Review Article

Lasers – A Leading Edge in Orthodontics - An Update

Dhanare P, Verma VK, Panda S, Singh K

ABSTRACT: Lasers have got wide-ranging relevance in the field of dentistry and the field of orthodontics does not remained untouched. Laser therapy is worthwhile by virtue of providing haemostatic, painless, non-invasive and quicker surgery. Incorporation of lasers in an orthodontic practice necessitates comprehensive learning regarding its various aspects to prevent possible tissue damage while using laser dental systems. This article has been reviewed with the application of lasers in orthodontics such as orthodontic tooth movement, stimulated intraoral laser microwelding of orthodontic appliances, debonding orthodontic brackets, reducing pain, etching enamel for bonding and enamel decalcification reduction.

Key Words: Laser Therapy; Debonding; Tooth Movement; Microwelding; Fluorescence; Radiation.

Introduction

Laser or "light amplification by stimulated emission of radiation" is monochromatic, invariant optical device, consisting of single wavelength of light. Laser fluorescence is a unique source of focused electromagnetic energy that is capable of usable work. Laser beam is a composite of the elements in the periodic system such as atoms, gases, organic molecules, diodes, chemicals or electrons.[1,2]

Dental lasers have revolutionized the treatment delivery systems, assisting orthodontist in achieving painless, effortless and atraumatic treatment in orthodontics.[3,4] Laser irradiation may be used to remove the smear layer.[5,6] Physical changes such as melting and recrystallization after laser etching occurs in the enamel. Therefore, laser irradiation has been proved to be a feasible method to etch enamel surfaces. In 1960, physicist Theodore H Maiman developed first functioning laser at the Hugles Research Laboratories in Malibu, CA.[2]

The introduction of lasers into the profession has allowed the soft tissue problems associated with orthodontic treatment to be addressed. Anti-inflammatory properties and regenerative effect on neurons led to the launching of Low-level laser therapy (LLLT) to control pain thereby, enhancing the blood supply and promote recovery of dental tissues as well. [7,8,9,10,11] Laser is a boon for the consumer of health services. The word laser has a magic hold on society and is perceived to be modern, high tech, and better.

Implication of lasers in orthodontics:

Lasers have various extensive applications in orthodontics such as orthodontic tooth movement, stimulated intraoral laser microwelding of orthodontic appliances,[12] debonding orthodontic brackets,[13] reducing pain,[14] etching enamel for bonding and enamel decalcification reduction.[15] Soft tissue applications such as frenectomies,[16] gingival contouring and crown lengthening can also be accomplished.

Reducing pain in orthodontic treatment:

A major concern for clinicians and patients is pain or discomfort during orthodontic treatment which may discourage patients from pursuing or continuing treatment.[17] The incidence and severity of pain have been reported to be higher than those of extractions.[18] Studies have shown that peak of pain occurred approximately 24 hours after separators or initial wire placement and decrease over the next 6-8 days.[19,20,21,22]

The mechanism of action of LLLT in reduction of orthodontic pain is not clearly known. It has been suggested that it affects the release of serotonin and acetylcholine at the central level and in the peripheral level release of histamine and prostaglandine are affected.[23,24] Some studies have shown that they increase the blood supply and promote the recovery of dental tissues.[11] It was proposed by Harris[25] that LLLT has a benign stimulatory influence on depressed neuronal and lymphocyte respiration. LLLT is a new method to manage pain in orthodontics. It is non-invasive, easy to administer and has no adverse tissue reactions.

Debonding ceramic orthodontic bracket:

The basic concept of debonding is to break the bracket-resin interface and remove the bracket from the tooth surface. The properties of ceramic bracket are different from metallic brackets and thus the conventional method of debonding metallic brackets are not as effective in debonding ceramic bracket. Most common problems encountered during ceramic bracket debonding are enamel fracture and bracket fracture.[26,27]

Conventional lasers soften the adhesive resin due to its heating property and helps in debonding of the brackets.[28,29,30] however different adhesives may require different softening temperature. The temperature of the heated brackets may rise too high and also pulpal damage may occur.[31,32] In recent years Nd:YAG laser have been recommended as it has a lower ceramic absorption than that of the carbon-dioxide laser, thus direct application to the resin enhances the effect of thermal ablation and photoablation.[33,34]

Effects on tooth movement:

In recent years a lot of focus has been paid to acceleration of orthodontic tooth movements. Various methods have been advocated in the literature to accelerate tooth movement out of which LLLT has shown a lot of promise. Studies have shown that LLLT accelerate bone remodelling process by stimulating osteoblasts and osteoclasts cell proliferation and function during orthodontic tooth movements.[23,35]

