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Retrospective Evaluation of Nd: YAG Laser Application with Visual Analog Scale in the Treatment of Dentin Hypersensitivity

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: Dentin hypersensitivity (DH); It is a common oral complaint characterized by a sharp pain in the dentin in response to stimuli such as touch, hot-cold, osmotic pressure changes, and chemical agents. The treatment of DH is difficult due to the difficulties in determining the pain intensity and the change in pain threshold from patient to patient. Many desensitizing products and techniques with different effect mechanisms have been used in the treatment of DH, which has more than one treatment option. Today, lasers have been used to increase the success of DH treatment. Although different types of lasers are used in DH treatment, it has been reported that Nd: YAG laser may be more effective in reducing patient pain compared to other laser types.
Aim: It was aimed to evaluate the effect of Nd: YAG laser on dentin sensitivity treatment by comparing the pre-treatment and first year control VAS (Visual Analog Scale**)** value records.
Materials and Methods: Records of 16 (13 females, 3 males) patients were examined, Nd: YAG laser treatment was performed for DH, and the data of 90 teeth were analyzed using the records taken with the VAS scale at the beginning and at the first year.
Results: Compared to the beginning, there was a statistically significant decrease in DH in the first

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year after treatment (p <0.001).
Conclusion: Nd: YAG laser irradiation could reduce the symptoms of DH; thus, and it may be viable alternative for the treatment of this condition.

Keywords: Dentine hypersensitivity; Desensitizing; Laser; Nd: YAG laser.

1. INTRODUCTİON

Dentin hypersensitivity (DH); It is a common oral complaint characterized by a sharp pain in dentin in response to stimuli such as touch, hot-cold, osmotic pressure changes, and chemical agents [1,2]. Dentin sensitivity is an important problem in dentistry that needs to be investigated, due to its high prevalence, lowering the quality of life of patients, and interruption of oral hygiene practices, and periodontal problems that may occur as a result of this [3]. Dentin exposure basically occurs due to the reduction or complete loss of the enamel layer covering the outer tooth or the root surface coming out after the loss of cementum and the periodontal tissues covering it. Various factors such as atrision, abrasion, erosion, abfraction and periodontal diseases can also cause dentin hypersensitivity [4]. The treatment of DH is difficult due to the difficulties in determining the pain intensity and the change in pain threshold from patient to patient. Therefore, clinical examination, together with a good anamnesis to be obtained from the patient, is very important in determining the treatment method [1,2]. Dental pathologies that make the diagnosis of DH difficult by producing symptoms similar to dentin sensitivity are; cracked teeth, broken restorations, sensitivities after restoration, dental caries, tubercle fractures, marginal leakage, occlusal trauma, advanced pulpitis stages, gum recessions, palatogingival grooves, sensitivity after tooth whitening, prepared teeth for crowns and gingival inflammations [5-8]. Many theories have been put forward to explain the formation mechanism of DH. Although it is tried to be explained with different theories such as odontoblastic transduction theory and neural theory, the most widely accepted today is the hydrodynamic theory explained by Brännström [9]. The hydrodynamic mechanism is the sudden movement of the fluid in the dentinal tubules by physical and chemical stimuli and the activation of mechanically sensitive A-δ nerve fibers. Activation of nerve fibers is directly related to the presence of opened or occluded tubules [10]. DH is also directly related to the size and opening of dentinal tubules. Absi et al. reported that hypersensitive teeth have larger and numerically more dentinal tubules than non-sensitive teeth [11]. In the treatment of DH, which has more than one treatment option, many desensitizing products and techniques with different effect mechanisms have been used [12]. Although these products and techniques have certain advantages, they also have disadvantages such as slow clinical effects, difficulty in applying to all areas, and the need for continuous use [13]. Desensitizing agents are classified according to their mechanism of action as sedative agents, anti-inflammatory drugs, protein precipitators, tubule occlusive agents, and tubule sealants [14]. Today, lasers have been used to increase the success of DH treatment. Laser therapy was reported to be an important method in the treatment of DH in 1985 [15]. Most of the mechanism that causes a decrease in sensitivity in laser therapy is not fully known, but it is thought that the mechanism is different for each laser [14,16]. The use of Nd: YAG (neodymium: yttrium aluminum garnet) laser in DH was first reported by Matsumoto et al. In 1985. The output power of this laser varies between 0.3 and 2 W [15]. The Nd: YAG laser, which can be used in continuous or pulsative mode, the wave length on pulsatif mode varies between 10 and 20 Hz. It has been reported that Nd: YAG laser dissolves dentine and occludes tubules [17]. Er: YAG and Nd: YAG lasers reduce dentin permeability. In this way, the DH problem can be solved [18]. The effect of Nd: YAG laser on sensitive teeth has been reported that it can be formed by preventing the flow of fluid inside the dentin tubules or directly blocking the unmyelinated C and A-δ nerve fibers due to the coagulation of proteins inside the dentinal tubules or the occlusion of the tubules by melting and recrystallization of hydroxyapatite crystals of dentin, by creating a photobiomodulatory effect on odontoblasts [19,20]. It has been reported that Nd: YAG laser energy at 1064 nm creates pulpal analgesia by showing a thermal effect on dentin. It is suggested that the laser temporarily changes the cell membrane permeability and sensory axon terminations by acting on the sodium pump mechanism. Treatment efficiency has been reported between 5.2% and 100% in different studies [21]. When Nd: YAG lasers are used together with sodium fluoride varnishes, it has been reported that tubule covering efficiency reaches up to 90% [22]. It has been reported that Nd: YAG laser may be more

