COMPARATIVE EVALUATION OF TWO DIFFERENT LOW LEVEL ENERGY LASER WAVELENGTHS ON THE RATE OF ORTHODONTIC TOOTH MOVEMENT: A SPLIT MOUTH DESIGN STUDY

Dr. Fulari Sangamesh G[1*], Dr. Manglekar Sachin[2], Dr. Agrawal Jiwanasha[3], Dr. Shetti Shraddha[4], Dr. Nanjannawar Lalita[5], Dr. Fulari Deepti S[6], Dr. Shirkande Amol[7]

Article History: Received: 20.05.2023 **Revised:** 29.06.2023 **Accepted: 0**1.08.2023

Abstract

Introduction: Orthodontics nowadays has been progressing greatly in achieving the desired results both clinically and technically through new technologies and methods to accelerate teeth movement and decrease pain. Among various methods, low-level laser therapy was found to be effective by inducing the remodeling process.
Aim and objective: To compare and evaluate the effect 810nm and 980nm diode laser on the rate of individual canine retraction
Materials and method: A sample of 14 patients involved a split-mouth design study having a laser group and a control group. All cases were aligned till 19*25 ss wire followed by the first premolar extraction**.** Laser irradiations were given on day 1, 21,42,63**.** A digital vernier caliper was used to measure the linear distance between the contact point of canine (Distal) and second premolar (Mesial), on Day 1 and day 84 of the study models by a single operator.
Result: Significant space reduction was observed from day 1 to day 84 mean difference of 3.35 and 2.28 mm for 810nm and 980nm groups respectively. The laser group 810nm showed a greater reduction than the 980nm diode laser group on day 84 in the laser group.
Conclusion: The use of 810nm and 980nm diode laser effectively help in accelerating the orthodontic tooth movement, thereby reducing treatment time. However, 810nm showed greater reduction than 980nm diode laser

Keywords: Orthodontic Tooth Movement, Low-Level Laser Irradiation, Canine Retraction.

[1*]MDS- Orthodontics and Dentofacial Orthopedics Associate Professor, Department of Orthodontics and Dentofacial Orthopedics Bharati Vidyapeeth (Deemed to be University) Dental College & Hospital. Sangli. INDIA
Email: [1*]sangamesh.fulari@bharatividyapeeth.edu
ORCID ID: [1*]0000-0002-0773-0546
[2]MDS- Periodontics Professor & HOD, Department of Periodontics Bharati Vidyapeeth (Deemed to be University) Dental College & Hospital. Sangli. INDIA
Email: [2]sachin.mangalekar@bharatividyapeeth.edu
[3]MDS- Orthodontics and Dentofacial Orthopedics Professor & HOD, Department of Orthodontics and Dentofacial Orthopedics Bharati Vidyapeeth (Deemed to be University) Dental College & Hospital. Sangli. INDIA
Email: [3]jiwanasha.agrawal@bharatividyapeeth.edu
[4]MDS- Orthodontics and Dentofacial Orthopedics Assistant Professor, Department of Orthodontics and Dentofacial Orthopedics Bharati Vidyapeeth (Deemed to be University) Dental College & Hospital. Sangli. INDIA

Email: [4]shraddha.shetti@bharatividyapeeth.edu
[5]MDS- Orthodontics and Dentofacial Orthopedics Associate Professor, Department of Orthodontics and Dentofacial Orthopedics Bharati Vidyapeeth (Deemed to be University) Dental College & Hospital. Sangli. INDIA
Email: [5]lalita.nanjannawar@bharatividyapeeth.edu
[6]MDS- Prosthodontics Associate Professor, Department of Prosthodontics Bharati Vidyapeeth (Deemed to be University) Dental College & Hospital. Sangli. INDIA
Email: [6]deepti.fulari@bharatividyapeeth.edu
[7]MDS- Orthodontics and Dentofacial Orthopedics Assistant Professor, Department of Orthodontics and Dentofacial Orthopedics Bharati Vidyapeeth (Deemed to be University) Dental College & Hospital. Sangli. INDIA
Email: [7]amol.shirkande@bharatividyapeeth.edu

