Periodontal treatment with combined: mechanical therapy plus low-energy laser irradiation compared to scaling and root planning. A clinical and microbiological split mouth study.

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ABSTRACT:

Background: The present study is aimed to describe a six-months result on selected microbiological and clinical parameters obtained by subgingival debridement in periodontitis.

Material and Methods: Thirty patients with moderate to advanced periodontal destruction were treated under local anesthesia and the quadrants were randomly allocated in a split-mouth design to receive one of 2 types of treatment procedure: 1- Scaling and root planning (SRP) using hand instrument, and 2- Scaling and root planning (SRP) and then irradiated with (Ga As) infrared diode laser. The selected teeth were assessed for microbiological and clinical variables. Clinical measurements of plaque index (PI), gingival index (GI), bleeding on probing (BOP), probing depth (PD), gingival recession (GR) and clinical attachment level (CAL) were made prior to and at 3 and 6 months after treatment. Subgingival plaque samples were taken at each appointment and analyzed using dark field microscopy for the presence of cocci, non-motile rods, and spirochetes. Differences in clinical parameters and prevalence of bacterial species were analyzed using the paired t-test.

Result: The mean value of BOP decreased in the laser group (SRP/L) from 59% at baseline to 20% after 6 month (P < 0.001) and in SRP group from 55% at baseline to 25% after 6 months (P < 0.001). The mean value of PD decreased in the laser group from 5.0 ± 0.7 mm at baseline to 2.9 ± 0.6 mm after 6 months (P < 0.001) and in SRP group from 5.0 to 0.6 mm at baseline to 3.3 mm after 6 months (p < 0.001). The mean value of the CAL decreased in the laser group from 6.8 ± 1.0 mm at baseline to 4.5 ± 1.0 mm after 6 months (P < 0.001) and in the SRP group from 6.9 ± 1.0 mm at baseline to 5.4 ± 1.0 mm after 6 months (P < 0.001). The reduction of the BOP score and the CAL improvement was significantly higher in the laser group than in the SRP group (P < 0.05, P < 0.001, respectively). Both groups showed a significant increase of cocci and non-motile rods and a decrease in the amount of motile rods and spirochetes.

Conclusions: With in the limits of this study soft laser therapy provided additional microbiological and clinical benefits over conventional mechanical debridement.

Key words: Low energy laser, scaling, periodontal root planning, (J Bagh Coll Dentistry 2008; 20(1) 37-44)

INTRODUCTION

The high energy lasers (Nd: YAG neodimium-doped: yttrium, aluminum, and garnet) and CO2 lasers are limited due to their thermal side effects whereas the low energy lasers Er:YAG (erbium-doped: yttrium, aluminum, and garnet) and Ga As (gallium arsenide diode laser ) show efficiency in medical and dental applications because of its thermomechanical ablation mechanism and the high absorption of its wavelength by water.

Recently, various biostimulatory effects of low-energy laser irradiation have been reported and it's possible medical photo-biological and photo-chemical effect have been investigated by several researchers. this involves the stimulation of wound healing, fibroblast proliferation, collagen synthesis, and enhancement of bone fracture healing.

A primary goal in the treatment of periodontitis is the removal of bacterial deposits and halting of the disease progression. To achieve this goal, a complete removal of adherent plaque, calculus, and infected cementum is necessary. The management of periodontal disease includes many treatment modalities such as conventional therapies consisting of surgery and/or non-surgical methods. In any case, the purpose of periodontal treatment is to arrest progressive tissue destruction and to prevent further attachment loss. Undoubtedly, to successfully treat periodontitis, we have to find more effective techniques, surgical as well as non-surgical, in recent years; the use of laser radiation has been suggested as an alternative to the conventional periodontal mechanical therapy. It was proposed that various advantageous characteristics inherent in the laser-based root surface treatment e.g. hemostasis, selective calculus removal or antibacterial effects, might lead to improved periodontal therapy.

Low power energy laser irradiation produce biostimulatory effects on cellular proliferation in
periodontal ligament (PDL) and alveolar bone (AB) (enhanced cellularity of PDL and bone remodeling) \(^{16,17}\).

