Bölüm 5

RESTORATİF DİŞ HEKİMLİĞİNDE LAZERLER

Oya ŞEKER[1]
Hazal Deniz KÖSE[2]

GİRİŞ

Türkçesi uyarılmış ışıma yoluyla ışık genliğinin yükseltimi olan lazerin temeli 1916 yılında Einstein tarafından atılmıştır. Theodore H. Maiman tarafından lazer 1960 yılında keşfedildiğinde "Maser" olarak adlandırılmıştır. Maiman ürettiği lazer 694 nm dalga boylu ruby (yakut) lazerdir. Goldman isimli araştırmacı ilk olarak 1964 yılında diş hekimliğinde denemiştir (1–4). Diş üzerinde uygulama yapıldığında hasta ağrı hissetmemiş ancak yüzeyel hasar meydana gelmiştir. İlerleyen araştırmalarla erken dönem lazerlerinde negatif sonuçlar elde edilince kullanımlarından vazgeçilmiştir (5). 1970-1980'lerde CO_2 lazerler ağız içi olarak kullanılmaya başlanmıştır. Yalnızca diş hekimliği için üretilmiş lazer Nd:YAG'dir. Myers tarafından geliştirilen d-lase 300 cihazı 1990 yılında FDA'dan yumuşak doku üzerinde kullanılması için onay almıştır. Lazerlerin sert dokularda kullanımlarına ise 1997 yılında başlanmıştır (6).

Diş hekimliğinde 488-10600 nm dalga boyu arasındaki lazerler çok geniş kullanım alanına sahip olmalarına rağmen hala araştırmalar sürmektedir. Diş çürüğünün temizlenmesinde ve önlenmesinde, kavite dezenfeksiyonu (3) ve şekillenmesinde, hassasiyet tedavisinde, restoratif materyallerin polimerizasyonunda, beyazlatmada, pulpa kanallarının dezenfeksiyonunda kemik ablasyonu, diş etinin şekillendirilmesi ve hastalıklarının tedavisinde, implant ve periimplantitis tedavisinde ve analjezide lazerler kullanılmaktadır (2,6–8).

Çürüğün temizlenmesi ve kavitenin şekillendirilmesi için CO_2, Er:YAG, Argon ve Nd:YAG lazerleri kullanılmaya başlanmıştır (9–11). Yapılan araştırmalar sonucunda; CO_2, argon, He-Ne, Nd:YAG gibi lazerler kavite preparasyonu için su soğutması altında çalışılmadığında pulpa nekrozu ve diş dokularında harabiyete neden olduğu görülmüştür (12).

[1] Doktor Öğretim üyesi, Hatay Mustafa Kemal Üniversitesi, oyyaseker@yahoo.com
[2] Araştırma görevlisi, Hatay Mustafa Kemal Üniversitesi, hzldnzsri@gmail.com

Işığın merkezinde bulunan boşluktaki madde CO_2 lazerindeki gibi gaz halindeyse solunum sistemi üzerinde zararlı etkilere neden olmaktadır. Genel anestezide kullanılan anestezik gazlarla birlikte dokuya uygulanan lazerler etkileşime girebilir (139).

Bu gibi yaralanmaları önlemek amacıyla lazerlerin kullanım protokollerine uyulması gerekmektedir. Hekimler bu konularda eğitilmelidir. Kullanılabilecek en uygun düşük güçte lazerler kullanılmalıdır. Kullanılan alanda lazer ışınını yansıtacak yüzeyler bulunmamalıdır. Gözler lazerlerin çeşidine uygun gözlüklerle korunmalıdır. Hasta üzerinde herhangi bir yanlış etki meydana gelmemesi adına uygulama alanı ve yakındaki tüm cilt yüzeyi kuru tutulmalıdır (2,8,136).

Lazerlerin kullanıldığı ortamdaki yanıcı maddelerin tutuşma ihtimali bulunduğundan, lazerlerin kullanıldığı alanlarda kolayca yanmayan maddelerin kullanılması gerekmektedir (141).

Lazer tedavisi diş hekimliğinde birçok avantaj sağlamaktadır. Ancak bu avantajların yanında birçok tehlikede barındırdığından kullanım sırasında dikkatli olunmalıdır.

