Low-Level Laser Therapy for Treatment of Pain Associated with Orthodontic Elastomeric Separator Placement: A Placebo-Controlled Randomized Double-Blind Clinical Trial

Celestino Nóbrega, DDS,¹ Edina Mariko Koga da Silva, MD, PhD,¹ and Cristiane Rufino de Macedo, DDS²

Abstract

Objective: The objective of this study was to evaluate the effectiveness of the use of irradiation with a low-level laser therapy (LLLT), wavelength 830 nm, for treating pain inherent to tooth movement caused by orthodontic devices, simulated by positioning interdental elastomeric separators. Methods: Sixty orthodontic patients were randomly assigned to two groups: GA (ages 12–25 years; mean 17.1 years) was the control, and GB (ages 12–26 years; mean 17.9 years) the intervention group. All patients received elastomeric separators on the mesial and distal surfaces of one of the lower first molars, and immediately after insertion of the separators received irradiation as randomly indicated. The intervention group (GB) received irradiation with LLLT (aluminum gallium arsenide diode), by a single spot in the region of the radicular apex at a dose of 2 J/cm² and application along the radicular axis of the buccal surface with three spots of 1 J/cm² (wavelength 830 nm; infrared). Control group (GA) received irradiation with a placebo light in the same way. This was a double-blind study. All the patients received a questionnaire to be filled out at home describing their levels of pain 2, 6, and 24 h and 3 and 5 days after orthodontic separator placement, in situations of relaxed and occluded mouth. Results: The patients in the intervention group (LLLT) had lower mean pain scores in all the measures. The incidence of complete absence of pain (score = 0) was significantly higher the intervention group. Conclusions: Based on this study, authors concluded that single irradiation with LLLT of wavelength 830 nm efficiently controlled the pain originating from positioning interdental elastomeric separators, to reproduce the painful sensation experienced by patients when fixed orthodontic devices are used.

Introduction

Pain is a collateral effect that follows orthodontic treatment, caused by application of forces to promote tooth movement.¹ When mechanical forces are applied to the teeth, the resultant alterations of the blood flow start an inflammatory reaction in the periodontal tissue.² From this inflammatory reaction, some mediators are released, such as histamine, encephalin, dopamine, serotonin, prostaglandins, and leukotrienes, which produce hyperalgesia.³⁻⁵

It has been demonstrated that after compression of the periodontal ligament, prostaglandins and other mediators of inflammation, such as substance P, histamine, and serotonin, cause sensitivity to the free nerve terminations and discomfort after orthodontic adjustment or placement of dental separators.⁶

It has been reported that the initial tooth displacement caused by using dental separators causes pain and immediate release of mediating biochemical compounds into the gingival fluid.⁷ The same report attributed the increase in the levels of prostaglandin E2 to the initial intensity of the pain, and the increase in interleukin (IL)-1 to the intensity of pain 1 day later. Another study reported that 90% of patients undergoing orthodontic treatment complained of pain, and that 30% had considered the possibility of prematurely terminating the treatment because of the painful experience.⁸

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Therefore, distinct nonpharmacological and pharmacological methods have been indicated and used for controlling pain during orthodontic treatment. Among the pharmacological methods, nonsteroidal anti-inflammatory drugs (NSAIDs) administered before or after using tooth separators have been shown to be practical and safe for controlling the pain relating to this procedure.

However, it has been suggested that tooth movement may be affected in patients who use NSAIDs.\textsuperscript{10,11} Moreover, in using pharmacological analgesics, side effects need to be taken into account. These drugs are contraindicated for patients who are allergic to them. Some authors have emphasized the need to reduce pain in orthodontic treatment without administration of analgesic drugs.\textsuperscript{10,11}

Among nonpharmacological methods, researchers have demonstrated that low-level laser therapy (LLLT) produces an analgesic effect in some clinical and therapeutic applications. Some authors have attributed the analgesia produced by LLLT irradiation to its anti-inflammatory and neuronal effect, including breath stimulation of nerve cells and lymphocytes, thereby transmitting stabilization of the membrane potential and releasing neurotransmitters into the inflammatory tissue.\textsuperscript{12}