Saito and Shimizo[36] have shown bio-stimulatory effects of bone repair in mid-palatal sutures during rapid maxillary expansion in rats. Takada[37] has shown stimulation for bone regeneration at extraction site in rats. However some studies have shown contradictory results that LLLT does not have any effect on the rate of orthodontic tooth movement.[38] Researchers advocate that LLLT use laser energies varying from 2 to 54 J for stimulating and accelerating tooth movement.[39,40]

Etching of enamel for bonding:

Studies have shown that laser is capable of removing smear layer from the surface of enamel.[41] Once exposed to laser enamel undergoes physical changes such as melting and recrystallization.[42] These changes resemble the etching pattern produced by phosphoric acid.[43] Review of literature shows that the results have been variable when bond strength of laser etched enamel was compared with the bond strength after conventional etching. Ozer et al[44] in their study found that irradiation with a 1.50 w laser produced sufficient etching for orthodontic bonding but irradiation with 0.75 w laser didn’t. Basaran et al[45] in their study have found that mean shear bond strength and enamel surface etching obtained with Er,Cr:YSGG laser was comparable to that obtained with acid etching. However some authors have found laser etching to have significantly less bond strength when compared to acid etching.[46,47]

Enamel decalcification reduction:

After bonding enamel is susceptible to plaque accumulation around the orthodontic attachments. This often leads to caries and enamel decalcification.[48] Sognnaes and stern[49] in their study have shown that enamel exposed to laser irradiation shows resistance to acid attack. Anderson et al[50] in their in vivo study have shown that argon irradiation is effective in reducing enamel decalcification during orthodontic treatment. They have also shown that pumicing and etching do not appear to reduce the effect of laser on enamel solubility. Fox, Duncan and Olsaka[51] found that in addition to decreasing enamel decalcification laser reduced the threshold of pH at which dissolution occurred by a factor of five. A number of studies have shown that combining laser with fluoride therapy has synergistic effect on acid resistance of enamel.[52,53,54]

Conclusion: The use of Lasers in orthodontics is wide spread. Lasers are widely used in tooth movement, debonding ceramic orthodontic bracket, reducing pain in orthodontic treatment, etching enamel for bonding, enamel decalcification reduction etc. However laser is not a magic but when used efficaciously with thorough knowledge and training, it gives resounding results and this modern technology may bring revolution in the field of dentistry in near future.

Author affiliation: 1. Dr. Poorvasha Dhanare, Post Graduate, 2. Dr. Vinay Kumar Verma, MDS, Professor& Head, 3. Dr. Sujit Panda, MDS, Professor, 4. Dr. Karuna Singh, MDS, Senior Lecturer, Department of Orthodontics and Dentofacial Orthopaedics, Rama Dental College of science and research center, Kanpur, Uttar Pradesh, India, e-mail: prvsha04@gmail.com

