

Effect Of Erbium Laser On Pain Experience Following Separation Of Teeth For Orthodontic Treatment - A Split Mouth Prospective Pilot Study

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Abstract

Aim :The aim of the present study was to evaluate the effect of the Er ;YSGG laser on pain experience following separation of teeth for orthodontic procedures.

Materials and methods : This split mouth pilot prospective study involved a total of 10 patients in whom separation of permanent lower first molars was performed with elastomeric separators. In Group 1(experimental side) the teeth were subjected to laser exposure and group 2 (control)- no laser exposure. Subjective pain experience at 0,1,2,3,4,and 5 days was recorded using Visual analogue scale. Descriptive statistics, Independent sample t tests were used to compare the mean pain levels between the groups.

Results : In both groups, the intragroup association revealed a significant reduction in pain over 7 days (P value <0.05). For the first three days, the results of an independent t test comparing two separate groups were statistically insignificant, but from day four to day seven, the results were statistically significant, where p value <0.05.

Conclusion : Spontaneous pain was significantly reduced with a single dose of Er,Cr :Ysgg laser, at 0.25W power which has an effect on reducing separator pain in orthodontic patients.

Keywords : Er,Cr:YSGG - Erbium chromium-doped yttrium scandium gallium and garnet, separators, laser, photobiomodulation.

Introduction

The procedure of banding the molars necessitates sufficient separation in order to allow band positioning without causing periodontal damage. E.H.Angle was the first to attempt tooth separation using brass wire [1]. Various methods for tooth separation have been used in modern day Orthodontic practice, including brass wire, elastic ring separators, Kesling separators, C separators, dumbbell shaped separators, NiTi spring separators, Kansal separators, and so on[2].

Separator placement creates strain, tension, soreness, and discomfort, all of which can negatively impact a patient's attitude toward future orthodontic procedures[3,4]. According to randomized control trials by Ngan et al,[5,6] the discomfort associated with separator placement normally begins within 4 hours of insertion and peaks over the next 24 hours and then gradually falls within 7 days to the pre-placement levels and 40%

Orthodontic pain is the result of an inflammatory response that results in changes in blood flow after orthodontic force is applied [7]. According to Smith and Burstone [8] , an immediate painful response is due to compression and delayed painful response is due to hyperalgesia of the periodontal ligament (PDL) after orthodontic force application. Prostaglandins (PGEs) which make the PDL responsive to released hormones including histamine, bradykinin, PGEs, serotonin, and substance P, have been linked to hyperalgesia[9,10]. The Visual Analogue Scale (VAS) is a subjective tool for pain assessment that has been widely used in numerous studies for pain severity assessment[11–13]. The use of questionnaires to measure patient distress, on the other hand, is an objective approach for assessing separator-associated pain.

The methods for pain control included use of non-steroidal anti-inflammatory drugs (NSAIDs), anesthetic gel, bite wafers, transcutaneous electrical nerve stimulation, low-level laser use, and vibratory stimulation[14–16]. Research on laser application in dentistry has been reported for acceleration of tooth movement, enamel etching prior to bonding, debonding of ceramic braces, pain relief after orthodontic force, and prevention of enamel demineralization, improving primary stability of recently placed mini implants. Extensive literature has reported on the use of lasers for reducing pain in dental practice [20]. Erbium have been used in orthodontic setup for alleviating pain caused due to various orthodontic procedures [17]. Yilmaz et al[21] investigated the efficacy of Er,Cr:YSGG laser irradiation on pain reduction and healing rate of recurrent aphthous stomatitis. They concluded that use of the laser reduces pain and accelerates healing. The aim of the present study was to evaluate the effect of the Er, YSGG laser on pain caused by orthodontic procedures.

Materials and methods

This split mouth prospective pilot study was conducted at the Department of Orthodontics, Saveetha Dental College, SIMATS, in Chennai. Ethical approval was obtained from the institutional review board, (IHEC Ref NO: [REDACTED]). A Total sample size of 20 patients were involved in this study (12 females, 8 males ; 25±5 years).

