



Effect of low-level laser therapy on orthodontic pain caused by canine retraction force

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ABSTRACT

Introduction: The purpose of this study was to determine the effect of low-level laser therapy on orthodontic pain after the first canine retraction force.

Materials and Methods: This single-blind split-mouth placebo-controlled randomized clinical trial was performed in 30 orthodontic patients requiring bilateral canine retraction in Shahed University. Once canine retraction was initiated, a single dose of diode laser radiation (660nm, 80MW, and 3.8 J/cm² density, diameter of the optical fiber tip: 0/45cm²) was administered to a randomly selected maxillary or mandibular quarter for 30s. The other quarter served as the placebo side and was treated using the same device without turning on the laser. On the first, second, fourth, and seventh days, the patients rated the pain they experienced on each side at home by using visual analog scale-based questionnaires. Changes in pain were analyzed using non-parametric analysis with SPSS software.

Results: In patients who experienced pain, a significant pain reduction was noted on the first and fourth days after low-level laser therapy on the experimental side compared to that on the placebo side (P<0.05).

Conclusion: A single dose of diode laser therapy (660nm) can be an efficient modality to reduce the orthodontic pain associated with canine retraction.

Keywords: Canine retraction; Diode laser; Laser irradiation; Low-level laser therapy (LLLT); Orthodontic pain; Visual analog scale (VAS).

Introduction

Orthodontic treatment is one of the most prevalent treatments in current dentistry practice and more and more people undergo such treatment every day. The treatment can improve both dental function and dentofacial esthetics [1]. One of the common problems associated with orthodontic treatment is pain during the forces applied to the teeth, which affects patients' masticatory function and hence decreases patients' quality

of life [2]. It is well documented that more than 90% of orthodontic patients experience such pain while chewing [3] and 70-90% complain about it [4]. Orthodontic pain is of the inflammatory type since by applying orthodontic forces, periodontal tissue sensory receptors are activated and release inflammatory mediators such as histamine, serotonin, dopamine, glycine, and prostaglandins, thus initiating the inflammatory cascade [5,6].

The pain usually starts within 12 h after the orthodontic forces are applied, reaches its peak within 24 h, and begins to diminish by 7 days after the treatment [7,8]. According to the latest reviews, one of the most common ways to reduce this pain is to use non-steroidal anti-inflammatory drugs (NSAIDs) [6,9]. Some studies, however, have proposed the use of topical analgesics because of the contraindications of NSAIDs, such as allergic reactions, kidney or liver injury, and hypertension, and the diminishing effects on tooth movements [6]. Low-level laser therapy (LLLT) could be an option for reducing pain associated with orthodontic treatment. The mechanism underlying the effect of LLLT has been investigated in previous studies, and the analgesic property of LLLT is mostly attributed to its anti-inflammatory and neuronal effects. LLLT stimulates nerve cells and lymphocytes to release neurotransmitters into inflammatory tissues and blocks neural signaling, thereby reducing pain perception [10]. It also increases local blood circulation, thus eliminating the pain-inducing inflammatory mediators and increasing cellular activity [11]. Investigations have been performed on the effectiveness of LLLT in reducing pain associated with three different orthodontic treatments. There have been reports of the positive impact of LLLT in the days following separator placement and initial archwire insertion [12]. However, studies on LLLT in cases of canine retraction are lacking and thus the efficacy of LLLT remains controversial [12]. In addition, all of the canine retraction studies (except for one) have utilized aluminum-gallium lasers of wavelength greater than 750nm and no study on diode laser of 660nm had been done. Therefore, the aim of this study was to evaluate the effectiveness of diode laser of 660nm in reducing the pain associated with canine retraction.