effective in reducing patient pain compared to other laser types [23]. In the study, the effect of Nd: YAG laser on dentin sensitivity treatment was evaluated retrospectively by comparing the VAS (Visual Analogue Scale) value records taken before the treatment and the first year control time.

2. MATERIALS AND METHODS

As a result of the power analysis performed on the retrospective planned study; 95% power, 0.05 sensitivity, sample size was determined as 16 patients. Of the 26 patients who applied to Ondokuz Mayis University Faculty of Dentistry Department of Periodontology with the complaint of dentin sensitivity between 2017 and 2019, data for 90 teeth affected by DH from 16 (13 female, 3 male) patients who were treated with Nd: YAG laser and met the working conditions were examined. However, broken teeth, deep restorations, crowns and abutments are also excluded. Patients who had DH complaints for a long time and who were still uncomfortable despite using toothpastes with high fluoride content were included in the study. Patients who had supragingival and subgingival scaling and root planıng two weeks before laser application in order to avoid confusion with dentin sensitivity that may occur due to periodontal disease were included in the study. In addition, the polishing process was applied just before the application, considering that the decrease in the effectiveness of laser application can be prevented. Before the laser application, the pain levels were determined using the VAS values. By spraying cold air (at a temperature of 21-22 degrees with a pressure of 55-60 psi) with air spray for 1-2 seconds at a right angle with air spray to 6 different regions of the teeth(mesiobuccal, distobuccal, midbuccal, mesiolingual, distolingual and midlingual) with DH, the patient's pain degree was asked to be evaluated over 10, and these values were averaged. In order to prevent false positive results, the teeth other than the measured tooth are insulated with cotton rolls. Routine follow-ups of the patients were made at regular intervals after the treatment and the VAS value was recorded again with the same method during the first year controls. Nd: YAG laser device with a wavelength of 1.064 nm was used in the study. Laser was applied to the samples with a 300 µm fiber optic tip at a distance of 1 mm by scanning motion at a right angle for 40 seconds. The laser parameters used were adjusted according to the manufacturer's instructions, with an energy output of 100 mJ / pulse, a frequency of 10 Hz, and a pulse interval of 180 ms. An existing software program was used for statistical analysis (SPSS Inc., version 19.0, Chicago, IL, USA). Whether the data showed normal distribution or not was evaluated using the Shapiro-Wilk test. According to normality test results, Wilcoxon test and Mann-Witney u test were used for intergroup comparisons. P <0.05 was considered statistically significant.