[*]Corresponding Author
Dr. Fulari sangamesh G[1*]
[1*]Associate Professor, Department of Orthodontics and Dentofacial Orthopedics Bharati Vidyapeeth (Deemed to be University) Dental College & Hospital. Sangli. INDIA Wanlesswadi, Sangli – Miraj road. Sangli 416414 Maharashtra. India
Email: [1*]sangamesh.fulari@bharatividyapeeth.edu
ORCID ID: [1*]0000-0002-0773-0546

DOI: 10.31838/ecb/2023.12.s3.716

1. INTRODUCTION

The Orthodontic tooth movement revolves around bone remodelling process, alteration of the surrounding tissue, especially periodontal tissues under the influence of applied mechanical force to aid tooth movement.[1,2] Tooth movement within biological limit can move upto 0.5 to 0.75 mm per month. A treatment plan that if includes extraction, mainly premolars, the treatment duration can prolong and causing much non-cooperation from the patients. Such longer duration treatment time is correlated to the problems of periodontal disease, discomfort, pain, external apical root resorption, suboptimal oral hygiene, white spot lesions, and dental caries. Shortening the treatment time can help in reducing the adverse effects that might be due to orthodontic treatment and also improve social life.[3]

Various methods have been advocated to reduce the treatment duration including pharmacological, surgical, and non-surgical. Pharmacological methods and surgical methods are not much promising because they cause undesirable side effects such as it can cause pain and discomfort at the site of injection and incision and sometimes root resorption and also alleviate pain several procedures are available non-steroidal anti-inflammatory drugs (NSAIDs) have been commonly used. However, they come with a major drawback of obstructing osteoclastic activity which reduces tooth movement rate. In addition, they can cause allergies, gastric ulcers, and bleeding disorders.[4-8]

Among them, Low-level laser therapy has been able to provide a good solution in accelerating tooth movement. Studies have proven the efficacy of Lasers at biological levels in accelerating tooth movement. However, no definite ideal parameter of lasers has been defined that yields good results. This study aims to evaluate the effect of two different commonly used Laser wavelength configuration of low-level laser therapy on orthodontic tooth movement, an option that could be used routinely in practice for accelerating tooth movement.[9-10]

2. MATERIALS AND METHOD

Ethical approval for the study was sought and granted by the medical ethical committee of the Bharati Vidyapeeth (Deemed to be University) Medical College and Hospital, Sangli, Maharashtra. In this investigation 14 patients, aged 14 to 25 years (mean 19 ± 4.21 years) from the Department of Orthodontics,

Bharati Vidyapeeth Dental College and Hospital, Sangli who came to seek orthodontic treatment were selected. Prior to the study, patients and guardians were informed about the study and written informed consent was taken.

The sample size was determined using power analysis, based on the tooth movement objective. Having 80% power, an alpha that indicates the significance level was set at 0.05, with standard deviation of 0.99 mm and considering 1 mm difference clinically meaningful. Minimum sample size was 14. Including expected dropouts and possible errors, 18 patients were recruited for the study.

The selection criteria were Angles Class II Division 1 malocclusion cases, requiring orthodontic treatment with first premolar extraction bilaterally in the maxillary arch only. Patients with mild to moderate crowding requiring extractions only for alignment were not included in the study. Patients with no systemic disease, no previous extraction of permanent teeth and not receiving medical treatment that could interfere with bone metabolism, such as NSAIDS or doxycycline, having no inflammation and obvious calculus and the bleeding on probing and plaque index less than 15 %, no periodontal disease or radiographic evidence of bone loss, no pregnancy during treatment, and have a good level of oral hygiene were included in the study. Exclusion criteria included patient unwillingness to participate in the study, inappropriate oral hygiene, multiple missing teeth, and impacted teeth other than third molars, parafunctional habits and prolonged drug consumption during treatment.