KAYNAKÇA

1. Maiman TH. Stimulated optical radiation in Ruby. Nature. 1960. doi:10.1038/187493a0
2. Aoki A, Sasaki K, Watanabe H, Ishikawa I. Lasers in nonsurgical periodontal therapy. Periodontology. 2004;36(1):59–97.
3. Andersen K. Laser technology--a surgical tool of the past, present, and future. AORN J. 2003.
4. Schawlow AL, Townes CH. Infrared and optical masers. Phys Rev. 1958. doi:10.1103/PhysRev.112.1940
5. Myers TD, Myers WD, Stone RM. First soft tissue study utilizing a pulsed Nd:YAG dental laser. Northwest Dent. 1989.
6. Sulewski J. Historical survey of laser dentistry. Dent Clin North Am. 2000.
7. Gimbel CB. Hard tissue laser procedures. Dent Clin North Am. 2000.
8. Güngörmüş M, Ömezli MM. Diş Hekimliğinde Lazer Kullanimi Sirasinda Oluşabilecek Zararlar Ve Alinacak Önlemler. Atatürk Üniversitesi Diş Hekim Fakültesi Derg. 2007;17(2):31–33. doi:10.17567/dfd.48494
9. Olivi G, Genovese MD. Laser restorative dentistry in children and adolescents. Eur Arch Paediatr Dent. 2011. doi:10.1007/BF03262782
10. Hibst R. Lasers for Caries Removal and Cavity Preparation: State of the Art and Future Directions. J Oral Laser Appl. 2002.
11. Eguro T, Maeda T, Tanabe M, Otsuki M, Tanaka H. Adhesion of composite resins to enamel irradiated by the Er:YAG laser: Application of the ultrasonic scaler on irradiated surface. Lasers Surg Med. 2001. doi:10.1002/lsm.1063
12. GÜDER G. Er:YAG lazer ve geleneksel yöntem ile hazırlanmış sınıf V kavitelerde uygulanan farklı adeziv sistemlerin mikrosızıntı açısından incelenmesi. 2016.
13. Bader C, Krejci I. Indications and limitations of Er:YAG laser applications in dentistry. Am J Dent. 2006.
14. Chen C-C, Huang S-T. The Effects of Lasers and Fluoride on the Acid Resistance of Decalcified Human Enamel. Photomed Laser Surg. 2009. doi:10.1089/pho.2008.2312
15. Matsumoto K, Funai H, Shirasuka T, Wakabayashi H. Effects of Nd:YAG laser in treatment of

