Healing process and laser therapy in the superficial periodontium: a histological study

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Abstract

Aim: To evaluate the efficiency of laser therapy in healing, regeneration and repair processes located in the superficial periodontium after gingivectomy procedures. Materials and Methods: The study group consisted of 38 patients without any systemic diseases presenting with gingival hypertrophy developed exclusively within the clinical context of gingivitis and/or periodontitis. All patients were included in the study based on their informed consent. All patients required several surgical interventions at the level of the superficial periodontium. Subgroup 1 (17 patients) was treated only through gingivectomy procedures. For subgroup 2 (21 patients), the gingivectomy was associated with laser therapy, applied every day for seven days. Gingival mucosa fragments were taken on day 1 (curative gingivectomy) and on day 21 (clinical control and corrective gingivectomy), and routinely processed for the microscopic exam, using Hematoxylin–Eosin and special stains (trichrome Szekely and Periodic Acid–Schiff). Results and Discussion: The comparison between the morphological pictures characterizing the healing process associated or not with laser therapy, allowed the identification of some features supporting the benefits of laser therapy. We believe that the decrease in the inflammatory infiltrate located in the lamina propria is the critical morphological trait for the control of a healing process as near to restitutio ad integrum as possible. The diminished number of lymphocytes and macrophages will implicitly determine a lower production of chemical mediators interfering with the sequences of the healing process. Conclusions: The morphological differences identified at the gingival epithelium level and subjacent lamina propria support the value of laser therapy, stimulating an improved healing of the damaged tissues.

Keywords: gingival mucosa, gingivectomy, laser therapy.

Introduction

The restitution process of damaged tissue involves a healing mechanism, which entails regeneration and/or repair (cicatrisation).

The regeneration is defined as the renewal (partial or complete) of a tissue, the injured components being replaced by identical counterparts.

The repair consists in the replacement of the affected tissues through the process of scar formation.

Wound healing within the oral cavity context is an extremely complex mechanism where multiple characters may intervene, such as cell and/or tissue interrelations, growth factors and salivary components. The periodontium represents a unique histological system, because of the individual connection between the epithelium and connective tissue forming the dento-gingival junction [1–3].

At the level of the superficial periodontium, the free gingival mucosa repairs through regeneration based on epithelial restoration, while the dento-gingival junction supports only the development of granulation tissue with subsequent cicatrisation.

The laser technology was introduced in dentistry in the 80’s, their performances as therapeutic methods constantly growing and being largely accepted [4]. A great variety of lasers (CO2, Nd:Yag, Er:Yag) are used in periodontology for tissue ablation, root scaling, curettage of periodontal pockets, bacteria elimination and other surgical techniques [5–7].

Recently, the low frequency laser has been introduced. This type of laser is characterized by a 400–900 nm low wavelength spectrum [8, 9] and biostimulation and biomodulation properties, due to the capacity of this wavelength spectrum to modify tissue behavior [10–12], through its action on the calcium channels [13] initiating an increase of the cellular metabolism and proliferation rate [14].

Starting from the information in the literature, the purpose of our study was to evaluate the efficiency of laser therapy in healing, regeneration and repair.
processes located in the superficial periodontium after gingivectomy procedures.

Materials and Methods

The study group consisted of 38 patients without any systemic diseases presenting with gingival hypertrophy developed exclusively within the clinical context of gingivitis and/or periodontitis.

All patients were included in the study based on their informed consent.

All patients required several surgical interventions at the level of the superficial periodontium. Subgroup 1 (17 patients) was treated only through gingivectomy procedures. For subgroup 2 (21 patients), the gingivectomy was associated with laser therapy, applied every day for seven days.

Gingival mucosa fragments were taken on day 1 (curative gingivectomy) and on day 21 (clinical control and corrective gingivectomy), and routinely processed for the microscopic exam, using Hematoxylin–Eosin and special stains (trichrome Székely and Periodic Acid–Schiff).

Results

The fragments harvested on day 1 were extremely relevant for the pathological picture corresponding to the initial lesions.

The microscopic exam revealed the following characteristics:

- at the epithelial level: areas of mucosa without epithelium, covered by ulcerations and fibrinous leukocyte exudates; areas of mucosa presenting epithelial hyperplasia with ortho- and para-keratinisations; presence of intraepithelial lymphocytes, dispersed or forming small clusters modifying the normal arrangement of the keratinocytes;
- at the lamina propria level: presence of chronic inflammatory infiltrate, consisting predominantly of lymphocytes, associated with macrophages and plasma cells, located both in the superficial and deep lamina propria, separating the collagen bundles.

These pathological features reflect and support the morphological background of superficial periodontium disease (Figures 1–6).

The microscopic exam performed for the fragments harvested on the 21st day (clinical control and corrective gingivectomy) allowed the evaluation of the healing process, confirming differences between the patients that did not benefit from laser therapy (subgroup 1), and those that did (subgroup 2).
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Figure 5 – Free gingival mucosa with an abundant chronic inflammatory infiltrate diffuse in the superficial lamina propria, and with a nodular disposition in the profound lamina propria (HE stain, ob. ×4).

For subgroup 1, the gingival mucosa presented (Figures 7–9):

▪ at the epithelial level: large areas of orthokeratinisation, fairly smooth epithelial-connective interface;

▪ at the lamina propria level: persistent inflammatory infiltrate, in a moderate quantity compared to the initial lesions.

