Effects of low intensity laser on pain sensitivity during orthodontic movement

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Abstract

Objective: To evaluate the efficiency of infrared diode laser on pain reduction during canine initial retraction. **Methods:** Twelve patients in need of canine retraction were selected. The canines were retracted with closed NiTi coil springs activated to 150 g per side. One canine of each patient was randomly selected for laser irradiation immediately after activation and after 3 and 7 days. The contralateral canines were taken as control group and were submitted only to simulation of laser application. Diode laser (ArGaAl) was employed at wavelength of 780 nm, power of 20 mW and energy density in the target tissue of 5 J/cm^2, for 10 seconds per point, delivering an energy of 0.2 J per point and total energy (TE) of 2 J. The analgesic effect was evaluated with aid of a visual analogue scale (VAS), on which the patients indicated 0 to 10 according to the pain experienced at 12, 24, 48 and 72 hours after coil spring activation and laser application. The procedure was repeated after one month, upon reactivation of canine retraction. **Results and Conclusions:** There was no statistically significant difference between irradiated side (LG) and control side (CG). Thus, utilization of infrared diode laser (780 nm) according to the present protocol was not statistically effective to reduce pain sensitivity caused by orthodontic movement.

Keywords: Diode laser. Low intensity laser. Orthodontic movement. Pain.

INTRODUCTION AND LITERATURE REVIEW

In clinical practice, there is almost a consensus that therapy with low level laser (LLL) or laser therapy (LT) causes analgesic effect.[3,10,13,15,19,24] Thus, laser could become an important aid for orthodontic treatment[6,9,13,14,20] since fear of feeling pain is one of the main factors which discourages many patients to undergo this kind of treatment.[1,4,25]

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Low level laser reduces pain through two different mechanisms: Stimulating the production of beta-endorfine, a natural mediator produced by the organism to reduce pain, and inhibiting the release of arachidonic acid, from the damaged cells, which would generate metabolites that interact with the pain receptors. While arachidonic acid produces local effect, beta-endorfine produces analgesic effect throughout the body.[17,18] Another type of laser action on the mechanisms for suppressing pain, consists in the repression of the conduction of nervous impulses, at the peripheral nerve endings, acting upon the mechanism of "sodium-potassium pump", in order to impair the transmission of local painful impulse.[12]

Other mechanisms of pain suppression by the employment of laser therapy have been reported in the literature, as consequence of the enhancement of endorphin synthesis, demonstrated by Benedicenti in 1982 (apud Genovese[8]), or even the inhibition of prostraglandines E_2 (PG-E_2) and interleukine 1-β (IL-1β),[23] well-known pain mediators, produced during the inflammatory process. Ataka[2] observed a decrease of nociceptive transmitters, such as bradykinin and serotonin, after low level laser irradiation. The nociceptors are the receptors present on the nervous terminals, free nerve endings of primary afferent neuron axon (thin mielinic A-delta fibers and amielinic C-fibers), capable to detect painful stimuli when the nociceptive transmitters are present.[16]

Some clinical research studies have also demonstrated the efficiency of laser to suppress pain.[5,11,13,22,24] Lim et al[13] in 1995, inserted elastic separators to induce pain in the interproximal contacts of premolars of 39 subjects. The diode laser (ALGaAs), 830 nm, 30 mW, 59.7 mw/cm², was applied on the middle third of the dental root and the subjects were divided into four groups: Three of them in accordance to the different periods of laser application (15, 30 and 60 seconds) and one group with placebo laser therapy for 30 seconds. The procedure was performed during five days and a scale was employed to quantify the pain experimented in each quadrant (Visual Analogue Scale –VAS). The authors concluded that the group treated with laser, demonstrated lower levels of pain, when compared to the placebo group, suggesting that low level laser reduces the intensity of pain caused by orthodontic movement.