cervical hypersensitive dentine. Japanese J Conserv Dent. 1985;28(1):760–765.
16. Kimura Y, Wilder-Smith P, Yonaga K, Matsumoto K. Treatment of dentine hypersensitivity by lasers: A review. J Clin Periodontol. 2000. doi:10.1034/j.1600-051x.2000.027010715.x
17. Ladalardo TCCGP, Pinheiro A, Campos RADC, vd. Laser therapy in the treatment of dentine hypersensitivity. Braz Dent J. 2004.
18. Coluzzi DJ. Fundamentals of dental lasers: Science and instruments. Dent Clin North Am. 2004. doi:10.1016/j.cden.2004.05.003
19. Katzir A. LASERS & OPTICAL FIBERS IN MEDICINE. Acad Press San Diego, USA. 1993:337. doi:10.1364/opn.2.2.000018
20. Parker S. Verifiable CPD paper: Introduction, history of lasers and laser light production. Br Dent J. 2007. doi:10.1038/bdj.2006.113
21. Dederich DN. Laser/tissue interaction: what happens to laser light when it strikes tissue? J Am Dent Assoc. 1993. doi:10.14219/jada.archive.1993.0036
22. Kutsch VK. Lasers in dentistry: comparing wavelengths. J Am Dent Assoc. 1993;124(2):49–54.
23. Cernavin I, Pugatschew A, de Boer N, Tyas MJ. Laser applications in dentistry: A review of the literature. Aust Dent J. 1994. doi:10.1111/j.1834-7819.1994.tb05543.x
24. Strauss RA, Magid KS. Esthetics and laser surgery. Içinde: Esthetic Dentistry: A Clinical Approach to Techniques and Materials, Third Edition. ; 2014. doi:10.1016/B978-0-323-09176-3.00030-9
25. Ceballos L, Osorio R, Toledano M, Marshall GW. Microleakage of composite restorations after acid or Er-YAG laser cavity treatments. Dent Mater. 2001. doi:10.1016/S0109-5641(00)00092-0
26. Walsh JT, Deutsch TF. Pulsed CO2 laser tissue ablation: Measurement of the ablation rate. Lasers Surg Med. 1988. doi:10.1002/lsm.1900080308
27. Frentzen M, Braun A, Aniol D. Er:YAG Laser Scaling of Diseased Root Surfaces. J Periodontol. 2005. doi:10.1902/jop.2002.73.5.524
28. Niemz MH, Langer J, Niemz MH. Laser-tissue interactions: fundamentals and applications.; 2007. doi:10.1081/E-EOE
29. Görüş Z, Meşe A, Tokgöz Çetindağ M, Evran OE. Dişhekimliğinde Kullanılan Er : YAG Lazerler. Ege Üniversitesi Diş Hekim Fakültesi Derg. 2018;39(1):1–7.
30. Sulieman M. An Overview of the Use of Lasers in General Dental Practice: 2. Laser Wavelengths, Soft and Hard Tissue Clinical Applications. Dent Update. 2005;(32):286–288. doi:10.12968/denu.2005.32.5.286
31. Moritz A, Beer F, Goharkhay K, vd. Oral Laser Application.; 2006.
32. Moritz A, Schoop U, Goharkhay K, Sperr W. The CO2 laser as an aid in direct pulp capping. J Endod. 1998. doi:10.1016/S0099-2399(98)80106-4
33. Müllejans R, Eyrich G, Raab WHM, Frentzen M. Cavity preparation using a superpulsed 9.6-µm Co2 laser - A histological investigation. Lasers Surg Med. 2002. doi:10.1002/lsm.10063
34. Moshonov J, Stabholz A, Bar-Hilel R, Peretz B. Chemical analysis and surface morphology of enamel and dentin following 9.6µ CO2 laser irradiation versus high speed drilling. J Dent. 2005. doi:10.1016/j.jdent.2004.11.005
35. Romano ACCC, Aranha ACC, Da Silveira BL, Baldochi SL, De Paula Eduardo C. Evaluation of carbon dioxide laser irradiation associated with calcium hydroxide in the treatment of dentinal hypersensitivity. A preliminary study. Lasers Med Sci. 2011. doi:10.1007/s10103-009-0746-4
36. Walsh LJ, Perham SJ. Enamel fusion using a carbon dioxide laser: a technique for sealing pits and fissures. Clin Prev Dent. 1991.
37. Convissar R. Principles and Practice of Laser Dentistry.; 2010. doi:10.1016/C2009-0-39174-6
38. Frame JW. Removal of oral soft tissue pathology with the CO2 laser. J Oral Maxillofac Surg. 1985. doi:10.1016/0278-2391(85)90221-6
39. Uzunov T, Uzunova P, Angelov I, Gisbrecht A. Comparative investigation of the penetration of different wavelength visible LED radiation into dental tissue. Içinde: 15th International School on Quantum Electronics: Laser Physics and Applications. ; 2008. doi:10.1117/12.822525

