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The outcome of CO_2 laser root conditioning in periodontal treatment

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Abstract

The purpose of this pilot study was to evaluate periodontal tissue repair after CO_2 laser applications in the treatment of severe periodontal defects. Five patients, three men and two women, age range 37 to 55 years, were enrolled. All of the participants in the study were in good general health and presented with at least one tooth with PD of 6 to 9 mm and bleeding on probing. At baseline, all patients were treated with full mouth SRP, motivation and oral hygiene instructions. Clinical assessment after cause-related therapy showed need for additional periodontal treatment. The periodontal surgery procedures were performed with the adjunctive use of a CO_2 laser in defocused pulsed mode at 4 W, with a frequency of 20 Hz and a duty cycle of 6%. All the patients participating in the study were re-assessed 12 months after surgery. All the teeth that received periodontal surgery in conjunction with laser treatment showed significant improvement in all periodontal parameters registered. This pilot study pointed out that CO_2 laser treatment could induce predictable clinical improvements when used as an adjunctive tool with traditional periodontal surgery. More extensive, long-term and comparative studies are needed to confirm this hypothesis and to better clarify the effect of laser treatment on periodontal wound healing.

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1. Introduction

The main goal of periodontal treatment is the regeneration of destroyed periodontal tissue. In the last decade, many attempts have been made to re-establish tissues destroyed

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by periodontal disease such as mechanical barriers [1], guided tissue regeneration (GTR), PTFA membranes [2] and resorbable membranes [3]. In addition, in order to prevent epithelial growth in an apical direction, a combination of membrane and osseous graft is also described in the literature: bone resorption is filled with osseous graft and covered with membrane [4]. Various types of bone defects can be treated with the GTR technique but the predictability of tissue response is limited; as an example, the dehiscences of gingiva appearance and membrane exposures are common. The most frequently treated defects are deep (>6 mm) multi-walled intrabony defects and Class II furcation defects with a vertical component [5].

In periodontal desease, bacterial microflora infiltrate not only soft tissues of the periodontal pocket wall [6,7] but also dentinal tubules [8,9]. Mechanical root debridement technique alone is not sufficient to eliminate bacterial plaque from the root surface [10]; besides scaling, chemical root conditioning procedures are advocated in periodontal surgical treatment. Citric acid surface root conditioning enhances surface decontamination and collagen exposure [11]; moreover, solutions containing tetracyclines are used for root surface detoxification [12]. With the techniques described above, connective tissue may be repaired but unfavourable effects of treatment, such as ankylosis and root resorption, are common [13].

The CO_2 laser beam has an excellent absorption in water and it provides surface conditioning on the treated root [14] as well as on the internal side of periodontal flap during surgery [15,16]. The experimental animal model shows the efficacy of CO_2 laser epithelial treatment [17]. During periodontal open flap surgery, the inner surface of the flap was de-epithelialized. With this technique, a significant decrease of epithelial apical ingrowth was reported during the healing period. The use of the CO_2 laser during periodontal treatment enhances the formation of connective tissue attachment [18]. During the healing period, in 10-day interval examinations, they reported a significant increase of the connective tissue attachment in the first 30 days after treatment. In the animal model, the regeneration of periodontal tissues after root conditioning and evaporization of periodontal pocket soft tissue with the CO_2 laser was evident [19].

2. Case report

A 36-year-old non-smoking female reported to the Department of Periodontology in the University of Genoa. Her dentist had diagnosed inflammation of the upper front interdental papila and extrusion of tooth number 11. She was in good general health and had no skeletal, gastrointestinal or urogenital disease. The patient had complained of tooth extrusion but no pain or mobility of other teeth had been reported.

2.1. Oral inspection and periodontal status

During clinical examination, good, but not excellent, oral hygiene was observed. Plaque was detected on the gingival and oral surfaces of front teeth. Tooth 11 was 1 mm extruded and an interdental diastema was observed. The inflamed interdental papilla had a darker color compared to other gingival tissue. Bleeding tendency upon gentle probing

was high on oral and distal sites. No recessions or gingival margin disruptions were recorded. However, clinical attachment loss was recorded on the mesial side of tooth 11. Root surfaces of teeth 11 and 21 examined with periodontal probe showed no detectable inclinations or rough areas. Probing pocket depths measured on six sites on each examined tooth varied from 2 to 11 mm with a mean value of 6 mm.

2.2. Radiographic examination

Horizontal bone resorption was generalised around both upper front incisors. Bone margin was 3 to 5 mm apically, measured from the enamel–cement junction. Alveolar bone showed no tendency to vertical resorption except on the mesial side of tooth 11, where vertical bone resorption was recorded. At this side, pocket depth upon probing was 11 mm. The resorption showed also a horizontal enlargement towards the mesial side of tooth 21 (Fig. 1).