Turhani et al[23] evaluated the effect of diode laser (670 nm; 75 mW; 30 seconds per tooth) in 38 patients undergoing orthodontic treatment, with fixed appliances. The laser was immediately applied over the middle third of the teeth and also after 6, 30, and 54 hours after insertion of the orthodontic arches. A control group received placebo laser therapy only. The results showed lower levels of pain for the group that received laser irradiation until 30 hours after the orthodontic activation. The authors concluded that laser therapy may have positive effects suppressing pain during orthodontic treatment.

Recently, Fujiyama et al[7] showed that the use of CO_2 laser seems to be efficient to control inhibitory effects on analgesia during the four first days, after force application, without interference on the amount of orthodontic movement, when 20 pulses of 2 W, 5 pulses per 1000 seconds, were applied at 2 mm focus.

It appears that there are still few studies which investigated the effects of low level laser for suppressing pain in orthodontics, and the protocols for laser application are still very variable. Thus, the purpose of this study was to evaluate the efficiency of diode laser, which presented wavelength at the infra-red spectrum (λ=780 nm, power output of 20 mW, with energy density 5 J/cm², 0,2 J of energy per point, 2 J total energy, submitted to orthodontic retraction, aiming to verify pain reduction during orthodontic movement.

MATERIAL AND METHODS

Material

A total of 12 patients were selected, from the Postgraduation in Orthodontics of the Brazilian Association of Dental Surgeons (ABCD, São Paulo, Brazil), with mean age of 12.66 years. The inclusion criteria were:

» need of extraction of first premolars, due to double protrusion or dental crowding;
» presence of permanent dentition;
» absence of systemic diseases;
» no use of any medication and no previous orthodontic treatment.

The diode laser (Twin Laser, MMOptics, São Paulo, Brazil) was employed to irradiate maxillary and mandibular canines, submitted to orthodontic retraction, and the painful sensitivity decurrent from this orthodontic movement was evaluated by a visual scale (Visual Analogue Scale – VAS).[13]

This protocol was approved by the Research Ethics Committee at the São Paulo Methodist University, protocol nº 105303/06.

Methods

Orthodontic treatment

Metallic brackets, Andrews prescription, 0.022 x 0.028-in slot (Ormco Corp. Orange, CA, USA), were installed on canines and second premolars, while the first molars were properly banded. Bilaterally, segmented stainless steel 0.016-in archwires were adapted to each side of the dental arch, in conjunction with a closed nickel-titanium spring (12 mm in length, Morelli Ltda, Brazil) for the initial retraction of the canines (right and left). The intensity of the force released by the spring was measured by a dynamometer (Morelli Ltda), delivering force of 150 g.

Laser irradiation and evaluation of pain sensitivity

After the activation of the spring, only one of the canines (left or right) of each patient was selected at random for application of diode laser Aluminum-Gallium-Arsenide (ArGaAl), low intensity, wavelength in the infra-red spectrum. For the canines on the opposite side, only one simulation was performed for laser application. The irradiated side was considered as laser group (LG) and the non irradiated side, as control group (CG).

The diode laser (Twin Laser, MMOptics, São Carlos, Brazil), with light emission at 780 nm wavelength, power output 20 mW, energy density on the surface tissue at 5 J/cm^2, was employed for 10 seconds per point, resulting in 0,2 J of energy per point. As 10 points per tooth (5 bucally and 5 lingually) received irradiation (Fig 1), the total energy (TE) surrounding canine roots was 2 J. The irradiations were performed by one operator, per points, employing light beam focused perpendicularly and in contact with the mucosa, which was kept clean and dry, through relative isolation.

