PHOTODYNAMIC LASER THERAPY IN PATIENTS WITH PERIODONTITIS

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REZUMAT


Cuvinte cheie: laserterapie fotodinamică, fotosensibilizant, parodontită

ABSTRACT

Aim: Integration of photodynamic laser therapy in the conservative approach of periodontitis. Material and methods: Thirty patients with periodontitis were included in the study. Clinical examination, oral hygiene status, bleeding on probing score (BOP), serial radiographs by parallel technique were performed. One week after scaling and root planing (SRP), photodynamic laser therapy (aPDT) was performed in selected areas, where bleeding on probing persisted. The patients were reevaluated 1 week and 1 month after photodynamic laser therapy. Results: The clinical parameter BOP was used. Significant diminishing of BOP was noted after photodynamic laser therapy, compared with SRP alone. The reduction of BOP has been maintained both at 1 week and 1 month after aPDT. One month after performing aPDT, we observed a discrete tendency to increase the bleeding scores, but at lower levels compared to the bleeding scores after SRP alone (baseline). Discussions: It is known that scaling and root planing alone are not always efficient on the biofilm in the periodontal pocket and also have little effect on the periodontal tissues. In our study, the photodynamic laser therapy contributed as an adjunctive method to reduce the bleeding on probing in the sessions after scaling and root planing. Conclusion: Photodynamic laser therapy could be an adjunctive method in the conservative non-surgical approach of periodontal disease.

Key words: antimicrobial photodynamic laser therapy (aPDT), photosensitizer, periodontitis

INTRODUCTION

The gold standard for the non-surgical treatment of periodontal disease remains the mechanical periodontal debridement (supragingival and subgingival plaque biofilm and mineralized deposits removal). The mechanical periodontal treatment has to be often sustained with various antiinfectious means, such as antiseptics or antibiotics, with their well-known secondary effects. We assist at the development of the antimicrobial photodynamic laser therapy
(aPDT), which claims the bacterial photoactivated decontamination as a modern approach in dentistry.

The concept of antimicrobial photodynamic therapy (aPDT) consists in the application of a specific non-toxic photosensitizer (dye) to the target cells or tissues, in our case the oral bacteria (mostly gram-negative, anaerobic). This will be followed by the photodynamic activation of the photosensitizer (dye) by means of a low intensity visible light at a specific wavelength. The combination between photosensitizer and low intensity visible light, in the presence of oxygen, produces cytotoxic effect (photodestruction) of the target cells. This photoinduced effect is due to the conversion of the excited photosensitizer from the ground state to the triplet state. Consequently, there result singlet oxygen and other reactive agents, which are very toxic to certain cells or bacteria.1,2

Data from the literature suggest that the aPDT could be considered ideal for local application, without damaging distant cells or organs due to the short lifetime in biological systems and the limited time of migration of the singlet oxygen to the target sites.3-5

The aim of this strategy is to analyze the integration of the photodynamic laser therapy in the conservative approach of periodontitis.

MATERIAL AND METHODS

Thirty patients with periodontitis were included in the study. The patients participated in a supportive periodontal therapy program at the department of preventive dentistry from “Iuliu Hatieganu” University of Medicine and Pharmacy Cluj-Napoca, Romania. All the participants signed an informed consent form. The present study is a prospective, controlled, clinical study, which obtained the approval of the Ethical Committee of the University of Medicine and Pharmacy „Iuliu Hatieganu” Cluj-Napoca.

Clinical periodontal examinations (probing depth, gingival recession, and clinical attachment level were measured at baseline), bleeding on probing (BOP), serial radiographs by parallel technique were performed. After scaling and root planning, the patients were reevaluated at 1 week. The clinical criterion of bleeding on probing (BOP) has been used. After 1 week, we performed a single treatment episode of antimicrobial photodynamic laser therapy (aPDT), in areas were bleeding on probing persisted after scaling and root planing. The patients were reevaluated at 1 week and 1 month after the photodynamic therapy, regarding bleeding on probing.