40. Guelmann M, Britto LR, Katz J. Cyclosporin-induced gingival overgrowth in a child treated with CO2 laser surgery: a case report. J Clin Pediatr Dent. 2003.
41. Monteiro LS, Mouzinho J, Azevedo A, da Câmara MI, Martins MA, la Fuente JM. Treatment of epulis fissuratum with carbon dioxide laser in a patient with antithrombotic medication. Braz Dent J. 2012. doi:10.1590/S0103-64402012000100014
42. McCormack SM, Fried D, Featherstone JDB, Glena RE, Seka W. Scanning Electron Microscope Observations of CO2 Laser Effects on Dental Enamel. J Dent Res. 1995. doi:10.1177/00220345950740101201
43. Whitters CJ, Strang R. Preliminary investigation of a novel carbon dioxide laser for applications in dentistry. Lasers Surg Med. 2000. doi:10.1002/(SICI)1096-9101(2000)26:3<262::AID-LSM3>3.0.CO;2-7
44. Azevedo Rodrigues LK, Nobre Dos Santos M, Pereira D, Videira Assaf A, Pardi V. Carbon dioxide laser in dental caries prevention. J Dent. 2004. doi:10.1016/j.jdent.2004.04.004
45. Wen X, Liu L, Nie X, Zhang L, Deng M, Chen Y. Effect of Pulse Nd:YAG Laser on Bond Strength and Microleakage of Resin to Human Dentine. Photomed Laser Surg. 2010. doi:10.1089/pho.2009.2579
46. Hossain M, Nakamura Y, Kimura Y, Yamada Y, Kawanaka T, Matsumoto K. Effect of Pulsed Nd:YAG Laser Irradiation on Acid Demineralization of Enamel and Dentin. J Clin Laser Med Surg. 2002. doi:10.1089/104454701750285421
47. Palazon MT, Scaramucci T, Aranha ACC, vd. Immediate and short-term effects of in-office desensitizing treatments for dentinal tubule occlusion. Photomed Laser Surg. 2013. doi:10.1089/pho.2012.3405
48. Myers T, J M. The pulsed Nd: YAG dental laser: review of clinical applications. J Calif Dent Assoc. 1991;19(11):25–30.
49. Liu J fen. Effects of Nd:YAG Laser Pulpotomy on Human Primary Molars. J Endod. 2006. doi:10.1016/j.joen.2006.01.005
50. Elliott RD, Roberts MW, Burkes J, Phillips C. Evaluation of the carbon dioxide laser on vital human primary pulp tissue. Pediatr Dent. 1999.
51. Franke M, Taylor AW, Lago A, Fredel MC. Influence of Nd:YAG Laser Irradiation on an Adhesive Restorative Procedure. Oper Dent. 2006. doi:10.2341/05-110
52. Oho T, Morioka T. A possible mechanism of acquired acid resistance of human dental enamel by laser irradiation. Caries Res. 1990. doi:10.1159/000261245
53. Van As G. Erbium lasers in dentistry. Dent Clin North Am. 2004. doi:10.1016/j.cden.2004.06.001
54. Nair PNR, Baltensperger MM, Luder HU, Eyrich GKH. Pulpal response to Er:YAG laser drilling of dentine in healthy human third molars. Lasers Surg Med. 2003. doi:10.1002/lsm.10155
55. Jin JY, Lee SH, Yoon HJ. A comparative study of wound healing following incision with a scalpel, diode laser or Er,Cr:YSGG laser in guinea pig oral mucosa: A histological and immunohistochemical analysis. Acta Odontol Scand. 2010. doi:10.3109/00016357.2010.492356
56. De Mello EDA, Pagnoncelli RM, Munin E, vd. Comparative histological analysis of bone healing of standardized bone defects performed with the Er:YAG laser and steel burs. Lasers Med Sci. 2008. doi:10.1007/s10103-007-0475-5
57. Takamori K, Furukawa H, Morikawa Y, Katayama T, Watanabe S. Basic study on vibrations during tooth preparations caused by high-speed drilling and Er:YAG laser irradiation. Lasers Surg Med. 2003. doi:10.1002/lsm.10140
58. Azevedo AS, Monteiro LS, Ferreira F, vd. In vitro histological evaluation of the surgical margins made by different laser wavelengths in tongue tissues. J Clin Exp Dent. 2016. doi:10.4317/jced.52830
59. De Munck J, Van Meerbeek B, Yudhira R, Lambrechts P, Vanherle G. Micro-tensile bond strength of two adhesives to Erbium:YAG-lased vs. bur-cut enamel and dentin. Eur J Oral Sci. 2002. doi:10.1034/j.1600-0722.2002.21281.x
60. Apel C, Meister J, Götz H, Duschner H, Gutknecht N. Structural changes in human dental enamel after subablative erbium laser irradiation and its potential use for caries prevention. Caries