In addition to the analgesic effect, several researchers have reported that LLLT provoked tissue biostimulation. Currently, specific wavelengths with specific energy densities are suggested for application in bone remodeling.\textsuperscript{13} The benefit of radiation instead of medications relates to the fact that there are no systematic negative effects on the patient’s body. The interaction of LLLT with bone components has been studied under different conditions and with different wavelengths and energy densities, within the medical field.\textsuperscript{14}

From these investigations, it has been reported that a wavelength of 660 nm will increase the number of osteoblasts in the irradiated area.\textsuperscript{15} With up to a wavelength of 780 nm, significant regeneration of the trabecular bone has been observed.\textsuperscript{16} The wavelength of 830 nm, produced by the aluminum gallium arsenide diode laser (AlGaAs) has been considered to have greater tissue penetration power than that shown by other systems.

Researchers have advocated the idea that LLLT can speed up bone regeneration in the median palatine suture during rapid orthopedic expansion of the jaw,\textsuperscript{17} and can stimulate collagen synthesis, thereby constituting the main protein matrix in the bone tissue.\textsuperscript{18,19} Studies have found that laser irradiation can accelerate orthodontic movement in rats.\textsuperscript{13}

In a recent study, authors tested the hypothesis that there is no difference in the pain associated with orthodontic force application after local CO\textsubscript{2} laser irradiation. They stated that this type of therapy could act as a high level laser (HLLT), where there is a photo-bio-destructive reaction that induces to cellular vaporization. On the other hand, the utilization of LLLT irradiation generates a photo-bioactive reaction that stimulates cellular proliferation and differentiation.\textsuperscript{20}

Because of all of these observations, LLLT seems to be a good option for treating the pain that comes with orthodontic treatment. Moreover, it appears to act as a stimulant for bone and fiber repair, as well as possibly speeding up the rate of tooth movement. Therefore, the objective of this study was to evaluate the effectiveness of using a single dose of LLLT at a wavelength of 830 nm in the treatment of pain inherent in orthodontic tooth movement.

Materials and Methods

This was a double-blind, placebo-controlled, randomized study, with two parallel group with 1:1 allocation ratio. The study was registered under the name “Evaluation of low level laser therapy (LLLT) for the treatment of pain associated with positioning elastomeric orthodontic interdental separators” at the Registro Brasileiro de Ensaios Clínicos (ReBEC) platform. The full trial protocol can be accessed at the web site http://ec.gov.br/bvsalud.org/ by the registration number RBR-8v3tkq.

The total of 60 patients were selected from an orthodontic clinic where patients of the public health service of the city São José dos Campos in Brazil are treated free of charge. The study was submitted and approved by the ethics committee of Universidade Federal de São Paulo, according to document number CEP 0407/08. All patients read and signed the informed consent document. Oral and written explanations about the study were supplied to the patients or their guardians. No rewards or incentives were given for participation, which was voluntary. Patients who had opted to not participate in the study received the standard recommended treatment. Any time during and after the clinical procedures and data collection, the participants could reach the main researcher for any kind of clarification. At the end of the research, the volunteers had access to the final results.

The following inclusion criteria were observed: (1) age \(>12\) years, (2) presence of erupted permanent first and second lower molars, (3) presence of erupted first and second premolars, and (4) voluntary participation in the study confirmed by signing the informed consent form. In addition, the following criteria were applied to exclude participants from the study: (1) using antibiotics or analgesics, (2) being pregnant or breastfeeding, (3) cardiac disease, (4) systemic diseases, (5) contraindications for NSAID use, (6) having undergone any type of surgical procedure during the preceding 2 weeks, (7) gastrointestinal illness (gastritis, gastric ulcer, lactose intolerance, chronic diarrhea or intestinal inflammatory illness), (8) presence of melanin pigmentation in the gingiva in the area to be irradiated, (9) presence of treated or untreated apical bone lesions, and (10) presence of one or more diastema in the region of the molars and/or premolars.