The inclusion criteria in the study were: 4 or more periodontally involved teeth; pocket depth (PPD) of ≥ 4 mm; over 18 years of age; informed consent forms signed by all subjects. The exclusion criteria were: patients requiring prophylactic antibiotic for dental treatment; antibiotic treatment in the last 6 months.

![Figure 1. TheraLite Laser (HELBO® Photodynamic Systems GmbH & Co KG, Grieskirchen, Austria)](image1)

![Figure 2. Photoinduced decontamination of the periodontal pockets (TheraLite® laser device)](image2)

For the antibacterial photodynamic laser therapy we used the dye/laser system of the HELBO® Photodynamic Systems GmbH & Co KG, Grieskirchen, Austria). The laser device is the diode laser TheraLite Laser (Fig.1), at 660 nm, 100 mW continuous wave (CV); output: 20mW (from HELBO® 3D Pocket Probe). The laser is class 2M and the photosensitizer is phenothiazine chloride. The aPDT procedure involves the activation of the photosensitizer by laser energy. In our study, the laser energy was delivered by means of a pen-like device, which has the applicator HELBO® 3D Pocket Probe (for periodontal applications) (Fig. 2). The dye is phenothiazine chloride, which stains the pathogenic bacteria and sensitizes these microorganisms to visible light, inducing damage. The dye is introduced in the periodontal pocket, from the bottom to the
crown. It remains 1 min; afterwards it will be rinsed with water and followed by the local application of the laser energy with the HELBO® 3D Pocket Probe. The optic fiber HELBO® 3D Pocket Probe is inserted in the periodontal pocket like the periodontal probe, in 4-6 points, for minimum 1 min/tooth/cm². The TheraLite represents a “friendly module” for rapid application of the concept of aPDT in dental practice. It has all the necessary components for performing aPDT with disposable items (HELBO® 3D Pocket Probe, dye delivered in special disposable syringes).

RESULTS

In the present study, all patients received a supragingival cleaning of all teeth associated with periodontal treatment comprising periodontal debridement, including scaling and root planing (SRP) of the periodontally involved teeth. The SRP was performed both with hand instruments and a piezo-electric ultrasonic scaler. The clinical criterion of bleeding on probing was used. The antimicrobial photodynamic laser therapy was performed after one week in subjects where the bleeding on probing persisted after periodontal debridement, respectively SRP. The patients were reevaluated at 1 week and 1 month after the aPDT. The clinical periodontal examination and the bleeding on probing were performed by two trained examiners. The Florida Probe device was used, both for probing and for the computerized periodontal charting. This automatized periodontal probe permits the probing of the pockets with a standardized pressure, calibrated at 20 g. Thus, false positive measurements and trauma of periodontal tissues during pockets probing can be avoided.6,7 The bleeding on probing (BOP) was evaluated as a full mouth bleeding score (FMBS) and as bleeding score of the treated sites (BOPTS) for the teeth with PPD ≥ 4 mm. On those teeth were PPD ≥ 4 mm and BOP was present, aPDT was performed (Fig 3).

One week after aPDT there was a significant reduction of BOP in the treated areas. Thus, there was a reduction of FMBS from 43% to 11% in one week after aPDT. The BOPTS was reduced from 69% to 19% in the first week after performing a single episode of aPDT. The reduction of BOP has been maintained at 1 week and 1 month after aPDT, compared to the bleeding scores after SRP alone. One month after aPDT, we observed a discrete tendency of increasing in the bleeding scores, but at lower levels as compared to the bleeding scores after SRP alone. This increasing tendency after 1 month was 7% for the FMBS and 4% for the bleeding scores at the treated sites.