The low-power, Ga-As diode laser devices have been used for experimental and clinical studies on periodontal treatment, bone formation and repair \(^{18,19}\). Today there is considerable evidence to support scaling and root planning as one of the most commonly used procedures for the treatment of periodontal diseases \(^{20}\). In searching of more efficient instrumentation, many investigators have proposed lasers as an adjunctive and sometimes alternatives, especially because of their ability to detoxify root surfaces and ease of use. However, until now no published data are available concerning the clinical outcomes following treatment with low-power Ga-As infra red diode laser when compared to well established procedures such scaling and root planning. Therefore the aim of the present study was to assess the clinical effectiveness of low energy Ga-As diode laser, after conventional periodontal therapy (SRP+LR) when compared to scaling and root planning alone (SRP)

MATERIALS AND METHODS

**Patient Population**

Thirty periodontal patients, aged between 28 to 72 years (mean age 50 years), were included in the study. They were all referred to Periodontal Department, College of Dentistry, University of Baghdad and all participants signed informed consent forms. Criteria for exclusion from the study were: (a) periodontal treatment within the last 12 months; (b) systemic diseases which could influence the outcome of the therapy; (c) pregnancy; or (d) systemic antibiotics within the last 6 months.

**Study Design**

The study was performed using a split-mouth design. A total of 45 maxillary and 30 mandibular pairs of contra lateral single and multirooted teeth were included (total 300 sites). Each tooth of each contra lateral pair exhibited gingival inflammation with a positive bleeding on probing (BOP), subgingival calculus and a probing depth (PD) of ≥4 mm on at least one aspect of the tooth. In each contra lateral pair, one tooth was randomly treated with subgingival scaling and root planning using hand instrument, while the other tooth was treated with the same mechanical technique plus irradiation with (GaAs) infrared diode laser. The distribution of 2 treatment modalities was equally divided between the right and left sides. All patients were treated by the same experienced operator.

**Oral Hygiene Program:**

For 4 weeks before treatment all patients were enrolled in a hygiene program and received oral hygiene instructions at 2 to 4 appointment as well as professional tooth cleaning according to individual needs. A supragingival professional tooth cleaning was performed at baseline as well as 3 and 6 months after treatment.

**Treatment:**

1. The mechanical subgingival instrumentation:
   (performed using hand instruments Universal curettes No. 1/2)
2. Procedure of laser irradiation:
   The laser equipment used for this study was OPTODENT unit which is patented dental for infrared and laser therapy (CM Scavini C.N.R physics instue-parma). The OPTODENT unit presents itself as ideal combination in one single apparatus of two sections, thus making the system very versatile in use according to the different diseases to be treated. Laser irradiation was administrated locally by placing the end of optical fiber in intimate contact with the gingival tissues to prevent reflection of laser beam.

**Laser section:**

- Gallium arsenide (Ga As) infrared diode laser
- Laser diode peak power: \(20\) W
- Laser diode average power: \(8\) mw.
- Average power (in optic fiber): \(5\) mw.
- Wave length \(904\)nm
- Impulse frequency: \(3,000\) H2

The laser hand piece was moved manually along the gingival tissue, during the total time of laser irradiation procedure which is 10 minutes.

Both groups were treated under local anesthesia, the instrumentation for both hand instruments and laser irradiated was performed until the operator felt that the root surfaces were adequately debrided and planed.

**Clinical Measurements**

At the baseline visit and 3 months and 6 months after the last treatment, the following clinical parameters were measured by one calibrated periodontist:
- Plaque index (PI) \(^{21}\)
- Gingival index (GI) \(^{22}\)
- Probing depth (PD)
- Gingival recession (GR)
- Clinical attachment level (CAL)

Bleeding on probing was assessed simultaneously to the pocket measurements.
Microbiological Evaluation

The bacterial samples were obtained as follows:

After professional supragingival tooth cleaning, a sterile paper point was introduced through the sulcus as far apically as possible. It was withdrawn after 30 seconds and then suspended in a sterile 0.9% sodium chloride solution. Within 30 minutes, the samples were evaluated using darkfield microscopy by classifying cocci, spirochetes, motile and non-motile rods from 100 to 150 bacteria from fields selected at random.²⁵

Statistical Analysis

A software package was used for the statistical analysis. The paired t-test was used to compare the mean scores of all investigated clinical parameters 1 from the baseline to those after 3 and 6 months for each treatment group.