Diagnosis and treatment planning were based on standard records, including photographs, study models, lateral cephalograms, and panoramic radiographs. Orthodontic procedure was initiated with banding of permanent maxillary molars and bonding by 3M Unitek-MBT prescription with 0.022 x 0.28 slot. All the patients were given trans- palatal arch in maxillary arch for anchorage reinforcement.

All the cases followed alignment and leveling stage with 0.014-in, 0.016-in, 0.017x0.025-in, 0.019x0.025-in nickel titanium wires, with each wire kept for minimum 5 weeks. After approximately 6 months treatment duration, final working wire of 0.019x0.025-in stainless steel archwire was placed. 21 days after the working wire placement, premolar extractions were carried out. The interval of a minimum of 3 days was kept during post extraction of right and left side premolar.

Post extraction after 7 days, initial records for the study were taken. Silicone impressions taken (Day 1) and positive replicas were made by using type III dental stone.

The maxillary anteriors were consolidated followed by en-masse retraction initiated by sliding mechanics delivering 25 gms/sq.cm of force (measured using dontrix gauge), from crimpable hook to molar hook. Crimpable hooks were crimped on the main archwire 1mm distal to the lateral incisor in both quadrants. Retraction was carried using closed coil springs.

Laser Irradiation

Sides for laser irradiation were randomly selected, where One Side of the maxillary arch was subjected for Laser of 810nm (Novolase), while the other side with 980nm diode laser (ZOLAR PHOTON).

A gallium aluminum arsenide (Ga-Al-As) semiconductor diode laser equipment emitting infra-red radiation, at continuous wave mode with an output power of 100mW, a dose of 10J/sq.cm, and exposure time of 10 sec/site was used in the study. Before starting laser irradiation, protective wear was worn by patients and operators. The glasses, provided by the manufacturer, were in accordance with the European norm EN 207 and had an optical density of $5 at the wavelength of emission from the diode.

The handpiece had a cylindrical quartz tip with a 0.4 mm. The routine method of sterilization and disinfection was followed. in particular, the handpiece body and the optic tips were sterilized by cold sterilization. A total of 10 irradiations were carried out, five on the buccal and five on palatal side of anterior teeth i.e., central, lateral and canine on the experimental side. The doses Buccal/Palatal were disseminated as:

Two irradiation doses on the cervical third (one mesial and one distal)
Two irradiation doses on the apical third (one mesial and one distal).
One on the middle third (center of the root).

Laser treatment would be carried out once in three weeks; total 4 laser treatment sessions; i.e. Day 1, Day 21, Day 42, and Day 63 of the en-masse retraction phase. To prevent intraoperative variations, all irradiations were done by the same operator [Figure 1]. On Day 84, the records were taken and study models were prepared for evaluation.

Data was assessed on study models taken on Day 1 and Day 84. Using a digital vernier caliper, both sides of maxillary arch, the mesial cusp tips of the first molar and the canine were used as the reference points [figure 2].[11-12]

Statistical analysis
Paired t-test was used to analyze the data Comparison of retraction within each group :Intragroup comparison [Table 1], Comparison of retraction among two groups at each interval: Intergroup [Table 2], and Comparison of the amount of retraction among two groups :Difference from day 1 to day 84 [Table 3].

3. RESULTS

The total duration of the study was 21 months, inclusive of all cases. Out of 18 cases included, 2 were not regular in their scheduled appointments, whereas two other cases coil spring came out prematurely and patient did not report. Total sample size thus contributed to 14 cases (9 males and 5 females). Comparison of retraction within each group (Intragroup comparison) showed a statistically significant difference between the two groups (3.35>2.28mm). A statistically nonsignificant was observed between two groups at day one and day 84.