Materials and Methods

This was a single-blind, split-mouth, placebo-controlled randomized clinical trial performed at the orthodontic Department of Shahed University (2017 & 2018, Tehran, Iran). Participants were selected from among those referred to the orthodontic Department of Shahed University and Montazery Clinic. This study included 60 bilateral canines retracted in 30 orthodontic patients (20 female and 10 male patients). Ethical approval was obtained from the ethics committee of Shahed University. The study protocol was explained to the patients. In case of patients younger than 18 years of age, the patients' parents or legal guardians were informed of the protocol in written and oral form. Patients and the parents or legal guardians of underage

patients were required to sign an informed consent form for study participation prior to the initiation of the study. The participants could voluntarily leave the study at any stage.

We included patients desiring to cooperate in this kind of treatment, showing the indications for bilateral canine retraction by extraction of first premolars, and presenting with no systemic or periodontal disease, no chronic pain or mental disabilities, and no history of medication intake five days prior to the treatment initiation. Subjects were excluded if either they took analgesics during the study or did not return the completed questionnaires. This study used a split mouth design; thus, the placebo and experimental (the side treated by laser) sides for each patient were chosen randomly. After the aligning and leveling stage, the first premolars were extracted and canine retraction was started bilaterally by using stainless steel wires (0/016 or 0/018) and short chains. Short chains had to be connected to the first molars and canines, not to the second premolars. The laser profile used in this study was diode 660nm, 80mW, 3.8 J/cm² at each point. The irradiation duration was 30 s, and the device tip diameter was 0/45cm². Laser treatment was performed exactly following the first retraction force, and only the buccal surface just above the CEJ was affected by the laser. The tip of the device was held perpendicular and was in gentle contact with the soft tissue during laser irradiation. The patients were unaware of the experimental and placebo sides. For the placebo side, radiation was simulated for the same duration and using the same procedural details with the device turned off. This was done to ensure that the patients could not determine the placebo/experimental sides.

Pain measurement

Each patient filled out the visual analog scale (VAS) questionnaire for both the experimental and placebo sides. The questionnaire was to be completed at home on the first, second, fourth and seventh day following laser irradiation. On these days, the patients were reminded by phone to fill out the questionnaires. VAS is a standard questionnaire including 10 equal parts. A score of 0 indicates the absence of any pain, while a score of 10 indicates pain that was considered intolerable, necessitating an emergency visit or causing them to wake from sleep [13].

Results

A total of thirty subjects were selected on the basis of the inclusion and exclusion criteria. The mean age

of the patients was 18.57 years (range: 12-40 years, 22 females and 8 males). Canine retraction was performed on the maxillary arch in 24 patients and the mandibular arch in 6 patients. Data obtained on the specified days showed that low-level laser therapy had no effect on pain reduction.

Another statistical analysis was performed only on patients experiencing pain either on the experimental or placebo side. This analysis was performed on 18 patients with a mean age of 15.67 years (range: 12-27 years; 12 females & 6 males). The one-way test showed significant pain reduction in the experimental side in comparison with the placebo side on days 1 and 4 ($p < 0.05$), although there was no significant difference between the experimental and placebo groups on the second and seventh days.

Discussion

Many studies have evaluated the effect of laser therapy on orthodontic treatment. These studies focused on the use of lasers for better and faster tooth movement and for reduction of the pain caused by these treatments. These studies have been conducted on three types of treatments: separator placement, arch-wire insertion, and canine retraction [12]. The present study was performed on canine retraction for the following reasons:

1. In canine retraction, the pain is localized to the canine area, thus reducing the patients' error rate in reporting the pain [10,14].
2. There were fewer studies on this treatment. Furthermore, the existing studies yielded controversial findings [12].

Pain perception depends on age, sex, and pain threshold [14-16]. Therefore, to avoid individual variability, the present study utilized a split-mouth design similar to many previous studies [14,17-19] rather than the parallel design [20]. The major advantage of this method is the elimination of most interfering factors, thus making the results more reliable [21]. A low-powered diode laser is usually used in various dental fields. This laser has shown positive effects on soft tissues and the bone, including faster and better osseous remodeling [22], better tissue repair [23], disinfection of the dental canal, better and faster osseointegration in dental implants [13] and pain reduction [24,25]. The 660-nm wavelength was selected on the basis of the following considerations:

- To decrease inflammatory pain without increasing

tissue temperature during LLLT in conditions such as orthodontic pain, a wavelength between 600-1000nm should be used [26].