2.3. Diagnosis

The following diagnosis was made based on clinical and radiographic observations and on the initial periodontal measurements: on tooth number 11, parodontitis gravis et complicata, on tooth 21 parodontitis gravis and acute oedematous inflammation of the interdental papilla.

Fig. 1. Preoperative radiography of the teeth.

2.4. Periodontal treatment

After examination and diagnosis, initial plaque removal and instruction on oral hygiene maintenence took place. On both upper front teeth, a one-stage scaling and root planing was made. No antibiotic or other systemic treatment was subscribed. A modified Widmann open flap surgery was performed to remove coagulations and inflammation products from deep periodontal pockets. Vertical incisions were made in the papilla to preserve as much gingival tissue as possible (Fig. 2). After the flap was raised, the inner gingival granulations were removed. Then the CO_2 laser was used (El.En®, Florence, Italy). The laser beam was applied to the exposed root surfaces in defocused pulsed mode at 4.0 W and frequency of 20 Hz by a duty cycle of 6%. The duty cycle is defined as laser pulse duration divided by the whole period, and it has a range between 2% and 40% [20]. On the periodontal soft tissues, the laser beam was applied at 13 W, with a frequency of 40 Hz and a duty cycle of 40% in defocused pulsed mode (Fig. 3). Hard and soft tissue necrosis left by the laser beam was removed with a sonic scaler and washed with sterile saline solution. The wound was sutured and protected with a periodontal dressing for 1 week, after which the sutures were removed.

2.5. Rest period and orthodontic treatment

For the first 3 months after the periodontal and laser therapy the patient was advised to go through a rest period, during which a monthly plaque control was performed and good oral hygiene compliance was observed. After the rest period, orthodontic treatment with a fixed appliance was performed. Six months after treatment, tooth 11 was repositioned apically and has a normal position. In addition, the interdental diastema closed. After the orthodontic treatment, immobilization of the front teeth with a cemented orthodontic wire on the palatal surfaces was carried out.

Fig. 2. Facial flap reflected showing large buccal–mesial lesion on tooth number 11.

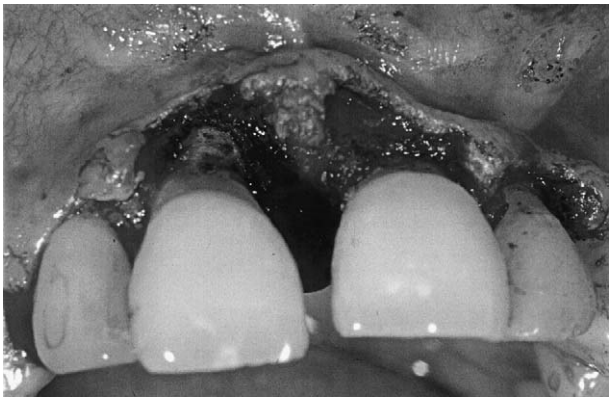

Fig. 3. CO_2 laser root conditioning, and vaporization of soft tissues.

2.6. Treatment result

One year after the initial periodontal therapy combined with CO_2 laser the following observations were made:

- When the reentering was made, the regeneration of mesial alveolar bone was observed.
- On the mesial side of tooth 11, a radiographic examination showed interdental bone crest regeneration (Fig. 4).
- Probing depth measurements remained under 3 mm with mean PD of 1.85 mm.
- The gingival surface showed normal appearance and color.

Fig. 4. Bone crest regeneration.

- Gingival margin on labial side of tooth 11 remained about 1 mm apically compared with the margin on tooth 21.

3. Discussion

Shariati et al. [21] studied the effect of a continuous wave carbon dioxide laser on dentin as a function of power density and exposure time, utilizing a scanning electron microscope. Three different layers on the root surfaces were observed: (a) a superficial layer of vaporization with complete elimination of microbial cells and root cementum; (b) a second layer of "glazed" dentin, where the dentin surface appeared as a melted and a resolidifed layer; (c) below a layer of plugged tubules, beneath the melted dentin, dentinal tubules appeared completely sealed. Rossman et al. [17], in an experimental study on monkeys, after induced periodontal disease, removed oral epithelium from opened flaps using CO_2 laser irradiation. They observed less epithelium and more connective tissue attachment at the experimental site compared with the control. Our observations confirm Rossman's findings. Tissue regeneration in the laser-treated sites with new cementum [19] and radiographic evidence of bone regeneration is probably the effect of decontamination of tissues [22] (Fig. 5). However, biostimulation of the laser beam might explain the biologic processes during wound healing [23]. Friedman et al. [24] reported significant correlation between enhanced tissue healing response and the laser beam. In our case, regeneration of the interdental bone was observed. Same results are reported also by Mester and Mester [25].

Fig. 5. Radiographic documentation.

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