4. DISCUSSION

Orthodontic treatment has its importance based on aesthetic and functional rehabilitation of the masticatory system and the dentoalveolar structure. Changes are brought by force application and force elimination. An Orthodontic force when applied would cause inflammation around the periodontal ligament due to changes in blood flow leading to the secretion of different inflammatory mediators like colony-stimulating factors, cytokines, growth factors, arachidonic acid metabolites, and neurotransmitters. As a result of these secretions, remodelling of the bone occurs. Macrophage colony-stimulating factor (M-CSF), Receptor activator of nuclear factor kappa B ligand (RANKL), and osteoprotegerin (OPG) by osteoblasts play a key role in Orthodontic tooth movement. RANKL binds to its receptor, RANK (Receptor activator of nuclear factor kappa B) on the surface of osteoclastic cells at the developmental stage. The RANKL/RANK binding is very critical for the functional differentiation and survival of osteoclasts in Orthodontic tooth movement. All these sequential osteoblastic and osteoclastic activity aids in tooth movement.[10,12]

To bring about orthodontic tooth movement within biological means, treatment time takes a toll of an average 14 -24 months. As treatment is time-consuming, any method that could accelerate the tooth movement is beneficial to the patients. [11]

Among a variety of methods, the bio-stimulating effect of Low-level laser therapy has proven it efficacy in accelerating tooth movement, and many laboratory and clinical research do support them. However, most of the studies done have used laser vs. control group, and hence different laser wavelengths have given varied results. No study yet has been done to assess different laser modes under same clinical condition. Owing to gain a concrete evidence of Laser efficacy, the present study made use of both right and left halves of the maxilla for laser irradiation. Hence, the same patient acted as their control thus eliminating the bias.

Lasers act by their ‘Bio-stimulation’ effect, resulting in an effective bone remodelling process and thus accelerating the rate of tooth movement. Laser irradiation has a variety of effects on tissues, and this effect depends upon the different parameters of laser device as its wavelength, energy output and dosage used.

The combinations of these parameters with different experimental designs has often complicated the results output, as each study differed greatly according to different type of laser wavelength, energy output, mode of delivery and time. Also, when studies were conducted on different subject models, interpretation of those results with previous studies was difficult. Owing to these possible errors, this study took a deep dig in past literature and evaluated, and used those two best laser parameters combinations in this study which have yielded the best possible positive outcome. [10,11]

Thus this study made use of two different laser wavelengths, 810nm and 980nm, with an application of 10 J/cm^2 on a 10mW output.

For accelerating tooth movement, lasers that give bio stimulatory effect have a wide range of 600 to 1000 nm wavelength.[13]The Laser wavelength ranges from the red and near infrared region. The efficacy of a cellular activity depends on the absorption rate, the wavelength. This absorption energy enhances the vitality actions of the cell by increasing the mitochondrial ATP production. This primary reaction is capable of controlling cellular metabolism of the cell. The activation leads in production of protein, cytokines and cell proliferation, inducing activation of cell.[14,15]

Some studies found deeper penetration depth lies with higher wavelength.[16,17] However, yet some studies have shown lower wavelength too have yielded positive outcomes.[18,19] According to Tiina Karu, the laser that can provide a photostimulation effect are within the wavelength range of 600-1000nm.[20] A 980nm and 810nm diode laser (Gallium-Aluminium-Arsenide) used in the study has a wavelength close to the lower end infrared electromagnetic spectrum. On skin chromophores, this wavelength causes bio-stimulation on surrounding bone tissue; infrared radiation of this wavelength has a low absorption coefficient in haemoglobin and water and more in irradiated tissue that could probably reach cortices and alveolar bone. Studies done using 810nm wavelength Naseem Joy Garg et, 17 Guneet Guram [12] And 980nm wavelength by Yassaei et al[16] Have shown promising positive outcomes.