RESULTS

Clinical Measurements

At the baseline examination, there were no statistically significant differences in any of the investigated parameters (Table 1, 2). Initially the plaque index was 1.0±0.5 in both groups, at the 3 month examination the plaque scores were markedly reduced and remained low throughout the study. No statistically significant difference was observed between surfaces treated by the 2 methods of instrumentation (Table 1). The gingival index was significantly reduced in both treatment groups at the 3 and 6 months examination compared baseline (P<0.001, P<0.001, respectively). At the baseline examination 58% the surfaces in the SRP/LR group and 56% of the surfaces in SRP group demonstrated bleeding on probing. Subsequent to instrumentation, a marked and gradual improvement of the bleeding scores took place until 19% of SRP/LR group and 23% of the SRP group at the 3 month examination and 15% of the SRP/LR group and 22% of SRP group at the 6 month examination reached a statistically significant difference could be observed at the 3 months (P<0.05) and the 6 months (P<0.05) examination between the 2 treatment groups.

Throughout the study, a significant reduction of the PD and highly significant gain of CAL took place in both treatment groups (P<0.001). At the 3 and 6 month examination the statistical analysis showed a significant difference for PD (P<0.05, P<0.001, respectively), CAL (P<0.01, P<0.001 respectively) and GR (P<0.01, P<0.001 respectively) between 2 treatment groups (table 2). The effect of both treatments (SRP & SRP/LR) at different initial probing depths is shown in figure 1. Initially deeper pockets (>7mm) showed the greatest changes in PD), CAL, and GR. Moderately deep pockets (4 to 6mm) showed moderate improvement, with shallow sites exhibited the least amount of changes. In particular, sites with initially deep probing depths showed more CAL gain, more OR, and deeper residual PD at baseline and 6 months examination than sites with initial moderate to shallow PD. In the SPR/LR group, at 6 months, there was a mean loss of CAL of 0.2 mm for shallow sites, in contrast to a 0.1mm means gain for moderately deep sites, and a 3.1 mm means gain for deep sites. In the SRP group, at 6 months, there was a mean loss of CAL of 0.6 mm for shallow sites, in contrast to a 0.7 mm mean gain for moderately deep sites, and 2.0 mm mean gain for deep sites (figure 2). The difference between 2 groups was more significant in initially deep pockets (P<0.001) in modarate or shallow pockets (P<0.01, P<0.05 respectively).

Microbiological Evaluation:

Both treatment groups led to a significant reduction of motile rods and spirochetes and a significant increase of cocci and non-motile rods at months (P<0.001) (Figure 4). However, the total count of the motile rods at the 6 months was almost identical to the baseline score in both treatment groups. After 6 months increasing percentages of spirochetes and decreasing percentages of cocci and non-motile rods could be observed in both groups. No significant differences were observed between the SRP+laser groups and SRP groups (Figure 4).

DISCUSSION

All investigated parameters such as PI, GI, BOP, PD and mean CAL showed a marked improvement 3 months post-treatment with even further improvements up to 6 months. The most obvious changes in the bacterial distribution occurred in the first 3 months and remained stable for another 3 months, with the exception of the motile rods and the spirochetes with slightly increasing percentages of the total count. These findings are consistent with results from previous studies which have shown that the bacterial recolonization occurs after 3 months.²⁴,²⁵

Recently, results from controlled clinical studies shown that the stability of gained clinical attachment following conventional and regenerative periodontal treatment is dependent upon stringent oral hygiene.²⁶,²⁷ Further more, it should be pointed out that in the present study, the
difference between treatment groups was more significant in deeper pockets than in moderate or shallow pockets (Figure 1).