It was aimed to evaluate the effect of Nd: YAG laser on dentin sensitivity treatment by comparing the pre-treatment and first year control VAS value records.

3. RESULTS

In our study, DH treatment was applied to a total of 90 teeth of 16 patients, as 3 male (18,2%) and 13 female (81.2%), with ND: YAG laser. The age range of treated men was 25-63 and treated women was 39-49 Table 1 .

Compared to the beginning, there was a statistically significant decrease in DH in the first year after treatment (p <0.001) *Table 2. At the end of 1 year, compared to the beginning; in 6.67% of the total teeth, it was observed that DH decreased as tolerated by the patient, but continued (VAS score: 3-9 [min-max]), and completely disappeared in the remaining 93.3% teeth. Of the 90 treated teeth, 50 were anterior and 40 were premolar molar teeth. The decrease in the VAS scale is statistically significantly higher in premolar-molar teeth compared to anterior teeth (p = 0.001) **Table 3.

Table 1. Age and gender distribution

	N (%)	Age (mean±sd)	Age(median, min-max)
Male	3 (18.8)	39.92±11.42	38 (25-63)
Female	13 (81.2)	43±5.29	41 (39-49)
Total	16 (100)	40.5±10.47	39.5 (25-63)

** Wilcoxon test was used. ** Mann-Witney u test was used*

Table 2. Region distrubition

Region	N (%)	Beginning		After 1 year		p
		mean±sd	Median (min-max)	mean±sd	Median (min-max)	
anterior	50 (55.6)	6.8±1.6	6 (5-10)	1.68±1.68	1 (0-6)	P<0.001
Premolar-molar	40 (44.4)	7.9±1.62	8 (5-10)	1.65±1.55	1.5 (0-6)	P<0.001
Total	90 (100)	7.29±1.7	7 (5-10)	1.67±1.61	1 (0-6)	P<0.001

Table 3. Difference assessment between anterior and posterior

Region	Decrease difference Median (min-max)	p	Percentage decrease Median (min-max)	p
anterior	5 (3-9)	0.001	80 (37.5-100)	0.472
Premolar-molar	6 (3-10)		79.17 (40-100)	

The decrease in the VAS scale is not statistically significant by regions as a percentage (p = 0.472) Table 3.

4. DISCUSSION

DH is a common oral problem, with prevalence levels up to 68% in the general population in different studies affecting more than 40% of adults worldwide [24]. The cervical region of the teeth is the most common area of DH. It has been reported in studies that canine and premolar teeth may be the teeth most affected by DH [25]. However, there are studies reporting that mandibular incisors can often be affected [26]. It has been reported that the width and number of tubules are important in the formation of DH, and that teeth with DH have eight times more and twice the width of tubules than those without DH [27]. Studies have reported that the patency of the dentinal tubules and their density in the cervical region are directly related to pain [10]. Although the number and radius of dentinal tubules are related to fluid flow and hence sensitivity, it is thought that tubule diameter may be a more influential parameter than the number, as the flow velocity of the fluid is proportional to the square of the tubule diameter [28]. In our study, the decrease in VAS values was statistically significantly higher in premolar-molar teeth compared to anterior teeth [Table 3]. This may be caused by due to the larger surface area in the premolar and molar teeth, there may be more dentinal tubules and the Nd: YAG laser obstruct the tubules by dissolving dentin and causing clogging of the tubules by coagulation of proteins within the dentinal tubules or by dissolution and recrystallization of the hydroxyapatite crystals of dentin [17]. Women constitute 81.2% of the patients we included in the study. It may be due to the fact that female patients are more eager for treatment due to DH or that the rate of getting professional help in cases such as pain and illness is higher than men [2]. There are studies reporting higher prevalence of dentin sensitivity in women compared to men, as well as studies reporting that there is no statistically significant difference [29,30].

