or flanges of mandibular prostheses. Tori and exostoses are formed mainly of compact bone and, usually, it is a simple matter to cut them off the underlying alveolar bone. Soft tissue lasers may be used to expose the exostoses, and erbium lasers may be used for the osseous reduction. A smooth, rounded, midline torus normally does not create a prosthetic problem because the palatal acrylic may be relieved or cut away to avoid the torus.

Soft tissue lesions

Persistent trauma from a sharp denture flange or overcompression of the posterior-dam area may produce a fibrous tissue response. Hyperplastic fibrous tissue may be formed at the junction of the hard and soft palate as a reaction to constant trauma and irritation from the posterior-dam area of the denture. The lesion may be excised with any of the soft tissue lasers and the tissue allowed to re-epithelialize. On occasion, true fibromas may develop. Fibromas are firm and hard on palpation and, unless traumatized, their surface is pink and keratinized. Fibroma removal is discussed elsewhere in this issue.

Fig. 1. Preoperative photograph of patient.

The following case history illustrates the use of soft tissue and hard tissue lasers in the delivery of removable prosthetic care. A 63-year-old man presented to the office for an emergency appointment complaining of gum swelling and loose teeth in his upper jaw. Clinical and radiographic examination revealed advanced periodontal disease with fremitus, pain on percussion, and purulent discharge from the periodontal pockets. The pockets ranged in depth from 8 to 10 mm, with +3 mobility of the teeth (Figs. 1 and 2). The examination also revealed high frenum attachments in the maxilla. The rest of the dental examination, including temporomandibular joint evaluation, was unremarkable. The medical history included coronary bypass 2 years ago, for which the patient takes one aspirin daily. A treatment plan was developed for the patient that included extraction of the remaining teeth in the maxilla, with immediate insertion of a full upper denture. The patient was informed in detail of the possibility of using lasers to complete the treatment plan. Because the patient was phobic about dental treatment (hence, the poor condition of his mouth), informed consent for laser surgery was obtained. The treatment plan for laser surgery included the following:

Removal of granulomatous tissue in and around the extraction sockets
Osseous recontouring of the residual ridge and sockets
Frenectomy
Hemostasis

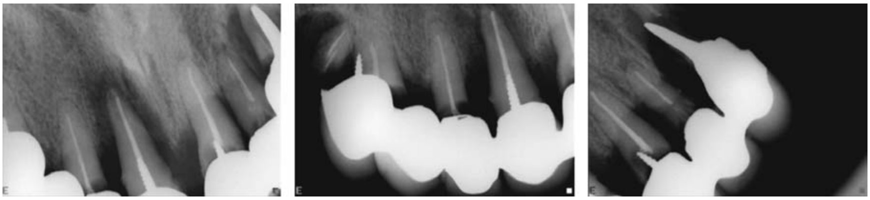

Fig. 2. Preoperative radiographs of patient.

Fig. 3. Granulation tissue removal and bone recontouring with Er:YAG regular-handpiece laser.

Due to the bactericidal nature of lasers [15,16] and anecdotal reports of less postoperative discomfort with a laser compared with conventional techniques [17], it was anticipated that the patient should have an uneventful postoperative course.

Appropriate impressions were made to fabricate an immediate-insertion full upper denture, and the patient was reappointed for surgery.

At the surgical appointment, the patient was anesthetized with 3 Carpules of 2% mepivicaine and the remaining maxillary teeth were extracted.

The sockets were debrided with the erbium:yttrium-aluminum-garnet (Er:YAG) laser (600-μm sapphire tip with water spray) until clean bone was visible without granulation tissue (Fig. 3). The CO_2 laser was used (3 W continuous) to clean and decontaminate the soft tissue. The laser was moved out of focus to obtain hemostasis. A Z-plasty was performed to prevent impingement of the denture base on the muscle attachments and dislodgement of the denture during function. The incisions were made with the CO_2 laser (3 W continuous) through the mucosa, lateral to the frenum insertion on the lip to the attachment at the alveolar crest. The frenum was separated from the adjacent tissue and bony insertion by the Er:YAG laser (1000 mJ,

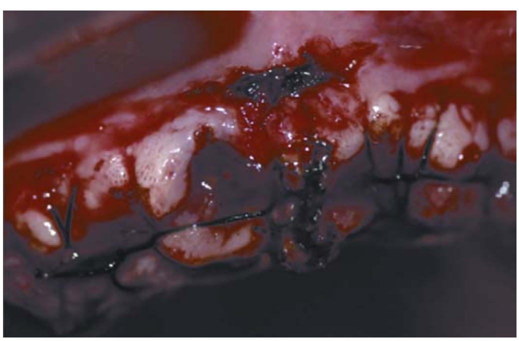

Fig. 4. Immediate postoperative view.

Fig. 5. Three-month postoperative view.

20 Hz). Sutures were used to close the wound. To prevent frenum relapse, the denture was modified with reline material. The patient was instructed to take ibuprofen if needed for any postoperative discomfort, rinse with warm salt water or Peroxyl rinse, and maintain good oral hygiene. Due to the hemostatic effect of the lasers, no significant bleeding occurred and the area was left unpacked. Antibiotics were not prescribed. Fig. 4 shows an immediate postoperative view. The patient was called 24 hours after treatment. He was comfortable and reported no pain; 48 hours after treatment the patient still reported no discomfort. The area remained asymptomatic, and on examination 1 week postoperatively, the patient reported no pain, with good healing. The three-month photograph of the area showed complete healing with no complications (Fig. 5). The soft tissue remained healthy and no osseous recession was observed.

Summary

Laser treatment during construction of removable prosthetic devices results in minimal noninvasive surgical procedures and minimal side effects. As with any surgical procedure, before treatment is initiated, the dentist must make a correct diagnosis and outline a treatment plan that addresses the patient's needs.

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