References

1. Kravitz ND, Kusnoto B. Soft-tissue lasers in orthodontics: An overview. Am J Orthod Dentofacial Orthop 2008;133:110-114.
2. Maiman TH. Stimulated optical radiation in ruby lasers. Nature 1960;187:493.
3. Basarana G, Ozer T, Berk N, Hamamcı O. Etching Enamel for Orthodontics with an Erbium,Chromium:Yttrium-Scandium-Gallium-garnetlaser System. Angle Orthod 2007; 77:117-123.
4. Donald J. Coluzzi. Fundamentals of dental lasers: science and instruments. Dent Clin N Am 2004;48:751–770.
5. Takeda FH, Harashima T, Eto JN, Kimura Y, Matsumoto K. Effect of Er:YAG laser treatment on the root canal walls of human teeth: an SEM study. Endod Dent Traumatol. 1998; 14:270–273.
6. Takeda FH, Harashima T, Eto JN, Kimura Y, Matsumoto K. A comparative study of the removal of smear layer by three endodontic irrigants and two types of laser. Int Endod J. 1999;32:32–39.
7. Harazaki M, Takahashi H, Ito A, Isshiki Y. Soft laser irradiation induced pain reduction in orthodontic treatment. Bull Tokyo Dent Coll. 1998;39:95–101.
8. Lim HM, Lew KK, Tay DK. A clinical investigation of the efficacy of low level laser therapy in reducing orthodontic postadjustment pain. Am J Orthod Dentofacial Orthop. 1995;108:614–622.
9. Turhani D, Scheriau M, Kapral D, Benesch T, Jonke E, Bantleon HP. Pain relief by single low-level laser irradiation in orthodontic patients undergoing fixed appliance therapy. Am J Orthod Dentofacial Orthop. 2006;130:371–377.
10. Doshi-Mehta G, Bhad-Patil WA. Efficacy of low-intensity laser therapy in reducing treatment time and orthodontic pain: a clinical investigation. Am J Orthod Dentofacial Orthop. 2012;141:289–297.
11. Abi-Ramia LB, Stuani AS, Stuani MB, Mendes Ade M. Effects of low-level laser therapy and orthodontic tooth movement on dental pulps in rats. Angle Orthod. 2010;80:116–122.
12. Rueggeberg FA, Lockwood P. Thermal debracketing of orthodontic resins. Am J Orthod Dentofacial Orthop 1990;98:56-65.
13. Bergius M , Kiliardis S , Berggren U. Pain in orthodontics: a review and discussion of the literature . J Orofac Orthop. 2000;61(2):125-137
14. Usumez S, Orhan M, U¨ su¨mez A. Laser etching of enamel for direct bonding with an Er,Cr:YSGG hydrokinetic laser system. Am J Orthod Dentofacial Orthop. 2002;122:649–656.
15. Edwards JG. The diastema, the frenum, the frenectomy a clinical study. Am J Orthod 1977;71:489-508.
16. Tortamano A, Lenzi DC, Haddad AC, Bottino MC, Dominguez GC, Vigorito JW. Low level laser therapy for pain caused by placement of the first orthodontic archwire: a randomized clinical trial. Am J Orthod Dentofacial Orthop. 2009;136:662–667.
17. Oliver RG, Knapman YM. Attitudes to orthodontic treatment. Br J Orthod. 1985;12:179–188.
18. Jones ML, Chan C. Pain in the early stages of orthodontic treatment. J Clin Orthod. 1992;26:311–313.
19. Krishnan V. Orthodontic pain: from causes to management:A review. Eur J Orthodont 2007;29:170–179.
20. Kima WT,Bayomeb M; Parkc JB, Parkd JH, Baeke SH. Effect of frequent laser irradiation on orthodontic pain A single-blind randomized clinical trial. Angle Orthod 2013;83:611–616.
21. Jones ML, Chan C. Pain in the early stages of orthodontic treatment. J Clin Orthod. 1992;26:311–313.
22. Scheurer PA, Firestone AR, Burgin WB. Perception of pain as a result of orthodontic treatment with fixed appliances. Eur J Orthod. 1996;18:349–357.
23. Nalcacil R, Cokakoglu S. Lasers in orthodontics. Eur J Dent. 2013;7:S119-S125.
24. De Nguyen T, Turcotte JY. Lasers in dentistry and in oral and maxillofacial surgery. J Can Dent Assoc 1994;60:227-228.
25. Harris DM. Biomolecular mechanism of laser biostimulation. J Clin Laser Med Surg 1991;8:277-280.