For the sample size calculations, the prevalence of pain relating to orthodontic movement was considered to be 91%, based on previously published studies.\textsuperscript{8} According to the

![FIG. 1. Scheme of the irradiation points of the low-level laser therapy (LLLT).](image-url)
literature, the minimum difference value for a pain scale from 0 (zero) to 10 with clinical relevance is considered to be 1–2 points.\textsuperscript{21–23} Therefore, the minimal difference was assumed to be 2 points and the standard error type I ($\alpha$) was assumed to be 0.05 and the standard error type II ($\beta$) was assumed to be 2.0. The calculation resulted in a sample of 26 patients in each arm of the experiment. For the final samples and considering the possibility of possible losses, 30 patients were allocated to each group, making a total of 60 individuals.

The procedures were codified as A and B, and for allocation of the participants, a computer generated list of random letter was used (program available at: http://www.dave-reed.com/Nifty/randSeq.html) with blocked randomization to ensure the ratio 1:1. The randomization sequence was protected in opaque envelopes, sealed, and consecutively numbered, and the entire procedure was performed by another person, and not the investigator.

The manufacturer (Kondorthe – Sa˜o Carlos, Brazil) provided an AlGaAs device (class 3B), model name Bio Wave LLLT Dual. The laser spot diameter was 2 mm, and the irradiation time was automatically set according to the chosen dose. The irradiation time was 25 sec per each 1 J/cm\textsuperscript{2}. Once the total dose utilized was 5 J/cm\textsuperscript{2} (Fig, 1) the overall time was 125 sec for 5 J/cm\textsuperscript{2}.

The manufacturer sent a device with two different probes named A and B. These enabled indistinguishable application of light laser or placebo, as the two probes had equal appearance, shape, size, and weight. Prior to application of the procedures, the manufacturer evaluated the equipment and issued a report (established using a radiometer) that demonstrated that the calibration measurements on the radiation emissions (40.6 mW) were correct.

During the phase of procedures and data collection, only the manufacturer had knowledge of the respective functions of the laser probes and not only the patients, but also the operator/researcher were blinded, and in all the cases, the researcher also acted as the operator. The respective functions of the laser probes A and B were revealed to the operator and researchers only after data collection had been completed.

For all the patients in groups A and B, separators (3M Unitek\textsuperscript{6}) were placed manually. The separators were placed on the mesial and distal sides of the first permanent lower molars on the left and right sides.

Immediately after the separators had been placed, the volunteers received the irradiation indicated according to the randomization. Intervention group received irradiation with LLLT, using an AlGaAs diode, with a single spot application to the region of the root apex at a dose of 2 J/cm\textsuperscript{2}, and along the root axis on the buccal side, with three spot applications of 1 J/cm\textsuperscript{2} at the infrared wavelength of 830 nm.\textsuperscript{8,24} The control group received irradiation with placebo infrared light radiation in the same spots and taking the same amount of time for the procedure as was used for the other group.

The manufacturer and patient used intense blue protective goggles in accordance with the standard safety rules. A warning sign plate was used.

The primary end point with respect to effectiveness was the comparison of the mean of pain intensity in the intervention and placebo groups. As a secondary outcome, the frequency of reports of absence of pain was compared. The patients

\begin{itemize}
  \item Have you experienced any pain in your teeth due to the elastic separators over the last 2 hours?
  \begin{itemize}
    \item Date: ___/___/___
    \item Time: ___:___h
    \begin{itemize}
      \item ( ) NO
      \item ( ) YES
    \end{itemize}
  \end{itemize}

  \item If you experienced pain, please make a vertical mark on the lines below, to show the amount of pain that you are experiencing now, 2 hours after receiving the elastomeric separators, in the situation below:
  \begin{itemize}
    \item Without making any movement with your mouth or tongue (spontaneous pain):
      \begin{itemize}
        \item 0
        \item 1
        \item 2
        \item 3
        \item 4
        \item 5
        \item 6
        \item 7
        \item 8
        \item 9
        \item 10
      \end{itemize}
    \item When you close your mouth and bite with your posterior teeth:
      \begin{itemize}
        \item 0
        \item 1
        \item 2
        \item 3
        \item 4
        \item 5
        \item 6
        \item 7
        \item 8
        \item 9
        \item 10
      \end{itemize}
  \end{itemize}