Laser irradiation was performed immediately after the closed NiTi coil spring was activated (day 0), 3 and 7 days after the first application, resulting in 6 J/month of energy. The evaluation of the analgesic effect of laser irradiation was performed by the employment of a visual scale (Visual Analogue Scale – VAS)[13] provided

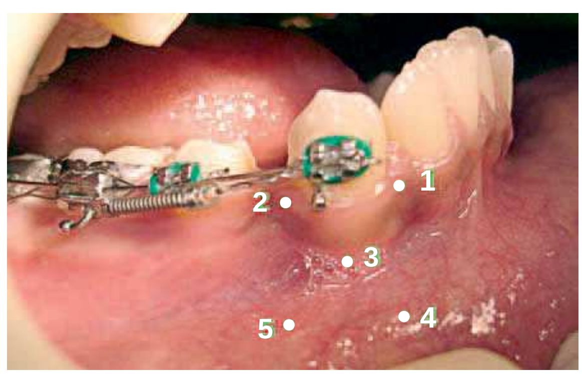

FIGURE 1 - Points for laser application at the buccal surface: 1) mesiobuccal gingival ridge; 2) distobuccal gingival ridge; 3) buccal central point - central in relation to the other points; 4) bottom of oral vestibule, at the same vertical direction of point 1, and at the level of the root apex; 5) Bottom of oral vestibule, at the same vertical direction of point 2, and at the level of the root apex. The same points were selected for lingual application, totalizing 10 points.

to each patient (Fig 2). According to this scale, the patient was oriented to mark from 0 to 10, according to the intensity of pain experimented, differentiating the left and right sides, after 12 (T1), 24 (T2), 48 (T3) and 72 (T4) hours of laser irradiation.

After 30 days, the patients were submitted to a new activation of the closed springs, in order to keep the force exertion at 150 g/side, previously established. A new laser irradiation, following the same protocol, was performed on the same tooth which had been already irradiated, and one more time, the sensitivity was evaluated on the four periods described, employing the same scale. The outcomes were computed into an Excel table, for statistical analysis.

Statistical analysis

For comparison between the "irradiated" and "non-irradiated" sides, over several periods of evaluation, the parametric Wilcoxon test was employed ($p<0.05$).

RESULTS

Tables 1 and 2 show the outcomes obtained on the first and second months, respectively, in the four evaluated moments (T1=12 h, T2=24 h, T3=48 h and T4=72 h) after laser application on the irradiated and non-irradiated sides.

The results presented on the first and on the second months, demonstrated that there is no statistically significant difference between the irradiated and control sides, that is, the irradiation employing infra-red diode laser (780 nm) with the application protocol of 20 mW-10 sec-5J/cm², 0,2 J per point, Et=2 J, was not statistically significant for the reduction of sensitivity to pain, caused by orthodontic movement during the initial retraction of canines.

DISCUSSION

In the literature, it is clear that almost all patients submitted to fixed orthodontic treatment suffer some type of discomfort, considering the separation of teeth for posterior orthodontic banding or during the arch insertion, reaching

EVALUATION OF PAIN AFTER SPRING ACTIVATION
One form for each arch- mark X for the level of pain
Name:______________________________
Date of irradiation: ____/____/___

right side — 12 hours after — left side

0	1	2	3	4	5	6	7	8	9	10		0	1	2	3	4	5	6	7	8	9	10

right side — 1 day after (24 hours) — left side

0	1	2	3	4	5	6	7	8	9	10		0	1	2	3	4	5	6	7	8	9	10

right side — 2 days after (48 hours) — left side

0	1	2	3	4	5	6	7	8	9	10		0	1	2	3	4	5	6	7	8	9	10

right side — 3 days after (72 hours) — left side

0	1	2	3	4	5	6	7	8	9	10		0	1	2	3	4	5	6	7	8	9	10

FIGURE 2 - Visual Analogue Scale (VAS).

TABLE 1 - Outcomes obtained on the first month, during the four moments (T1=12 h, T2=24 h, T3=48 h and T4=72 h) after laser application on the irradiated and non-irradiated sides.