Res. 2005. doi:10.1159/000081659
61. Ansari G, Creanor S, Reid JS. The effect of laser caries removal on anxious children. Içinde: The 2nd congress of ESOLA. ; 2002:8.
62. Kokuzawa C, Ebihara A, Watanabe S, vd. Shaping of the root canal using Er:YAG laser irradiation. Photomed Laser Surg. 2012. doi:10.1089/pho.2012.3226
63. Kohara EK, Hossain M, Kimura Y, Matsumoto K, Inoue M, Sasa R. Morphological and Microleakage Studies of the Cavities Prepared by Er:YAG Laser Irradiation in Primary Teeth. J Clin Laser Med Surg. 2002. doi:10.1089/104454702760090227
64. Takeda FH, Harashima T, Kimura Y, Matsumoto K. Comparative study about the removal of smear layer by three types of laser devices. J Clin Laser Med Surg. 1998.
65. Gonçalves M, Milori Corona SA, Djalma Pécora J, Palma Dibb RG. Influence of the frequency of Er:YAG laser on the bond strength of dental enamel. J Clin Laser Med Surg. 2003.
66. Martínez-Insua A, Dominguez LDS, Rivera FG, Santana-Penín UA. Differences in bonding to acid-etched or Er:YAG-laser-treated enamel and dentin surfaces. J Prosthet Dent. 2000. doi:10.1067/mpr.2000.108600
67. İşcan Yapar M. Farklı pürüzlendirme yöntemleriyle dentine uygulanan kompozit rezin ve cam iyonomer siman materyallerinin makaslama bağlanma dayanımlarının incelenmesi. 2015.
68. Liu Y, Hsu CYS, Teo CMJ, Teoh SH. Potential mechanism for the laser-fluoride effect on enamel demineralization. J Dent Res. 2013. doi:10.1177/0022034512466412
69. Liu Y, Hsu CYS. Laser-induced compositional changes on enamel: A FT-Raman study. J Dent. 2007. doi:10.1016/j.jdent.2006.08.006
70. Kiper Akatay D. Başlangıç çürüğü oluşturulmuş diş minesinde lazer ve fluorid uygulamasının yüzey mikrosertliğine, fluorid alınımına ve aside dirence etkilerinin araştırılması. 2015.
71. Tao S, Li L, Yuan H, vd. Erbium Laser Technology vs Traditional Drilling for Caries Removal: A Systematic Review with Meta-Analysis. J Evid Based Dent Pract. 2017. doi:10.1016/j.jebdp.2017.05.004
72. Diaci J, Gaspirc B. Comparison of Er:YAG and Er, Cr:YSGG lasers used in dentistry. J Laser Heal Accademy. 2012;2012(1):1–13.
73. Lee BS, Lin PY, Chen MH, vd. Tensile bond strength of Er,Cr:YSGG laser-irradiated human dentin and analysis of dentin-resin interface. Dent Mater. 2007. doi:10.1016/j.dental.2006.03.016
74. Inamoto K, Horiba N, Senda S, vd. Possibility of root canal preparation by Er:YAG laser. Oral Surgery, Oral Med Oral Pathol Oral Radiol Endodontology. 2009. doi:10.1016/j.tripleo.2008.09.005
75. Calixto L, Bandéca M, Clavijo V, Andrade M, Vaz Lg, Campos E. Effect of Resin Cement System and Root Region on the Push-out Bond Strength of a Translucent Fiber Post. Oper Dent. 2012. doi:10.2341/11-035-l
76. Apel C, Meister J, Ioana RS, Franzen R, Hering P, Gutknecht N. The ablation threshold of Er:YAG and Er:YSGG laser radiation in dental enamel. Lasers Med Sci. 2002. doi:10.1007/s101030200036
77. Powell GL, Morton TH, Whisenant BK. Argon laser oral safety parameters for teeth. Lasers Surg Med. 1993. doi:10.1002/lsm.1900130509
78. Bjelkhagen H, Sundström F. A Clinically Applicable Laser Luminescence Method for the Early Detection of Dental Caries. IEEE J Quantum Electron. 1981. doi:10.1109/JQE.1981.1071024
79. Kotlow LA. Lasers in pediatric dentistry. Dent Clin North Am. 2004. doi:10.1016/j.cden.2004.05.005
80. Haider SM, White GE, Rich A. Combined effects of argon laser irradiation and fluoride treatments in prevention of caries-like lesion formation in enamel: An in vitro study. J Clin Pediatr Dent. 1999.
81. 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.
82. Westerman GH, Hicks MJ, Flaitz CM, Powell GL, Blankenau RJ. Surface morphology of sound