Inclusion criteria : Subjects indicated for fixed orthodontic treatment with full set of dentition, periodontally healthy non-carious full complement of teeth with good interproximal contacts were included in the study. Exclusion criteria: Subjects with multiple restorations, decayed teeth missing teeth, or interdental spacing were excluded in the study.

The process of laser application was explained to the patients orally, and obtained the informed consent structure for ensuring patients cooperation. Elastomeric separators (3M Unitek, Monrovia, Calif.) were placed in each patient using dental floss and separator placing pliers, Interproximally around the permanent first molars (both mesially and distally) on both sides of lower quadrants. The two treatment groups were divided into experimental (right side) as group 1 and control as placebo (left side) as group 2 in the lower arch of each patient's mouth.

Figure 1 : laser application following separator placement.



In the intervention side on day 1 after 6 hours of separator placement, Er,Cr:YSGG laser (Waterlase MD, Biolase, Irvine, CA, USA) on hard tissue mode using a mg6 sapphire tip (600 µm diameter, 6 mm length) at an energy level of 0.25 W with a repetition rate of 20 kHz, pulse duration of 140 µs without water and 10% air at 5 J/cm² energy density with non-contact mode. For 10 seconds each, the laser was applied buccally and lingually to three focuses: mesial, distal, and centre of the base of the mandibular first molar.

The tip of laser's usage is almost opposite the gingival tissue in near contact about to the centre of the root as shown in figure 1. We made certain that the discharged light from the intervention side did not affect the control side by directing it more towards the gingival tissue. In the control group, the placebo treatment hand, the laser was kept in the same position and for the same amount of time, but it was not turned on. The primary investigator and patient were all wearing protective glasses, and the methodology was carried out in a small space which is represented in figure 2.

Every patient was given a questionnaire that included a numeric rating with visual analogue scale and asked them to report their pain on a daily basis for seven days. Analgesics were not advised and data from the patients who had used analgesics were not considered in final statistics. Reminder phone calls were made to all patients asking them to score their pain response on the given sheets. 7 separate sheets depicting the VAS scale were given to the patients on day one and they were asked to score or experience pain once in a day for seven days. On the 8th day all patients were recalled and the response sheets were collected from them and referred for further orthodontic treatment.

The statistician not involved in the study tabulated the data from the forms and performed the statistical analysis.

Figure 3 : visual analogue scale for pain assessment for the patient.

PAIN ASSESSMENT

Name :

Age/Sex :

Day 1: Rate your pain score



Statistical analysis

IBM SPSS software statistics 23 , was used to analyze the data (version 23.0; IBM). The variations in pain levels during the week were evaluated using Visual analogue scale. Independent sample t tests were used to compare the mean pain scores between the experimental and placebo groups. The statistical researcher was also blinded without knowing the experimental group.

Result :

A total of Ten patients (females and males) were enrolled in the study and their mean age was 25 ± 5 years. On severe pain seen by the patients for each of the 7 days, there was a significant difference ($P<0.05$) between the experimental side and control side. In the placebo treatment group, the most severe level of uneasiness was linked to biting pain. Although Er:YSGG reduced pain perception while biting in the erbium group, it was still more prevalent than unrestricted pain in that group. The patients experienced the most severe pain 24 hours after the separators were placed, and it gradually decreased on the third day in almost all groups; however, the unrestrained pain in the placebo group decreased much more steadily. Even on day 7, some pain was still present when putting it together, as seen in table 1. In both groups, the intragroup association revealed a significant reduction in pain over 7 days (P value <0.05).

Table 1 : Described statistics for the experimental group and control group

Time	Group	N	Mean \pm SD	Mean df	Sig. (P value)
Day 1	Group 1	10	2.80 \pm 0.789	-4.30	0.93
	Group 2	10	7.10 \pm 0.738		
Day 2	Group 1	10	1.70 \pm 0.823	-4.60	0.75
	Group 2	10	6.30 \pm 0.675		
Day 3	Group 1	10	0.30 \pm 0.483	-5.10	0.39
	Group 2	10	5.40 \pm 0.516		
Day 4	Group 1	10	0.00	-3.90	0.02
	Group 2	10	3.90 \pm 0.738		
Day 5	Group 1	10	0.00	-2.0	0.02
	Group 2	10	2.00 \pm 0.816		

Day 6	Group 1	10	0.00	-0.50	0.01
	Group 2	10	0.50±0.527		
Day 7	Group 1	10	0.00	0.10	0.01
	Group 2	10	0.10±0.211		

Table 1 : For the first three days, the results of an independent t test comparing two separate groups were statistically insignificant, but from day four to day seven, the results were statistically significant, **where p value <0.05.**

Figure 1 : Bar graph representation of pain perception in experimental side and control side, according to time interval.