Biostimulatory effects on the bone are directly dependent on the dose applied. There is a great variety of applied doses between 5 J/cm2 and 6000 J/cm2.[14] Though no definitive dosage has been specified yet, higher dosage was preferred. A study by Luger et.al found effective dosage of 64 J/cm2.[21] as the finding of Limpanichkul W, Godfrey K, Srisuk N, Rattanayatikul[22] reported that Low-level laser therapy was too low to express either stimulatory or inhibitory effect. The author proclaimed that was because of insufficient radiation dose as stated by The Arndt-Schulz Rule and used of the higher energy density of 25J/cm^2 that they used. On the contrary, Youssef (8J/cm^2) [23] stated that stimulates the velocity of tooth movement and reported significant reduction in intensity in the first 1mm of penetration. Yamagishi et al[24] claimed that only 50% of the light can penetrate 1 mm depth in bovine mandibular cortical bone. Energy dosage cannot be precisely defined, but a mean which would not be high or low and even after scattering would yet deliver enough to activate the cellular activity is essential. A dosage of 10 J/cm^2 at 10 different points around teeth was used in this study that led homogenous distribution of mean energy density in ten points surrounding the entire tooth. Thus, a low level energy used in this study was found to aid bone cell remodelling. The low energy density accelerates the tooth movement and osteoclastogenesis on the pressure site via stimulation of receptor activator nuclear factor K-b (RANK-RANKLE) system and the c-FMS/macrophage colony-stimulating factor system. Same energy dosage was used for both the laser wavelength used in this study. A combination of 10J/cm^2 with 810nm wavelength was more effective compared to the 980nm group.[24]

The laser used in this study was in a continuous mode, not in pulse or super pulsed mode as pulse peak power generates thousands of watts resulting in ablation of soft tissue. Yoshida et al[25] and Kim et al[26] stated interrupted mode produced a greater stimulatory response, around 2.08-fold and 1.3-fold increase in the rate of throughout 2- 3 months, However, Bradley P, Takeda, Tuner J [27] who used continuous mode, found it be more effective. In another study by Hosseini MH,

Darbandi MM, Kamali A[28] who used the 890 nm diode laser and reported that the energy dose used (72 J per tooth) did not significantly increase dental movement, despite the mean canine retraction being greater on the side where the laser was used. The failure to obtain a positive result in their study could be due to the pulsed-mode application of the laser, the inadequate frequency of laser irradiation (2 weeks with 48 h intervals), or the high dose used in each application. Also, a continuous mode too has peaks and valleys as laser unit cannot emit continuously in real time. Thus a continuous mode, with low energy dosage can be more effective.

The total of 10 irradiations, for 10 seconds per site i.e., Cervical (mesial and distal), middle, apical (mesial and distal) of the root surface that covered the entire periodontal fiber and the alveolar bone area around an individual root surface was done. The amount of exposure per site and its efficacy depends on how much energy a cell could absorb. The energy absorption within the survival threshold gives the biostimulatory effect, whereas beyond it can lead to photo destruction. This study aimed for stimulatory effect with 10 sec of Low-level Laser Therapy (LLLT) per site.[12,17]

The study was undertaken at an interval of 21 days till Day 84 as the interval of 3 weeks as done by Garg et al. The three-week interval also coincides with the healing process and also routine Orthodontic recall visits. Similarly, expansion of PDL fibers observed at an interval of day 21 again helps in increasing Orthodontic tooth movement.[12,17,19]

A direct comparison between this study and previous studies was limited as most of the previous studies have evaluated effect of lasers on the rate on tooth movement by assessing individual canine retraction, and this only study assess retraction of all six anterior teeth. In orthodontic practice, treatment options do vary case dependent and often make use segmental or continuous mechanics. Hence it was essential to carry research that does focus on outcomes on treatment done with continuous mechanics. Taking this key point in consideration, this study has applied laser irradiation on all six anterior teeth used for retraction in a continuous mechanics.