Results from previous studies demonstrated that subjects with a high percentage of residual deep pockets (>6 mm) following treatment run a greater risk of additional attachment loss than subjects with a small percentage of such residual pockets (28,29). In a clinical study evaluating the clinical assessment of a low-energy laser for soft tissue surgery and scaling a total of 38 patients with moderate to advanced periodontitis were treated (30). Each subject was evaluated on the day of laser application and after 1, 2 and 3 weeks. The mean PD was reduced from 5.6±2.0 mm to 2.6±0.9 mm. These results were statistically and clinically significant compared to baseline. No further details concerning the development of CAL and GR were given. The obtained mean PD reduction was higher than that from the present study. This discrepancy might be explained by differences in the initial PD. Clinical studies have demonstrated that the reduction of PD and the improvement of the CAL after both non-surgical and surgical periodontal treatment is dependent on the initial PD (i.e., the greater the initial PD and CAL, the greater the PD reduction and CAL gain) (31,32). The clinical changes in SRP group were comparable to those reported in a number of clinical studies that described the effectiveness of non-surgical periodontal instrumentation therapy (28). The moderate increase of gingival recession in the laser irradiated group may be explained by the atraumatic use of the fiber tips. Results from clinical studies have indicated that trauma from instrumentation may be one reason for an increase in GR and subsequently, a loss of clinical attachment following non-surgical periodontal treatment (28,29). Shallow sites seem to be more susceptible than deeper sites (Figure 3) furthermore, it should be pointed out that in the present study the difference between laser-treated (SRP/LR) and hand instrumentation without laser treated (SRP) was much more significant in deeper pockets than in moderate or shallow pockets (Figure 1-3). These findings may indicate that, from a clinical point of view in shallow pockets, no differences between treatment with only hard instruments or combined with low-level laser irradiation can be observed.

Low-energy laser (soft laser) enhanced cellularity of periodontal ligament and bone remodeling. GaAs infrared diode laser irradiation increased proliferative activity of fibroblasts and osteoblasts as a result of laser biostimulation effect on these cells (33,34). Low-Power GaAs diode laser radiation enhanced healing process in laser treated surgical wound (35,36). So the reason for the higher CA1 gain measured in the SRP/LR is probably due to biostimulating effect of GaAs infrared diode laser irradiation on both fibroblasts and osteoblasts.

The necessity of cementum removal for accomplishing a successful periodontal therapy is still controversially discussed in the literature (36). While some authors consider the removal of the diseased cementum an important factor for a successful periodontal therapy, others have demonstrated the similar histological and clinical results can be achieved with both, complete removal of cementum and only polishing of the root surfaces. Furthermore, the results of a recent histological study in humans showed that even periodontal regeneration can be accomplished on a previously diseased cementum surface, if the bacterial deposits are mechanically or chemically removed (36). Thus, it can be anticipated that the detoxification of the cementum surface seems to be more important for the outcome of the therapy than the removal of the entire layer of cementum. In this context it is important to point to the result of previous studies which have shown that the low-power, GaAs diode laser has also high bactericidal potential (14, 37-39).

The reason for choosing darkfield microscopy in the present study was to observe certain microbiological features that are associated with healing period, without resorting to extensive culturing techniques. It is well known that periodontal diseased pockets are associated with a high percentage of spirochetes and motile rods and a low percentage of cocci and non-motile rods, while periodontal healthy sites show inverse relations (23,36). The findings of the present study have, furthermore, indicated that both therapies led to significant improvements on the microbiological level. A lack of correlation between clinical parameters and the proportions of spirochetes and motile rods at individual sites was previously described by other investigators (41). On the other hand, several studies have shown a clear association between changes in the proportions of spirochetes and motile rods and probing depth (42,43).

In conclusion, the results of the present study indicate that GaAs infrared diode laser radiation may represent a suitable adjunctive for non-surgical periodontal treatment. Further studies are needed in order to evaluate the long-term results of this treatment modality.
Table 1: Plaque index (PI), Gingival index (GI), and Bleeding on probing (BOP): Mean scores ± SD, n=30 patients) at baseline and 3 and 6 months.