enamel after argon laser irradiation: An in vitro scanning electron microscopic study. J Clin Pediatr Dent. 1996.
83. Wang X, Sun Y, Kimura Y, Kinoshita J-I, Ishizaki NT, Matsumoto K. Effects of Diode Laser Irradiation on Smear Layer Removal from Root Canal Walls and Apical Leakage after Obturation. Photomed Laser Surg. 2005. doi:10.1089/pho.2005.23.575
84. Alfredo E, Silva SRC, Ozório JEV, Sousa-Neto MD, Brugnera-Júnior A, Silva-Sousa YTC. Bond strength of AH Plus and Epiphany sealers on root dentine irradiated with 980 nm diode laser. Int Endod J. 2008. doi:10.1111/j.1365-2591.2008.01418.x
85. Kiomarsi N, Salim S, Sarraf P, Javad-Kharazifard M, Chiniforush N. Evaluation of the Diode laser (810nm,980nm) on dentin tubule diameter following internal bleaching. J Clin Exp Dent. 2016. doi:10.4317/jced.52666
86. Ghadimi S, Chiniforush N, Bouraima SA, Johari M. Clinical approach of laser application in different aspects of pediatric dentistry. J Lasers Med Sci. 2012.
87. Azma E, Safavi N. Diode laser application in soft tissue oral surgery. J Lasers Med Sci. 2013.
88. Desiate A, Cantore S, Tullo D, Profeta G, Grassi FR, Ballini A. 980 nm diode lasers in oral and facial practice: Current state of the science and art. Int J Med Sci. 2009. doi:10.7150/ijms.6.358
89. Sotoode SM, Azimi S, Taheri SA, vd. Diode laser in minor oral surgery: A case series of laser removal of different benign exophytic lesions. J Lasers Med Sci. 2015. doi:10.15171/jlms.2015.08
90. Amaral MBF, De Ávila JMS, Abreu MHG, Mesquita RA. Diode laser surgery versus scalpel surgery in the treatment of fibrous hyperplasia: A randomized clinical trial. Int J Oral Maxillofac Surg. 2015. doi:10.1016/j.ijom.2015.05.015
91. Bakhtiari S, Taheri JB, Sehhatpour M, Asnaashari M, Moghadam SA. Removal of an extra-large irritation fibroma with a combination of diode laser and scalpel. J Lasers Med Sci. 2015. doi:10.15171/jlms.2015.16
92. Saghiri MA, Garcia-Godoy F, Lotfi M, Ahmadi H, Asatourian A. Effects of Diode Laser and MTAD TM on the Push-Out Bond Strength of Mineral Trioxide Aggregate–Dentin Interface . Photomed Laser Surg. 2012. doi:10.1089/pho.2012.3291
93. Yanik D. Farklı yüzey dezenfeksiyon teknikleri uygulanan mineral trioksit agregatın cam iyonomere makaslama bağlanma dayanımının karşılaştırılması. 2018.
94. Wakabayashi H, Hamba M, Matsumoto K, Tachibana H. Effect of irradiation by semiconductor laser on responses evoked in trigeminal caudal neurons by tooth pulp stimulation. Lasers Surg Med. 1993. doi:10.1002/lsm.1900130603
95. Kol Kılınç E, Türkün M. Diş Beyazlatma Sırasında Kullanılan Aktivatör Işınların Pulpa Üzerindeki Sıcaklık Artışına Etkisi. Ege Üniversitesi Diş Hekim Fakültesi Derg. 2016;37(3):143–147.
96. Sari T, Celik G, Usumez A. Temperature rise in pulp and gel during laser-activated bleaching: in vitro. Lasers Med Sci. 2015. doi:10.1007/s10103-013-1375-5
97. Fekrazad R, Alimazandarani S, Kalhori KAM, Assadian H, Mirmohammadi SM. Comparison of laser and power bleaching techniques in tooth color change. J Clin Exp Dent. 2017. doi:10.4317/jced.53435
98. Lussi A, Megert B, Longbottom C, Reich E, Francescut P. Clinical performance of a laser fluorescence device for detection of occlusal caries lesions. Eur J Oral Sci. 2001. doi:10.1034/j.1600-0722.2001.109001014.x
99. Lussi A, Francescut P. Performance of conventional and new methods for the detection of occlusal caries in deciduous teeth. Caries Res. 2003. doi:10.1159/000068226
100. Uday Mohan PVM, Uloopi KS, Vinay C, Rao RC. In vivo comparison of cavity disinfection efficacy with APF gel, Propolis, Diode Laser, and 2% chlorhexidine in primary teeth. Contemp Clin Dent. 2016. doi:10.4103/0976-237X.177110
101. Rochkind S, Nissan M, Barr-Nea L, Razon N, Schwartz M, Bartal A. Response of peripheral nerve to He-Ne laser: Experimental studies. Lasers Surg Med. 1987. doi:10.1002/lsm.1900070512
102. Rochkind S, Nissan M, Razon N, Schwartz M, Bartal A. Electrophysiological effect of HeNe laser on normal and injured sciatic nerve in the rat. Acta Neurochir (Wien). 1986. doi:10.1007/BF01402391