26. Jeiroudi MT. Enamel fracture caused by ceramic brackets. Am J Orthod Dentofacial Orthop 1991;99:97-99.
27. Waes H, Matter T, Krejci I. Three-dimensional measurement of enamel loss caused by bonding and debonding of orthodontic brackets. Am J Orthod Dentofacial Orthop 1997;112:666-669.
28. Obata A. Effectiveness of CO2 laser irradiation on ceramic bracket debonding. J Jpn Orthod Soc 1995;54:285-295.
29. Obata A, Tsumura T, Niwa K, Ashizawa Y, Deguchi T, Ito M. Super pulse CO2 laser for bracket bonding and debonding. Eur J Orthod 1999;21:193-198.
30. Fraunhofer JA, Allen DJ. Thermal effects associated with the Nd/YAG dental laser. Angle Orthod 1993;63:299-303.
31. Zach L, Cohen G. Pulp response to externally applied heat. Oral Surg Oral Med Oral Path 1965;19:515-530.
32. Ma T, Marangoni RD, Flint W. In vitro comparison of debonding force and intrapulpal temperature changes during ceramic orthodontic bracket removal using a carbon dioxide laser. Am J Orthod Dentofacial Orthop 1997;111:203-210.
33. Hayakawa K. Nd: YAG laser for debonding ceramic orthodontic brackets. Am J Orthod Dentofacial Orthop 2005;128:638-647.
34. Tocchio RM, Willham PT, Mayer FJ, Standing KG. Laser debonding of ceramic orthodontic brackets. Am J Orthod Dentofacial Orthop 1993;103:155-162.
35. Altan BA, Sokucu O, Ozkut MM, Inan S. Metrical and histological investigation of the effects of low level laser therapy on orthodontic tooth movement. Lasers Med Sci 2012;27:131-140.
36. Saito S, Shimizu N. Stimulatory effects of low-power laser irradiation on bone regeneration in midpalatal suture during expansion in the rat. Am J Orthod Dentofacial Orthop 1997;111:525-32.
37. Takeda Y. Irradiation effect of low-energy laser on alveolar bone after tooth extraction. Experimental study in rats. Int J Oral Maxillofac Surg 1988;17:388-391.
38. Limpanichkul W, Godfrey K, Srisuk N, Rattanayatikul C. Effects of low level laser therapy on the rate of orthodontic tooth movement. Orthod Craniofac Res 2006;9:38-43.
39. 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 Surg Med 2004;35:117-120.
40. Sun G, Tunér J. Low level laser therapy in dentistry. Dent Clin North Am 2004;48:1061-1076.
41. Takada FH, Harashima T, Kimura Y, Matsumotok. A comparative study of the removal of smear layer by three endodontics irrigants and two types of laser. Int Endod J 1999;32:32-39.
42. Nelson DGA, Wefel JS, Jongbloed WL, Featherstone JDB. Morphology, histology and crystallography of human dental enamel treated with pulsed low energy infrared laser irradiation. Caries Res 1987;21:411-26.
43. Silverstone LM, Saxton CA, Dogon IL, Fejerskov O. Variation in the pattern of acid etching of human dental enamel examined by scanning electron microscopy. Caries Res 1975;9:373-87.
44. Ozer T, Başaran G, Berk N. Laser etching of enamel for orthodontic bonding. Am J Orthod Dentofacial Orthop 2008;134:193-197.
45. Basaran G, Ozer T, Berk N, Hamamci O. Etching enamel for orthodontics with an erbium, chromium:yttrium-scandium-gallium-garnet laser system. Angle Orthod 2007;77 (1):117-123.
46. Ariyaratnam MT, Wilson MA, Blinkhorn AS. An analysis of surface roughness, surface morphology and composite/dentin bond strength of human dentin following the application of the Nd: YAG laser. Dent Mater 1999;15:223-228.
47. Whitters CJ, Strang R. Preliminary investigation of a novel carbon dioxide laser for applications in dentistry. Lasers Surg Med 2000;26:262-269.
48. Visuri SR, Gilbert JL, Wright DD, Wigdor HA, Walsh JT Jr. Shear strength of composite bonded to Er: YAG laser prepared dentin. J Dent Res 1996;75:599-605.
49. Sognnaes RF, Stern RH. Dental laboratories accredited for 1965 by southern california state dental association. J South Calif Dent Assoc 1965;33:396-403.
50. Anderson AM, Kao E, Gladwin M, Benli O, Ngan P. The effects of argon laser irradiation on enamel decalcification: An in vivo study. Am J Orthod Dentofacial Orthop 2002;122:251-259.
51. Fox JL, Duncan Y, Otsuka M. Initial dissolution rate studies on dental enamel after Co_2 laser irradiation. J Dent Res 1992;71:1390-1398.
52. Kima JH, Kwonb OW, Kimc H. Acid Resistance Of Erbium-doped Yttrium Aluminum Garnet Laser–Treated and Phosphoric Acid Etched Enamels. Angle Orthod 2006;76:1052-1056.
53. Noel TL, Sheats RD. Effect of Argon Laser Irradiation on Demineralization Resistance of Human Enamel Adjacent to Orthodontic Brackets: An In Vitro Study. Angle Orthod 2003;73:249–258.
54. Flaitz CM, Hicks MJ, Westerman GH, Berg JH, Blankenau RJ, Powell GL. Argon laser irradiation and acidulated phosphate fluoride treatment in caries-like lesion formation in

enamel: An in vitro study. Pediatr Dent 1995;17:31-35.

Corresponding Author:
Dr. Poorvasha Dhanare,
Post Graduate,
Dept. of Orthodontics and Dentofacial Orthopaedics,
Rama Dental College of science and research center, Kanpur, U.P, India,
Contact no: 09839138625
Email id: prvsha04@gmail.com

How to cite this article: Dhanare P, Verma VK, Panda S, Singh K. Lasers – A Leading Edge in Orthodontics - An Update. Rama Univ J Dent Sci 2015 Mar;2(1):19-23

Sources of support: Nil **Conflict of Interest**: None declared