Time	Side	mean	median	1st quartile	3rd quartile	P
12 h	LG	3.8	3.5	2.0	4.5	0.173 ns
	CG	4.2	4.0	2.5	5.0	
24 h	LG	4.0	4.0	1.0	7.0	0.624 ns
	CG	3.9	3.5	1.5	5.5	
48 h	LG	1.9	2.0	0.5	3.0	1.000 ns
	CG	1.8	1.0	0.5	3.0	
72 h	LG	0.3	0.0	0.0	0.0	1.000 ns
	CG	0.3	0.0	0.0	0.0	

ns – not statistically significant.

TABLE 2 - Comparison of the values obtained, referring to pain intensity, between the sides irradiated and control, on the second month of treatment (Wilcoxon test).

Time	Side	mean	median	1st quartile	3rd quartile	P
12 h	LG	3.5	3.5	1.0	4.0	0.787 ns
	CG	3.8	3.5	1.0	7.0	
24 h	LG	3.2	3.0	1.0	4.0	0.109 ns
	CG	3.6	4.0	1.0	5.0	
48 h	LG	1.9	1.5	1.0	3.0	0.789 ns
	CG	1.8	1.0	1.0	2.0	
72 h	LG	0.8	0.5	0.0	1.0	1.000 ns
	CG	0.6	0.5	0.0	1.0	

ns – not statistically significant.

levels of pain which may also discourage them to continue the treatment, or even giving up at the beginning of the process.[13,24,25]

The perception of pain varies considerably from patient to patient.[20] Thus, pain is a highly subjective sensation and due to this fact, it becomes very difficult to quantify it in scientific researches.[13,20,24]

The Visual Analogue Scale (VAS) was proposed by Huskisson in 1974 in order to quantify pain.[20] It is a 10 cm line which comprehends a scale from 0 to 10 representing the thresholds of pain experimented, so that 0 represents absence of pain and 10 intense pain. For employing it, the patients are oriented to mark on the line the site correspondent to the intensity of pain experimented by them.[20]

The VAS has been employed by several authors[13,20] who affirm that this method is reliable, safe and easy to comprehend. Although being a subjective method, it is also employed with five-year-old children, who get used to it very easily.[20] Due to this fact, the VAS was adopted to quantify pain in the present study. In order to facilitate the measurement of pain sensitivity, the line was substituted by a scale[13,20] where the patients should mark an "X" on the score from 0 to 10 according to Figure 2.

The patients were oriented to mark the pain at 12, 24, 48 and 72 hours after the orthodontic activation, either on the right and left sides, and to prevent bias on the outcomes, one laser irradiation was simulated on the contra-lateral side (placebo).

Normally, pain during orthodontic treatment is noticeable, mainly on the first three days, reaching its maximum level in 24 hours, and decreasing after the third day of activation.[20,22,24] These data are according with the present study, and a higher average of pain can be observed on the periods of 12 and 24 hours after orthodontic activation, decreasing considerably after 48 and 72 hours of orthodontic activation.

Due to discomfort caused by pain during orthodontic treatment, several ways of minimizing it were proposed in the literature. The main way consists on the employment of analgesic and anti-inflamatory medication. However, studies have shown, that, besides the side effects inherent to medicine, dental movement may be inhibited by the administration of non-steroidal anti-inflammatory drugs.[1,4,13] Thus, laser therapy has been subject of many speculations concerning pain inhibition, because there are few contra indications and no side effects.[3,10,19]

Researchers and clinicians who employ this resource during daily practice, confirm that laser therapy inhibits pain, totally or partially.[5,8,10,13,17,18,20] Nevertheless in the literature the application protocols still generate some controversy, because different dosimetry can be found for the same procedure. In orthodontics, for pain treatment, employing laser Aluminum-Gallium-Arsenide diode laser, Neves et al[19] suggested energy density of 2 J/cm^2 on the root tip and three points along the axis of the root with energy density of 1 J/cm^2, applying frequency of application once or twice a week. Genovese[8] indicated the application of 4 J/cm^2 on the upper teeth and 5 J/cm^2 for the lower teeth, in two or three points, following the long axis of the roots.