For subgroup 2, the features identified confirmed the presence of an improved healing process, mainly due to the significant reduction of the inflammatory infiltrate at the lamina propria level (Figure 10). Moreover, the epithelial-connective interface presented marked interdigitations (Figure 11), and the subjacent lamina propria revealed newly formed collagen bundles (Figure 12) in a perpendicular array, elements which increase the resilience of the gingival mucosa to the unavoidable mechanical aggressions.

Figure 6 – Free gingival mucosa with lymphocytes ascending towards the epithelium (HE stain, ob. ×20).

Figure 7 – Free gingival mucosa with ortho- and para-keratinised epithelium, lamina propria with young collagen bundles arranged parallel to the epithelial-connective interface (HE stain, ob. ×20).

Figure 8 – Free gingival mucosa: detail for the orthokeratinised epithelium (HE stain, ob. ×20).

Figure 9 – Free gingival mucosa: detail for the chronic inflammatory infiltrate, vasodilatation and edema in the superficial lamina propria (HE stain, ob. ×20).

Figure 10 – Free gingival mucosa with a very small quantity of chronic inflammatory infiltrate in the superficial lamina propria (trichrome Szekely stain, ob. ×20).
Discussion

Conventional periodontal therapy, surgical or not, applied on the dento-gingival complex leads to damage and injury of the already inflamed periodontal tissues. The consequences of these therapeutic procedures depend mostly on the cellular and molecular events associated with wound healing [15]. Most of the events surrounding the healing of periodontal lesions are similar to those that occur in any other lesion in the body. However, there is one significant difference represented by the mineralized tissue interface present at the junction between epithelial and connective tissue, typical for the dento-gingival territory.

Current researches oriented towards the repair process focus mainly on a deeper understanding of the role played by the growth factors, as it may open wider perspectives for their usage in dental practice while developing new tools for periodontal therapy [16–19]. According to the literature, it is presumed that these biological “tools” could accelerate or slowdown the epithelial replacement, the granulation tissue construction and the wound healing without scarring [20]. Another research direction concentrates on the modulation of cells – extracellular matrix adhesion, regarded as a possible target for an optimal guided tissue repair [21].

At the periodontal level, the integrity of the dento-gingival junction (component of the superficial periodontium) is essential for the protection of the periodontal ligaments and of the subjacent bone (components of the profound periodontium). The structure of this junction suffers severe modifications through the chronic inflammation associated with periodontal disease. Therefore, the attempts to control the destructive effect of chronic periodontal disease and to regenerate the lost tissue to a certain degree require the restoration of the dento-gingival junction.

Applications of the low frequency laser therapy in dental and periodontal treatments represent the subject of many in vivo and in vitro studies [22–26], which recommend the use of laser therapy after gingivectomy and gingivoplasty procedures due to its ability to speed up the healing process.

Moreover, in vitro and in vivo studies suggest that this type of laser facilitates fibroblast and keratinocyte motility [8, 27], collagen synthesis [28], angiogenesis and growth factors release, thus facilitating the healing process [29]. Supplementary, laser therapy has been used in pain management protocols following gingivectomies [27], and as a complementary treatment in non-surgical periodontal procedures [9, 27]. Nevertheless, there still remain a great deal of unanswered questions regarding the use of laser technology in dental practice, mainly as a result of the small number of clinical trials validating the efficiency of laser therapy [30–32].

The healing after laser therapy is based largely on the activity of the fibroblasts, keratinocytes and immune cells [33, 34]; thus, a few days after the surgical procedure, the epithelial cells start to migrate towards the borders of the lesion, while the fibroblasts proliferate – consequently, a new junctional epithelium is formed [21, 35]. Meanwhile, the cytokines and growth factors expressed by the neutrophils and macrophages control and regulate the healing process [20, 36, 37]. Applying the laser technology can accelerate this process by increasing the motility of the keratinocytes (with a consequent faster epithelization), increasing the proliferation of the fibroblasts (with consequent extracellular matrix synthesis) and by early angiogenesis [38].

The time of exposure, wavelength and the type of irradiation are extremely important factors for the efficiency of laser therapy [4] and high variances of these parameters were comparatively analyzed in relation with the results [30, 39]. Hence, recent data indicates that the simultaneous use of a low frequency laser and Emdogain in the treatment of intraosseous defects determines a decrease in attachment loss, inflammation and post-surgical pain [23, 40].

The present study has a series of methodological limits because of the small number of patients and the limited type of periodontal pathology, so that the results must be interpreted with caution. Nevertheless, the comparison between the morphological pictures characterizing the healing process associated or not with
laser therapy allowed the identification of some features supporting the benefits of laser therapy. We believe that the decrease in the inflammatory infiltrate located in the lamina propria is the critical morphological trait for the control of a healing process as near to restitutio ad integrum as possible. The diminished number of lymphocytes and macrophages will implicitly determine a lower production of chemical mediators interfering with the sequences of the healing process. The morphological evidence is represented by a new normal epithelization, restoration of the epithelial-connective interface (with deep epithelial ridges, alternating with high connective papillae) and a perpendicular orientation of the collagen bundles adjusted to the mechanical forces acting on the ginviga.

Conclusions

The morphological differences identified at the gingival epithelium level and subjacent lamina propria support the value of laser therapy, stimulating an improved healing of the damaged tissues.

References


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