In the present study, cases presented with varied results. This suggests, effect of LLLT differs among individuals. As molecular absorption is prerequisite for any cellular effect, the difference in thickness or densities of the soft and hard tissues, the inflammatory response and healing potential tend to affect the therapy. The amount of extraction space reduction was found more in the laser group of 810nm than in the laser group of 980nm with a mean difference of 1mm. (3.35mm > 2.28mm). It could be thus noted 810nm wavelength has better absorption rate than the 980nm group and aids in faster tooth movement.

Further research is required to evaluate the role of LLLT on fixed Orthodontic treatment comparing maxillary, mandibular arch, and further studies with a larger sample size including female and male subjects are suggested to determine the most efficient diode laser wavelength to accelerate the velocity of tooth movement with the different geographic background.

Conflicting Interest: (If present, give more details): NIL

Acknowledgement: NIL

5. CONCLUSION

Low-intensity laser therapy increases the rate of orthodontic tooth movement in a physiologic manner and shortens the treatment time. It causes no side effects on the vitality or the periodontium of the teeth. 810nm wavelength laser therapies were found more efficient over the 980nm wavelength laser therapy in accelerating orthodontic tooth movement.

6. REFERENCES

1. Roberts WE, Huja S, Roberts JA. Bone modelling: biomechanics, molecular mechanisms, and clinical perspectives. seminars in orthodontics 2004 Jun 1 (Vol. 10, No. 2, pp. 123-161). WB Saunders.

2. Davidovitch Z, Nicolay OF, Ngan PW, Shanfeld JL. Neurotransmitters, cytokines, and the control of alveolar bone remodeling in orthodontics. Dental Clinics of North America. 1988 Jul 1;32(3):411-35.
3. Jawad MM, Husein A, Alam MK, Hassan R, Shaari R. Overview of non-invasive factors (lowlevel laser and low-intensity pulsed ultrasound) accelerating tooth movement during orthodontic treatment. Lasers in medical science. 2014 Jan;29(1):367-72
4. Nimeri G, Kau CH, Abou-Kheir NS, Corona R. Acceleration of tooth movement during orthodontic treatment-a frontier in orthodontics. Progress in orthodontics. 2013 Dec; 14(1):1-8.
5. Gianelly AA, Schnur RM. The use of parathyroid hormone to assist orthodontic tooth movement. American journal of orthodontics. 1969 Mar 1;55(3):305.
6. Davidovitch Z, Finkelson MD, Steigman S, Shanfeld JL, Montgomery PC, Korostoff E. Electric currents, bone remodeling, and orthodontic tooth movement: II. Increase in rate of tooth movement and periodontal cyclic nucleotide levels by combined force and electric current. American journal of orthodontics. 1980 Jan 1;77(1):33-47. 17.
7. Stark TM, Sinclair PM. Effect of pulsed electromagnetic fields on orthodontic tooth movement. American Journal of Orthodontics and Dentofacial Orthopedics. 1987 Feb 1;91(2):91-104. 18.
8. Nishimura M, Chiba M, Ohashi T, Sato M, Shimizu Y, Igarashi K, Mitani H. Periodontal tissue activation by vibration: intermittent stimulation by resonance vibration accelerates
9. Ohshiro T. 27 years of laser treatment: a personal perspective. Laser Therapy. 2000;12(1):42- 59. 21.
10. de Freitas LF, Hamblin MR. Proposed mechanisms of photobiomodulation or low-level light therapy. IEEE Journal of selected topics in quantum electronics. 2016 Jun 9;22(3):348-64.
11. Arumughan S, Somaiah S, Muddaiah S, Shetty B, Reddy G, Roopa S. A comparison of the rate of retraction with low-level laser therapy and conventional retraction technique. Contemporary clinical dentistry. 2018 Apr;9(2):260.
12. Guram G, Reddy RK, Dharamsi AM, Ismail PM, Mishra S, Prakashkumar MD. Evaluation of low-level laser therapy on orthodontic tooth movement: a randomized control study. Contemporary clinical dentistry. 2018 Jan;9(1):105.
13. Reza F, Farzaneh A, Katayoun KA, Nikoo T. Laser in orthodontics. INTECH Open Access Publisher; 2011 Nov 25
14. Goulart CS, Nouer PR, Mouramartins L, Garbin IU, Lizarelli RD. Photoradiation and orthodontic movement: an experimental study with canines. Photomedicine and Laser Therapy. 2006 Apr 1;24(2):192-6.
15. Altan BA, Sokucu O, Toker H, Sumer Z. The effects of low-level laser therapy on orthodontic tooth movement: Metrical and immunological investigation. JSM Dent. 2014;2(4):1040.
16. Yassaei S, Aghili H, Afshari JT, Bagherpour A, Eslami F. Effects of diode laser (980nm) on orthodontic tooth movement and interleukin 6 levels in gingival crevicular fluid in female subjects. Lasers in medical science. 2016 Dec;31(9):1751-9.
17. Garg NJ, Singh G, Kannan S, Rai D, Kaul A, Gupta A, Goyalia A, Gupta G. Effect of 810nm diode laser therapy on the rate of extraction space closure. Journal of Indian Orthodontic Society. 2014 Jul;48(3):143-8.
18. Cruz DR, Kohara EK, Ribeiro MS, Wetter NU. Effects of low-intensity laser therapy on the orthodontic movement velocity of human teeth: A preliminary study. Lasers in Surgery and Medicine: The Official Journal of the American Society for Laser Medicine and Surgery. 2004 Aug;35(2):117-20.
19. Doshi-Mehta G, Bhad-Patil WA. Efficacy of low-intensity laser therapy in reducing treatment time and orthodontic pain: a clinical investigation. American Journal of Orthodontics and Dentofacial Orthopedics. 2012 Mar 1;141(3):289-97.
20. Karu T. Photobiological fundamentals of low-power laser therapy. IEEE Journal of Quantum Electronics. 1987 Oct;23(10):1703-17.