In order to compare laser application protocols, energy density is not enough, it would be necessary that authors provided other data, such as the application time, power output and point size of the laser equipment employed (in case of application by points and by contact) and the number of irradiated points, so that the energy per point of application may be calculated and outcomes compared.

In the orthodontic literature the recommendation of high doses of laser for pain treatment can be observed after the activation of orthodontic/orthopedic appliances and the infra-red is the most indicated wavelength. For example, Lizzareli[15] in 2007, suggested a dose of 35 J/cm^2 or 1,4 J per point (79 mW and 20 seconds) in three points along the axis of the tooth buccally: a cervical point, a point in the center of the root and another at the apex of the root. With this protocol, there would be a total dose of energy of 4,2 J per tooth.[15]

However, Lim et al[13] found effective outcomes, employing infra-red wavelength, power output 30 mW, power density 59,7 mW/cm^2, in three distinct periods: 15, 30 and 60 seconds, providing energy per point corresponding to 0.45 J, 0.9 J and 1.8 J, respectively. As only one point was irradiated, the total energy per tooth would be equal to the energy per point, that is, much inferior to the protocol applied by Lizzarelli,[15] 4.2 J per tooth.

Turhani et al[23] observed satisfactory outcomes for analgesy during orthodontic treatment, with higher dosimetry. During the study, they employed 670 nm wavelength, power output 75 mW, power density 14 mW/cm^2 for 30 seconds. Thus, when energy was calculated per point, value 2.25 J was obtained for each tooth. Since one point was irradiated in the middle third of the root of all the teeth involved in the orthodontic mechanism, there would be a total of energy per dental arch of 27 J. Probably the positive effects towards analgesy obtained from this study were due to the sommatization of the irradiation effects throughout the dental arch innervations.

The present study employed infra-red wavelength, power output 20 mW, energy density 5 J/cm^2, 0.2 J per point, which are very similar values to the successfully employed by Lim et al[13] and by Turhani et al.[23] However, the outcomes obtained from the present study, demonstrated that there is no statistically significant difference between the data for irradiated and non-irradiated (placebo) teeth. This is probably due to the differences concerning the amount of applications. In the study of Turhani et al[23] the application was done throughout the dental arch, thus, the total energy accumulated was much higher than the present study. Besides that, in the study of Lim et al[13] although the energy per point is inferior than that applied in this study, the irradiation was done right after the insertion of the elastic separators, 1 day after and sequentially for three more days, that is, a total of five applications, so the total accumulated energy was higher than in the present study. Probably, these factors have influenced directly on the positive outcomes achieved by these authors, that is, a higher total laser dosimetry. This corroborates with the outcomes of Lizarelli,[15] who employed successfully higher dosimetry (total energy) when employing laser.

This protocol was selected for the fact observed in the literature, that low intensity laser in accordance with this dosimetry (780 nm / 20 mW / 5 J/cm^2 / 0.2 J per point / ET=2.0 J) promotes an enhancement on the dental movement speed in patients with fixed orthodontic appliance.[6,9] Due to this fact, a lower dosimetry was used to evaluate if a dosimetry indicated to get faster orthodontic movement would be able to decrease the pain sensibility. Nonetheless, due to the outcomes obtained, it is possible to suggest that, clinically it will be necessary to choose between a faster treatment applying lower dosimetry, or a treatment not so painful applying laser in higher dosimetry.

It is true that the ideal solution would be the employment of a dose capable of enhancing the speed of dental movement and to reduce pain sensitivity. Additional studies are necessary to achieve the ideal dosimetry for laser application, in order to establish a faster and less painful orthodontic treatment.

CONCLUSION

Based on the outcomes, it was concluded that laser diode irradiation (ArGaAl) 780 nm wavelength, power output 20 mW, energy density 5 J/cm^2, 0.2 J per point and total energy 2 J per tooth, was not enough to decrease pain, due to orthodontic movement. Thus, additional studies are necessary in order to check the best application protocol.

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