\end{itemize}

FIG. 2. Patient report used in the study (2, 6, and 24h, and 3 and 5 days after the procedure).

received a questionnaire asking about pain intensity, to be defined on a visual analogue scale (VAS), which they filled out during the days of the week subsequent to the procedure (Fig. 2). The patients marked the pain intensity in situations with a relaxed mouth (spontaneous pain) and upon biting only with the posterior teeth (in occlusion). The intensity of pain was reported by the patients 2, 6, and 24 h, and 3 and 5 days after orthodontic separator placement. The patients were instructed to avoid analgesic use. If some additional medication was necessary, the patients had been instructed to indicate the date and time of taking it, and the type of medication used, in the appropriate field on the questionnaire.

**Statistical analysis**

Statistical analysis was performed using the BioStat 5.0\(\text{®}\) program for Windows\(\text{®}\) with a 5% level of significance. The t-test for the significance of the difference between the means of two dependent and independent samples were used for intra- and inter-group comparisons, respectively. For comparisons between categorical variables, the \(\chi^2\) test was used. In all the statistical tests when the calculated \(p\) value made it possible to reject the null hypothesis, an asterisk was used to characterize this.

**Results**

In the period from June to December of 2008, a total of 72 patients were initially evaluated, and of these 12 were excluded for not meeting the inclusion criteria. Therefore, 60 patients were randomized to the intervention and control groups (Fig. 3). There were no differences in the baseline characteristics of the two groups regarding gender and age distribution of the sample (Table 1).

Table 2 shows data obtained from the patients' responses reporting pain after application of the elastic dental separators. There were significant differences in mean pain scores between the two groups favoring the group that received LLLT in all measures, for both spontaneous (Fig. 4) and in occlusion pain (Fig. 5), except on day 5, when the mean pain scores were similar.

For both groups, the highest averages were indicated in the 24h reports. This reinforces the hypothesis that the peak pain relating to orthodontic treatment occurs at this time. Excepting the mean of pain after 2h in the LLLT group, at all the times reported the mean scores for pain in occlusion were significant greater than the mean scores for spontaneous pain \((p<0.05)\). The proportion of patients reporting the absence of pain \((\text{VAS}=0)\) was significantly higher in the group receiving LLLT in all the measurements collected (Table 3). There was no other harm noted, and no patient reported the need for analgesic medication.

**Discussion**

Orthodontics is currently undergoing consistent advances, regarding tooth movement control. However, experience of pain still constitutes a constant concern for professionals, as it is recognized that such experience can influence patients' decisions and reduce the acceptability of orthodontic treatment.\(25\)

It is important to emphasize that some studies considered in the introduction of the present article were designed and performed as animal trials. It has to be taken in account when analyzing some statements, such as that specific wavelengths and doses could result in bone remodeling,\(14\) increasing the number of osteoblasts of the irradiated area\(15\) and stimulating collagen synthesis.\(19\) On the other hand, still regarding the positive influence of LLLT in bone remodeling and healing, authors of articles designed as human trials.

### Table 1. Sample Characteristics

<table>
<thead>
<tr>
<th>Gender</th>
<th>LLLT</th>
<th>Placebo</th>
<th>(p) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>12 (40%)</td>
<td>10 (36.3%)</td>
<td>0.60</td>
</tr>
<tr>
<td>Female</td>
<td>18 (60%)</td>
<td>20 (66.7%)</td>
<td>0.43</td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>17.9 (SD=3.9)</td>
<td>17.1 (SD=3.9)</td>
<td>0.60</td>
</tr>
<tr>
<td>Range</td>
<td>12.4 – 26.3</td>
<td>12.3 – 25.8</td>
<td>0.43</td>
</tr>
</tbody>
</table>