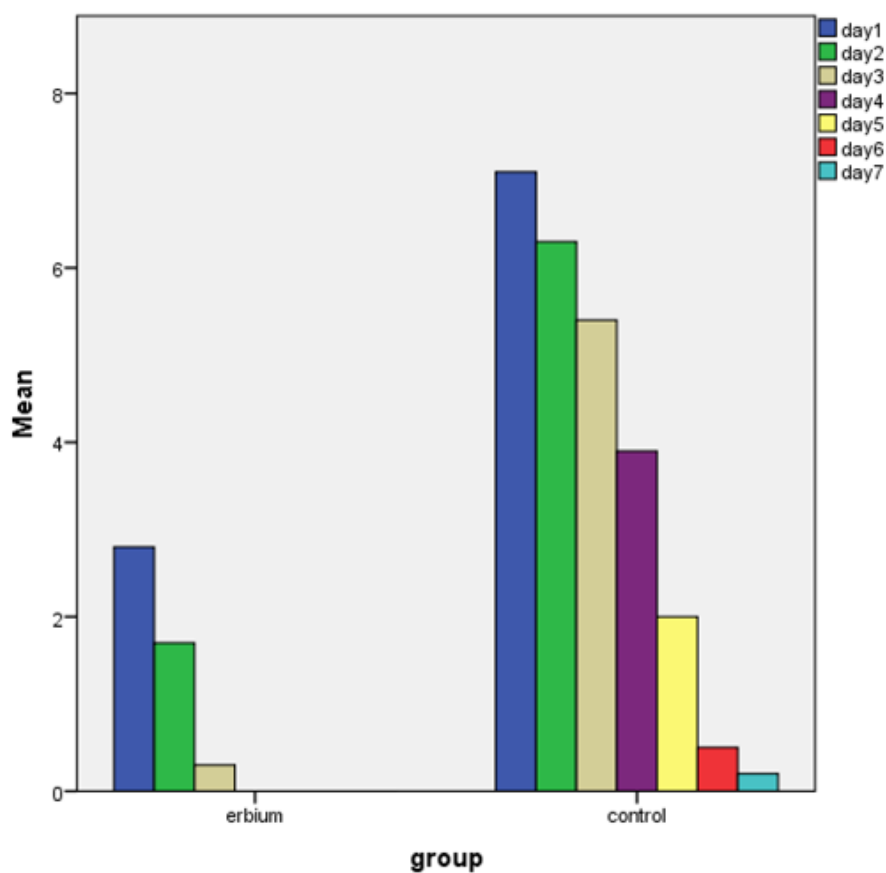


Figure 1: A bar graph representing the frequency distribution of pain perception with the experimental (erbium) and placebo (control) sides, demonstrating that by day 4 (purple), the experimental (erbium) side has registered no pain, while the control group experienced a gradual decrease until day 7 (cyan), with some participants experiencing moderate pain on that day.

Discussion

The effect of a single application of Er,Cr:YSGG on postoperative pain (spontaneous and chewing) associated with the positioning of orthodontic separators was investigated in the current study. According to the result from our study, the pain has mildly decreased by day 3 in the experimental group, and the pain has almost vanished by day 7 in the placebo group. There was a substantial difference in pain levels between the Erbium Group and the placebo groups ($P < 0.05$), indicating that Er,Cr:YSGG has an analgesic effect on orthodontic pain.

The use of Er,Cr:YSGG lasers has recently benefited oral surgery, preventive dentistry, periodontics, and endodontics [22–28]. In addition, orthodontics has become more common in recent years [29].

In our research, the Er,Cr:YSGG laser was used in pulse mode with a power setting of 0.25W for 10 secs on three points on both the buccal and lingual sides, as most LLLT (low level laser therapy) studies used the applications [30–33].