103. Senda A, Gomi A, Tani T, Yoshino H, Hara G. A clinical study on "soft laser 632", a He-Ne low energy medical laser. 1: Pain relief immediately after irradiation. Aichi Gakuin Daigaku Shigakkai Shi. 1985.
104. Matsumoto K, Funai H, Wakabayashi H, Oyama T. Study on the treatment of hypersensitive dentin by GaAlAr laser diode. Japanese J Conserv Dent. 1987;28:776–781.
105. Sicilia A, Cuesta-Frechoso S, Suárez A, Angulo J, Pordomingo A, De Juan P. Immediate efficacy of diode laser application in the treatment of dentine hypersensitivity in periodontal maintenance patients: A randomized clinical trial. J Clin Periodontol. 2009. doi:10.1111/j.1600-051X.2009.01433.x
106. Tengrungsun T, Sangkla W. Comparative study in desensitizing efficacy using the GaAlAs laser and dentin bonding agent. J Dent. 2008. doi:10.1016/j.jdent.2008.02.012
107. Caprioglio C, Olivi G, Genovese MD. Paediatric laser dentistry. Part 1: General introduction. Eur J Paediatr Dent. 2017.
108. Convissar RA. The biologic rationale for the use of lasers in dentistry. Dent Clin North Am. 2004. doi:10.1016/j.cden.2004.06.004
109. Ana PA, Bachmann L, Zezell DM. Lasers effects on enamel for caries prevention. Laser Phys. 2006. doi:10.1134/s1054660x06050197
110. Önal B. Diş sert dokularında lazer kullanımı. Diş hek K Derg. 1993;2:61–64.
111. Park IS, Chung PS, Ahn JC. Adipose-derived stromal cell cluster with light therapy enhance angiogenesis and skin wound healing in mice. Biochem Biophys Res Commun. 2015. doi:10.1016/j.bbrc.2015.04.059
112. Posten W, Wrone DA, Dover JS, Arndt KA, Silapunt S, Alam M. Low-level laser therapy for wound healing: Mechanism and efficacy. Dermatologic Surg. 2005. doi:10.1097/00042728-200503000-00016
113. Takeda Y. Irradiation effect of low-energy laser on alveolar bone after tooth extraction. Experimental study in rats. Int J Oral Maxillofac Surg. 1988. doi:10.1016/S0901-5027(88)80070-5
114. Paschoal MAB, Santos-Pinto L. Therapeutic effects of low-level laser therapy after premolar extraction in adolescents: A randomized double-blind clinical trial. Photomed Laser Surg. 2012. doi:10.1089/pho.2012.3243
115. Kučerová H, Dostálová T, Himmlová L, Bártová J, Mazánek J. Low-level laser therapy after molar extraction. J Clin Laser Med Surg. 2000.
116. Dantas CMG, Vivan CL, Ferreira LS, de Freitas PM, Marques MM. In vitro effect of low intensity laser on the cytotoxicity produced by substances released by bleaching gel. Braz Oral Res. 2010. doi:10.1590/S1806-83242010000400015
117. Sun G, Tunér J. Low-level laser therapy in dentistry. Dent Clin North Am. 2004. doi:10.1016/j.cden.2004.05.004
118. Abramoff MMF, Lopes NNF, Lopes LA, vd. Low-level laser therapy in the prevention and treatment of chemotherapy-induced oral mucositis in young patients. Photomed Laser Surg. 2008. doi:10.1089/pho.2007.2144
119. Aras MH, Ömezli MM, Güngörmüş M. Does low-level laser therapy have an antianesthetic effect? A review. Photomed Laser Surg. 2010. doi:10.1089/pho.2008.2430
120. Moshkovska T, Mayberry J. It is time to test low level laser therapy in Great Britain. Postgrad Med J. 2005. doi:10.1136/pgmj.2004.027755
121. Altan AB. Ortodontide lazer uygulamaları. Türkiye Klin J Orthod Top. 2015;1(1):42–49.
122. Başeren N, Gokalp S. Validity of a laser fluorescence system (DIAGNOdent) for detection of occlusal caries in third molars: an in vitro study. J Oral Rehabil. 2003;30(12):1190–1194.
123. Alencar CJF, Braga MM, De Oliveira E, Nicolau J, Mendes FM. Dye-enhanced laser fluorescence detection of caries lesions around brackets. Lasers Med Sci. 2009. doi:10.1007/s10103-008-0572-0
124. Sungurtekin E, Öztaş N. The effect of erbium, chromium: Yttrium-scandium-gallium-garnet laser etching on marginal integrity of a resin-based fissure sealant in primary teeth. Lasers Med Sci. 2010. doi:10.1007/s10103-009-0720-1
125. Lupi-Pégurier L, Bertrand MF, Genovese O, Rocca JP, Muller-Bolla M. Microleakage of re-