- Most of the previous studies that used wavelengths greater than 750nm did not report the effect of laser on pain relief, but in a study using a 635 nm wavelength [19], LLLT influenced pain reduction, so a wavelength of 600-800 nm was considered to show a positive effect.

A suitable dose of low-level laser is an important factor in achieving the ideal results. Doses less than 20 J/cm² per area and less than 5 J/cm² per point usually show better treatment effects [15,27]. Doses greater than 20 J/cm² should be avoided for inflammatory pain because they reduce the anti-inflammatory and analgesic effects [27,28]. A dose of 3.8 J/cm², believed to be within the acceptable range, was utilized in this study. Although the dosages used in most studies were within the acceptable range, some studies used higher and unacceptable doses. For instance, Heravi et al used a dose of 21.4 J/cm² per point in canine retraction treatment [29]. The VAS questionnaire is thought to be reliable, sensible, repeatable [22,30], and understandable by patients. Moreover, it is both practical and easy to use and was utilized for this study. It can be used for patients of any age and it allows the patient to best assess and report their pain level [13,31,32]. Therefore, almost all studies in this field use this specific questionnaire [16-19,27,29,33,34], and it was considered to be an appropriate choice.

The findings from articles on canine retraction can be divided into two distinct categories: some reported that the laser was effective in pain reduction while others found it to be ineffective [12]. The initial results of the present study showed that the laser had no effect on pain relief. However, another analysis performed only on patients who experienced pain during the study generally indicated a reduction in the severity of pain and the number of days the patients felt pain, and the severity reached zero in the experimental group by the seventh day. Statistical analysis showed that the pain decreased significantly on the first and fourth days in the experimental group, in comparison with the placebo group.

On the second day, although statistical analysis showed no significant difference between the placebo and experimental groups, on the basis of the data diagram, the perceived pain on the experimental side was less in the majority of the patients, and in a few patients, it was equal to that on the placebo side. Patient number 9 reported relatively severe pain on the

second day only on the experimental side. According to the diagram for the other days, this patient reported no pain on any other day. Thus, it can be concluded that the pain reported on this day was due to some unknown trauma not reported to the investigators. On the seventh day, although statistical analysis showed no difference, by considering the diagram for this day, the pain was found to be zero in all samples and only two patients showed preserved pain on the placebo side.

There are some articles that support the current study's final results. They conclude that LLLT can be effective for pain relief in canine reduction and that despite differences in the wavelengths and types of lasers used in these studies, no technical errors were observed [19,25,35]. Although a few studies have concluded that lasers are not effective in pain reduction, no technical mistakes were observed in these studies either [16,33], except one that utilized dosages above the acceptable range [29]. However, none of these studies mentioned that patients with no pain were excluded from the study. Perhaps the presence of a large number of such patients, like in the preliminary results of this study, interfered with the conclusions.

Another point to be found in all canine retraction studies, except for the current study and the study by Soubuti et al. [19], is that the main purpose of the studies was to evaluate the effect of LLLT irradiation on orthodontic movement and assessment of pain was a secondary objective. As a result, pain evaluation may have been somewhat deprioritized in these studies; therefore, further studies are needed to obtain definite findings, and these studies should consider the following points:

1. Use of a wavelength between 600 and 800nm. According to the Soubuti et al [19] study and the present study, laser at this wavelength may be effective, but more studies are needed to confirm this result.
2. Performing data analysis without the data for patients who did not experience pain.
3. Applying the laser on the canine and the first molar on the experimental side.

Conclusion

According to this study, the 660nm diode can be effective in patients experiencing pain from canine retraction. It can also reduce the number of days for which the patient experienced pain.

Conflict of Interest

There is no conflict of interest to declare.

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