21. Luger EJ, Rochkind S, Wollman Y, Kogan G, Dekel S. Effect of low-power laser irradiation on the mechanical properties of bone fracture healing in rats. Lasers in Surgery and Medicine: The Official Journal of the American Society for Laser Medicine and Surgery. 1998;22(2):97-102.
22. Limpanichkul W, Godfrey K, Srisuk N, Rattanayatikul C. Effects of low-level laser therapy on the rate of orthodontic tooth movement. Orthodontics & craniofacial research. 2006 Feb;9(1):38-43.A\
23. Youssef M, Ashkar S, Hamade E, Gutknecht N, Lampert F, Mir M. The effect of low-level laser therapy during orthodontic movement: a preliminary study. Lasers in medical science. 2008 Jan;23(1):27-33.
24. Fujita S, Yamaguchi M, Utsunomiya T, Yamamoto H, Kasai K. Low-energy laser stimulates tooth movement velocity via expression of RANK and RANKL. Orthodontics & Craniofacial Research. 2008 Aug;11(3):143-55.
25. Yoshida T, Yamaguchi M, Utsunomiya T, Kato M, Arai Y, Kaneda T, Yamamoto H, Kasai K. Low-energy laser irradiation accelerates the velocity of tooth movement via stimulation of the alveolar bone remodeling. Orthodontics & craniofacial research. 2009 Nov;12(4):289-98.
26. Kim SJ, Moon SU, Kang SG, Park YG. Effects of low-level laser therapy after Corticision on tooth movement and paradental remodeling. Lasers in Surgery and Medicine: The Official Journal of the American Society for Laser Medicine and Surgery. 2009 Sep;41(7):524-33.
27. Bradley P, Tuner J. (2007). Laser Phototherapy in Dentistry, In: Proceedings of the 1st International Workshop of Evidence Based Dentistry on Lasers in Dentistry, Gutknecht N, pp.(149-171),Quintessence publisher,ISBN:978-1-85097-167-2,Berlin
28. Hosseini MH, Darbandi MM, Kamali A. Effect of low level laser therapy on orthodontic movement in human. Journal of Dental Medicine. 2011 Sep 1;24(2).