**Variable** LLLT Placebo Mean difference \(95\% \text{ CI}\) \(p\) Value

<table>
<thead>
<tr>
<th>Spontaneous pain</th>
<th>(n=30) Mean (SD)</th>
<th>Mean difference (95% CI)</th>
<th>(p) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 h</td>
<td>0.21 (0.83)</td>
<td>-0.81 (-1.49 to -0.13)</td>
<td>0.01*</td>
</tr>
<tr>
<td>6 h</td>
<td>0.34 (1.10)</td>
<td>-1.78 (-2.69 to -0.88)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>24 h</td>
<td>0.91 (1.41)</td>
<td>-2.69 (-4.05 to -1.33)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>3 days</td>
<td>0.49 (1.06)</td>
<td>-1.61 (-2.71 to -0.50)</td>
<td>0.003*</td>
</tr>
<tr>
<td>5 days</td>
<td>0.16 (0.83)</td>
<td>-0.40 (-0.92 to 0.12)</td>
<td>0.06</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Occlusion pain</th>
<th>(n=30) Mean (SD)</th>
<th>Mean difference (95% CI)</th>
<th>(p) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 h</td>
<td>0.33 (0.97)</td>
<td>-1.71 (-2.67 to -0.75)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>6 h</td>
<td>0.76 (1.48)</td>
<td>-3.33 (-4.62 to -2.04)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>24 h</td>
<td>2.20 (2.59)</td>
<td>-4.24 (-5.67 to -2.80)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>3 days</td>
<td>1.29 (2.02)</td>
<td>-2.39 (-3.80 to -0.97)</td>
<td>0.001*</td>
</tr>
<tr>
<td>5 days</td>
<td>0.69 (1.91)</td>
<td>-0.43 (-1.40 to 0.53)</td>
<td>0.18</td>
</tr>
</tbody>
</table>

LLLT, low-level laser therapy.
concluded that speedy bone regeneration could occur in the median palatine suture during rapid orthopedic expansion of the jaw.17

Temporary placement of elastomeric separators has been widely used in scientific research, with the aim of simulating the pain caused by orthodontic movement.26,27,28–30 Pain induction through placing elastomeric separators presents methodological advantages in comparison with some studies that have investigated this subject by gathering gains from patients during the early phase of orthodontic treatment for tooth alignment and leveling using round geometrical archwires. In most of these studies, the mechanism that produced pain was related to the flexibility of the orthodontic leveling archwires, and patients with different levels of crowding underwent the same interventions, with assessment performed in the same way, in accordance with unified parameters. Some important variations were not considered, such as the amplitude of tooth movement, composition of the metal alloy, geometry of the orthodontic wire, skeletal age, or even the social context in which the patient belonged.11,25,31–34 In the present study, use of elastomeric separators prior to banding proved to be capable of originating consistent pain peculiar to the beginning of the orthodontic treatment, for which non-pharmacological interventions such as LLLT irradiation should preferably be applied.

Regarding the dose and wavelength used in the present study, infrared radiation in the 830 nm band was chosen, as several authors have demonstrated that deeper penetration occurs, with the possibility of reaching both cortical and alveolar bone tissues, and that this is more effective than laser therapy in the visible spectrum with a wavelength between 620 and 670 nm.17,35 These radiations are included in the biological window that reaches the skin, and are commonly applied when lower penetration is required.1