<table>
<thead>
<tr>
<th>Index/treatment</th>
<th>Baseline ± SD</th>
<th>3 month ± SD</th>
<th>P value</th>
<th>6 months ± SD</th>
<th>P Value</th>
</tr>
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<tbody>
<tr>
<td>PI SRP/LR</td>
<td>0.5± 1.0</td>
<td>0.4± 0.6</td>
<td>*</td>
<td>0.4± 0.5</td>
<td>*</td>
</tr>
<tr>
<td>SRP</td>
<td>0.5± 1.0</td>
<td>0.5± 0.7</td>
<td>NS</td>
<td>0.5± 0.5</td>
<td>NS</td>
</tr>
<tr>
<td>P. Value</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GI SRP/LR</td>
<td>2.0± 0.6</td>
<td>0.6±0.6</td>
<td>~</td>
<td>0.3±0.6</td>
<td>~</td>
</tr>
<tr>
<td>SRP</td>
<td>2.0± 0.6</td>
<td>0.7±0.7</td>
<td>~</td>
<td>0.4±0.7</td>
<td>~</td>
</tr>
<tr>
<td>P. Value</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BOP SRP/LR</td>
<td>59%</td>
<td>24%</td>
<td>~</td>
<td>20%</td>
<td>~</td>
</tr>
<tr>
<td>SRP</td>
<td>55%</td>
<td>26%</td>
<td>~</td>
<td>25%</td>
<td>~</td>
</tr>
<tr>
<td>P value</td>
<td>NS</td>
<td>*</td>
<td></td>
<td>*</td>
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</tbody>
</table>

Significance of differences within and between the groups at different time points by t test:
NS P>0.05, *P<0.05 ~ P<0.001.

Table 2: Probing Depth (PD), Gingival Recession (GR), and Clinical attachment (CAL): mean scores ± SD, n=30 patients) at baseline and 3 and 6 months.

<table>
<thead>
<tr>
<th>Index/treatment</th>
<th>Baseline (SD±)</th>
<th>3 month (SD±)</th>
<th>P value</th>
<th>6 months (SD±)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPD SRP/LR</td>
<td>±5.0±0.7</td>
<td>3.5±0.6</td>
<td>*</td>
<td>2.9±0.6</td>
<td>*</td>
</tr>
<tr>
<td>SRP</td>
<td>0.6±5.0</td>
<td>0.7±3.8</td>
<td>*</td>
<td>0.7± 3.3</td>
<td>*</td>
</tr>
<tr>
<td>P. value</td>
<td>NS</td>
<td>~</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAL SRP/LR</td>
<td>1.0±6.8</td>
<td>1.0±5.2</td>
<td>*</td>
<td>4.5±1.0</td>
<td>*</td>
</tr>
<tr>
<td>SRP</td>
<td>1.0±6.9</td>
<td>1.1±5.7</td>
<td>*</td>
<td>5.4±1.0</td>
<td>*</td>
</tr>
<tr>
<td>P. value</td>
<td>NS</td>
<td>~</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GR SRP/LR</td>
<td>1.4±1.0</td>
<td>1.5±0.7</td>
<td>Ns</td>
<td>1.5±0.7</td>
<td>Ns</td>
</tr>
<tr>
<td>SRP</td>
<td>1.5±1.0</td>
<td>1.9±0.8</td>
<td>*</td>
<td>0.8±2.0</td>
<td>*</td>
</tr>
<tr>
<td>P value</td>
<td>NS</td>
<td>*</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Significance of differences within and between the groups at different time points by t test
* p<0.0001, +p<0.05 , ~p<0.01.

Figure 1: Plot of mean probing depth at baseline , and 3 and 6 months at sites with initial probing of 1 - 3, 4 – 6, and > 7mm (n=30 patients).
Figure 2: Mean clinical attachment level at baseline, and 3 and 6 months at sites with initial probing depth of 1 - 3, 4 – 6, and > 7 mm (n=30 patients)

Figure 3: Plot of mean gingival recession at baseline, and 3 and 6 months at sites with initial probing depth of 1 - 3, 4 – 6, and 7 mm (n=30 patients)

Figure 4: Distribution of bacteria at baseline and 3 and 6 months (n=30 patients). Significant differences within the groups at different time points by t test (*P<0.001 +P<0.01).
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