sin-based sealants after Er:YAG laser conditioning. Lasers Med Sci. 2007. doi:10.1007/s10103-006-0437-3
126. Lepri TP, Souza-Gabriel AE, Atoui JA, Palma-Dibb RG, PÉcora JD, Milori Corona SA. Shear bond strength of a sealant to contaminated-enamel surface: Influence of erbium : Yrnet laser pretreatment. J Esthet Restor Dent. 2008. doi:10.1111/j.1708-8240.2008.00214.x
127. Borsatto MC, Corona SAM, De Araújo FP, De Souza-Gabriel AE, Pécora JD, Palma-Dibb RG. Effect of Er:YAG laser on tensile bond strength of sealants in primary teeth. J Dent Child. 2007.
128. Kato J, Moriya K, Jayawardena J, Wijeyeweera R. Clinical application of Er:YAG laser for cavity preparation in children. J Clin Laser Med Surg. 2003;21(3):151–155.
129. Zhang C, Matsumoto K, Kimura Y, Harashima T, Takeda FH, Zhou H. Effects of CO2 laser in treatment of cervical dentinal hypersensitivity. J Endod. 1998. doi:10.1016/S0099-2399(98)80117-9
130. Joiner A. The bleaching of teeth: A review of the literature. J Dent. 2006. doi:10.1016/j.jdent.2006.02.002
131. Joiner A. Tooth colour: A review of the literature. J Dent. 2004. doi:10.1016/j.jdent.2003.10.013
132. Dang J, Wilder-Smith P, Peavy GM. Clinical preconditions and treatment modality: Effects on pulp surgery outcome. Lasers Surg Med. 1998. doi:10.1002/(SICI)1096-9101(1998)22:1<25::AID-LSM7>3.0.CO;2-Z
133. Hasheminia SM, Feizi G, Razavi SM, Feizianfard M, Gutknecht N, Mir M. A comparative study of three treatment methods of direct pulp capping in canine teeth of cats: A histologic evaluation. Lasers Med Sci. 2010. doi:10.1007/s10103-008-0584-9
134. Kimura Y, Yonaga K, Yokoyama K, Watanabe H, Wang X, Matsumoto K. Histopathological Changes in Dental Pulp Irradiated by Er:YAG Laser: A Preliminary Report on Laser Pulpotomy. J Clin Laser Med Surg. 2003.
135. Kimura Y, Wilder-Smith P, Matsumoto K. Lasers in endodontics: a review. Int Endod J. 2000;33:173–185.
136. Szymańska J. Work-related noise hazards in the dental surgery. Ann Agric Environ Med. 2000.
137. Andersen K. Safe use of lasers in the operating room-what perioperative nurses should know. AORN J. 2004. doi:10.1016/S0001-2092(06)61151-4
138. Takac S, Stojanović S. Classification of laser irradiation and safety measures. Med Pregl. 1998.
139. Neiburger EJ, Miserendino L. Laser reflectance: Hazard in the dental operatory. Oral Surgery, Oral Med Oral Pathol. 1988. doi:10.1016/0030-4220(88)90312-X
140. Pick RM, Colvard MD. Current Status of Lasers in Soft Tissue Dental Surgery. J Periodontol. 1993. doi:10.1902/jop.1993.64.7.589
141. Lim RY, Kenney CL. Precaution and safety in carbon dioxide laser surgery. Otolaryngol Neck Surg. 1986. doi:10.1177/019459988609500221