In comparison to other studies that used a visual analogue scale alone, this study preferred numerics with visual analogue rating scale [30,31,33]. This was due to the fact that the numeric rating system was a more convenient way to obtain the data and telephone calls were also being used to ensure that patients had accurate information. Pain perception is influenced by age, gender, and pain threshold. As a result, the split-mouth design was used to minimize individual variability [9,34–36]. Records obtained from patients show their highest levels of pain was recorded at 24 hours after separator placement in both the placebo and experimental groups. This is consistent with previous research, that after 24 hours of orthodontic force application found that the peak level of prostaglandins which has coincided with the peak level [9,31,33,37]. The pain in the control group, which showed a more steady decline in pain intensity on day 3 after the operation, and the severity of pain in the Experimental (Er,Cr:YSGG) group showed a remarkable decrease in severity on day 3 after the procedure. On day 4, the placebo group experienced a decrease in pain intensity. Nobrega et al [38] also studied laser therapy effects on spontaneous and biting pain, and reported a smoother curve in the spontaneous pain in the LLLT group, indicating gradual changes in pain scores, unlike the placebo group. Because of forces acting on separators in close interproximal contact, the placebo sides had the highest pain intensity. In our study analysis, this was not clearly tested. Pain was present in the placebo group even on day 7, but it was substantially lower in the Experimental (Er,Cr:YSGG) group. This was in contrast to the results of Nobrega et al [38][33] and Kim et al ([33]), who found no substantial differences in visual analogue pain scores on day 5 in their samples between the placebo and LLLT groups.

This study used a type IV laser that emits infrared radiation with a wavelength of 2790 nm. Because of the necessary depth of penetration into the soft tissues, this spectrum was chosen. These lasers absorb very well in water and hydroxyapatite crystals, altering their crystalline form. Some visible-spectrum lasers may have shown more superficial effects [31,38]. Due to the laser's penetration and thermogenesis, the Er,Cr:YSGG laser formed a relatively thin coagulation layer on the lesion surface. The underlying tissues can become desensitized as a result of the coagulation layer. It was also discovered that the sterilizing effects of reactive oxygen species produced by erbium lasers in irradiated tissue. This effect can stimulate fibroblasts, collagen, and extracellular matrix formation [39,40]. Since bacteria have the ability to decrease pain thresholds at injured tissues due to increased inflammatory mediator synthesis and infection, the strong bactericidal potential of Er,Cr:YSGG laser [41] should also be considered. It is also noteworthy that the Er,Cr:YSGG laser has an effect on the TRPV1 (transient receptor potential) neural receptor that is stimulated by heat [42]. This effect may be another possible mechanism of reduction with the use of the Er,Cr:YSGG laser since thermal-sensitive TRPs in nerves may act as pain sensors as reported.

Kurtulmus-Yilmaz et al. [24] tested the effectiveness of the Er,Cr:YSGG laser on pain relief and the healing process of traumatic ulcerations (TU) in 30 patients over a 2-week span. According to them, laser irradiation offered immediate pain relief as well as a major healing effect after treatment. According to the findings of this randomized controlled clinical trial, it is possible that using an Er,Cr:YSGG laser with 0% water at 0.25W to relieve pain is acceptable [21].

In line with these findings, Er,Cr:YSGG laser therapy demonstrated substantial pain relief immediately after treatment as compared to the control group in the current study. As this is a pilot study, inclusion of larger sample size and further comparison with other laser groups can be done for future scope.

Conclusion

A single application of Er,Cr:YSGG with a 2790-nm wavelength can reduce orthodontic pain associated with the placement of separators. Spontaneous pain was significantly reduced with a single dose of Er,Cr :Ysgg laser.

Er,Cr:YSGG laser at 0.25W power has an effect on reducing separator pain in orthodontic patients.

Conflict of interest statement:

We have no conflict of interest to disclose in the article.

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Author contribution:

Data collection , tabulation, result formulation , manuscript writing was done by principle investigator. (Dr.PVN)

Manuscript verification , proofreading and result verification was done by a second investigator. (Dr.SRL)

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