<p>| Table 3. Distribution of the Reports of No Pain (VAS = 0): Spontaneous and Occlusion Situations |</p>
<table>
<thead>
<tr>
<th>VAS = 0</th>
<th>VAS &gt; 0</th>
<th>RR (95% CI)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>2h</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Spontaneous pain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LLLT</td>
<td>27</td>
<td>90.0</td>
<td>3</td>
</tr>
<tr>
<td>Placebo</td>
<td>11</td>
<td>36.7</td>
<td>19</td>
</tr>
<tr>
<td>Occlusion pain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LLLT</td>
<td>25</td>
<td>83.3</td>
<td>5</td>
</tr>
<tr>
<td>Placebo</td>
<td>9</td>
<td>30.0</td>
<td>21</td>
</tr>
<tr>
<td>6h</td>
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<td></td>
</tr>
<tr>
<td>Spontaneous pain</td>
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<tr>
<td>Placebo</td>
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<tr>
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<td></td>
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<td>9</td>
</tr>
<tr>
<td>Placebo</td>
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<td>10.0</td>
<td>27</td>
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<tr>
<td>24h</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spontaneous pain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LLLT</td>
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<td>50.0</td>
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<tr>
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<td>26</td>
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<td>Occlusion pain</td>
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</tr>
<tr>
<td>LLLT</td>
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<td>33.3</td>
<td>20</td>
</tr>
<tr>
<td>Placebo</td>
<td>0</td>
<td>0.0</td>
<td>30</td>
</tr>
<tr>
<td>3 days</td>
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</tr>
<tr>
<td>Spontaneous pain</td>
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</tr>
<tr>
<td>LLLT</td>
<td>20</td>
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<tr>
<td>LLLT</td>
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<td>53.3</td>
<td>14</td>
</tr>
<tr>
<td>Placebo</td>
<td>6</td>
<td>20.0</td>
<td>24</td>
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<tr>
<td>5 days</td>
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<td>Occlusion pain</td>
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</tr>
<tr>
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<td>76.7</td>
<td>7</td>
</tr>
<tr>
<td>Placebo</td>
<td>12</td>
<td>40.0</td>
<td>18</td>
</tr>
</tbody>
</table>

VAS, visual analogue scale, RR, relative risk; LLLT, low-level laser therapy.

FIG. 4. Distribution of the mean scores of pain (VAS) for placebo and low-level laser therapy (LLLT) groups in spontaneous situations of pain with relaxed mouth.

FIG. 5. Distribution of the mean scores of pain (VAS) for placebo and low-level laser therapy (LLLT) groups, in situations of pain when biting with posterior teeth in occlusion.
Phototherapy has been shown to be effective at $2 \text{J/cm}^2$. However, for severe pain, it is administered at higher doses (4–8 J/cm$^2$). Other studies have corroborated the dose used in the present study, while affirming the importance of using of doses <20 J/cm$^2$, so that they do not inhibit cell activity.34,37

The dose applied in the present study (AlGaAs) consisted of a total dose of 5 J/cm$^2$, with a spot application in the buccal region of the root apex of 2 J/cm$^2$ and over the root axis with three spots of 1 J/cm$^2$ each, using the infrared wavelength of 830 nm.8,24 Others authors have chosen to apply irradiation both at buccal and at lingual sites, with a total dose ranging from 2.5 to 8 J/cm$^2$.34,35 However, it is not necessary to irradiate the entire area in order to achieve the desired analgesic effect, given that the laser radiation is transmitted and propagated over a certain distance.8,35

In the present study, significant differences were found between the LLLT and placebo groups, such that the LLLT group presented lower means of pain scores over the almost entire period, in all reported situations. There are few objective findings on which the assessment of pain can rely. Pain is a subjective phenomenon and, therefore, the main assessment lies in the patient’s reporting, using a validated scale as the VAS. However, as the perception of pain intensity is variable for each individual, biases can be introduced by comparing the means difference between groups. Therefore, as a secondary outcome, the frequency of reporting no pain (VAS=0), a more objective measure, was analyzed. Again, important differences were observed when comparing the two groups, with higher proportions of reports of the absence of pain in the group receiving LLLT in all measures.

Our findings in this research confirmed the previous clinical trials that also observed the effectiveness of application of LLLT to control the pain in orthodontic treatment. According to a single-blinded study in which separation elastic modules were placed at the distal contacts of first maxillary molars, LLLT proved to reduce pain immediately after insertion of separators through 4 days later.20

Turhani et al.25 observed that LLLT immediately after leveling archwire placement reduced the prevalence of pain perception at 6 and 30 h in a single blinded study with 71 patients, and Tortomano et al.34 concluded that LLLT efficiently controlled pain caused by the first archwire in a double-blinded study with 60 orthodontic patients.

Conclusions

Application of LLLT radiation using the AlGaAs at the infrared wavelength of 830 nm promoted pain reduction after orthodontic movement caused by placement of elastomeric separators, and can be a clinically relevant alternative, because it is a noninvasive method with no adverse effects noted.

Author Disclosure Statement

No competing financial interests exist.

References


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