DISCUSSIONS

It is known that periodontal debridement is less effective on the biofilm in the periodontal pockets. The method of photodynamic laser therapy has contributed as an adjunctive method to the improvement of the clinical aspect of periodontal tissues and also to the reduction of bleeding on probing in the sessions following periodontal debridement. The principle of photodynamics involves the application of a photosensitizer in the treatment area, together with the use of light; this produces free oxygen radicals, with cytotoxic effects upon the target cells, in our case the microorganisms. Substances typical for oral environment (demineralized dentine, collagen) don’t interfere with the photoprocess.3,8

The causes of the improvement of the clinical appearance of periodontal tissues and of the reduction of bleeding on probing scores after a single episode of aPDT are not quite simple to explain. The following assertions could be considered:

– the beneficial effects of low level laser therapy in general;
– the antibacterial photoinduced effects of dyes, photosensitizers;
– the antibacterial effects of the dyes alone;
– accessibility of the aPDT in areas with difficult access for hand and mechanical periodontal instrumentation (furcations, etc).

The therapeutic effect of low level laser therapy induces beneficial influences upon collagen synthesis, tissue repair, reduction of healing time, a.s.o.9 The aPDT delivered by the TheraLite laser used in our study also offers, beside the beneficial effects of low level laser therapy, the photoinduced antibacterial properties of the dyes. The photoinduced antibacterial properties of the dyes have been demonstrated by studies in vitro 100 years ago, when there was observed that some microorganisms could be killed...
by the combination of visible light with dyes. The widespread of antibiotics could have caused perhaps a delay in the progress of PDT. The increasing antibiotic resistance amongst pathogenic bacteria may bring to an end “the antibiotic era”. The photosensitizer used during aPDT with the TheraLight laser is phenothiazine chloride (10 mg/mL), whose main component is toluidine–blue. This photosensitizer was tested in vitro, in preclinical and clinical studies, being approved by the FDA. There are also studies which suggest the antibacterial properties of the dyes used alone, without aPDT. Thus, the reduction of BOP may also be explained by application of the dyes. Considering the data from literature regarding the beneficial influences of low level laser therapy, and also the photoinduced antibacterial properties of the dyes, we can suppose that the beneficial effect of aPDT could also be important in areas with difficult access for hand and mechanical instrumentation. The aPDT can be used in association with other antiseptics, it does not induce resistance and it can often avoid the use of antibiotics. Studies in literature suggest that the aPDT may represent an alternative in the reduction of bone resorption in areas with open furcation. Further studies are necessary to determine if aPDT could be an alternative for patients with diseases that contraindicate the use of systemic antibiotics and also for prevention of bacteriemia following different dental procedures. The literature regarding the effect of aPDT in clinical controlled trials in dentistry is still lacking. In our study, there was a significant reduction of bleeding on probing scores at sites treated with a single episode of aPDT, compared with the bleeding scores following SRP alone. Future research should determine if in acute cases it is necessary to increase the period of action, to modify the frequency of aPDT application, etc. Extended protocols in order to better define the application of aPDT in different dental diseases are required. Our study is in accordance with some studies in literature concerning the evaluation of patients receiving supportive periodontal therapy, where there can be observed a significantly higher reduction in bleeding scores after the additional application of a single episode of aPDT compared to SRP alone.

CONCLUSIONS

Photodynamic laser therapy could represent an alternative approach in the conservative non-surgical adjunctive treatment of periodontal disease. Further studies are necessary to investigate the duration and frequency of the aPDT treatment in acute and chronic phase, in patients with aggressive periodontitis or during maintenance therapy, in the treatment of periimplantitis, and so on. Antimicrobial photodynamic laser therapy has a great potential to be applied more often in dentistry, due to the increasing bacterial resistance to antibiotics versus lack of resistance to aPDT, and to the compact design and “easy to use” components (photosensitizer, optic fiber, pen-like - no cord design) of the laser device. Being a non-thermal laser, it is obvious that the risk for bone necrosis is minimized. The concept itself of photodynamic laser therapy is very attractive, because it selects the target tissue by “marking” it with the photosensitizer, and the therapy (laser energy) is active (focused) only on “marked” cells or tissues. The aPDT is a minimally invasive local treatment and has a good potential to become an alternative in the adjunctive treatment of different dental diseases associated with bacterial contamination.

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