Table 1: Comparison of retraction within each group (Intragroup comparison)

Group	Day 1	Day 84	Difference	p value
980	4.78 ± 1.59	2.50 ± 1.35	2.28	0.001*
810	5.50 ± 1.47	2.15 ± 1.14	3.35	0.001*

Paired t test; * indicates significant difference at p≤0.05

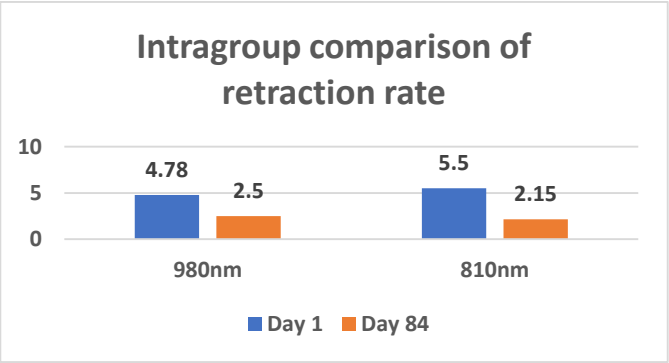

Table 2: Comparison of retraction among two groups at each interval (Intergroup)

Group	980	810	Difference	p value
Day 1	4.78 ± 1.59	5.50 ± 1.47	-0.72	0.207 (NS)
Day 84	2.50 ± 1.35	2.15 ± 1.14	0.35	0.450 (NS)

Paired t test; NS: non-significant difference

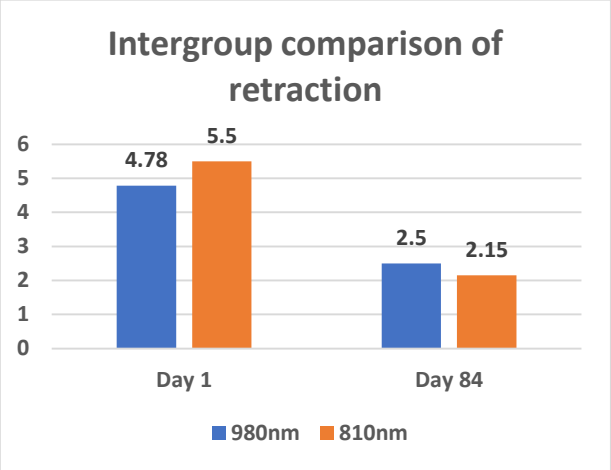

Table 3: Comparison of amount of retraction among two groups (Difference from day 1 to day 84)

Group	Difference from day 1 to day 84	p value
980	2.28 ± 0.62	0.001*
810	3.35 ± 0.71	

Paired t test; * indicates significant difference at p≤0.05

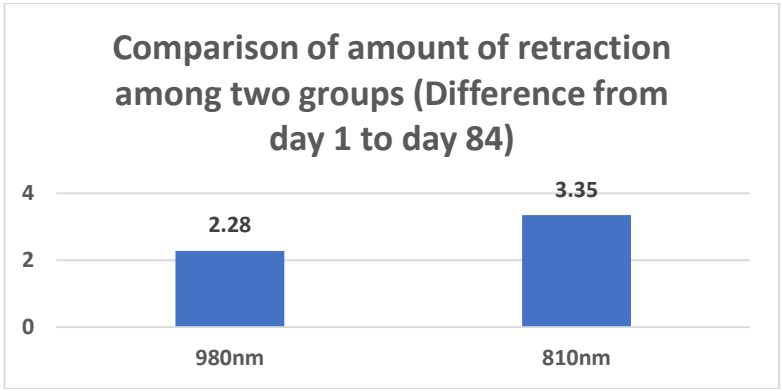

Figure 1: Laser Application On Buccal And Palatal Side

Figure 2: Measurements on cast using digital Vernier Calliper