The relationship between DH and aging is controversial in the literature. It has been suggested that the prevalence of sensitivity will increase with age, as the life expectancy of the general population increases and the teeth are kept in the mouth for a longer period of time due to improved treatment options [30]. It seems logical on the basis that gingival recession, loss of enamel and cementum are more common in older individuals. However, the occurrence of DH between the ages of 20-40, mostly at the end of thirties and decrease after the 4th and 5th decades of life has been explained by decreased dentin permeability and neural sensitivity with aging. It has been reported that these responses may have resulted from the natural desensitization of sclerosis and secondary dentin formation [31]. In addition, it has been reported that long-term use of fluoride-containing toothpastes may result in occlusion of open dentinal tubules, resulting in decreased sensitivity [32]. The average age of the patients included in this study is 40, and despite the limited patient population, it is consistent with the literature. The stimulus used in the diagnosis of DH; must be measurable and reproducible.

Application of air pressure with air spray in the evaluation of DH is a known method that has been used in many studies until today [3,4,5]. It has been reported in studies that the distance of the stimulus from the tooth to be measured and the application time is important in determining the sensitivity level [33]. It has been recommended to avoid long-term cold air applications and to apply short-term applications such as 1-2 seconds in order to prevent adverse effects that may occur due to heat change on the tooth surface with DH [34]. In the study, adjacent teeth were isolated with cotton pellets as suggested in the literature, and air was applied with air spray for 1-2 seconds from 1cm away from the tooth with sensitivity complaints. The same stimulus was applied to all patients in the same setting by the same investigator throughout the study to eliminate application and evaluation differences [35]. In this way, we think that differences that may arise from observation and application differences are prevented. Today, there is no standard method that can ideally be used in measuring and evaluating DH. However, the use of VAS is one of the most preferred methods in clinical studies [36]. In VAS, which is a numerical scale, the individual can express the pain more accurately and without directing by placing a mark on the straight line between the '0' point, which indicates no pain, and the '10' point, which indicates the most severe pain [37]. VAS was used to evaluate the severity of pain in our study in order to objectively score DH. Many desensitizing products and techniques with different effect mechanisms have been used in the treatment of DH, which has more than one treatment option [12]. Nd:YAG lasers are one of the frequently used options for DH treatment today. Treatment efficacy has been reported to range 51.5–100% [38]. Compared to traditional approaches, high cost, complexity of use, and the ability to have a placebo effect are the disadvantages that limit the clinical benefit of DH laser therapy [39]. The effectiveness and mechanism of action of laser treatment for DH treatment is controversial. Sgolastra et al. suggested that laser therapy may reduce the pain associated with DH, but its efficacy should consider the possibility of a placebo effect [40]. The possibility of a placebo effect should be considered, especially since patient reports are positive immediately after laser treatment. This effect consists of a complex mix of physiological and psychological interactions, which, depending on the doctor-patient relationship, both parties belief about treatment is worthwhile and need to seek symptom relief. On the other hand, questions arise regarding the reproducibility and safety of this technique as the mechanisms involved are multiple and uncertain [41]. Usage parameters (settings) of lasers affect the success of the treatment. When used in inappropriate settings, more light than necessary may penetrate the tooth and cause unwanted heat increase. Usage parameters of Nd: YAG laser in many studies has been reported that side effects disappear when the energy power is adjusted to 0.5-1 W, frequency 10-15 Hz and energy in the range of 60-150 mJ [42,43]. In this study, in order to avoid possible postoperative complications, the manufacturer's parameters and recommendations were followed. The clinical efficacy of Nd: YAG laser in reducing dentin sensitivity has been reported at the end of many studies [15,44]. Gutknecht et al. treated 120 teeth with DH with Nd: YAG laser in their study and reported that the sensitivity in more than 80% teeth completely disappeared at the end of 3 months [45]. In another similar study, 104 teeth were treated with Nd: YAG laser and it was reported that at 84 teeth sensitivity completely disappeared after 6 months and 20 teeth had cervical DH persistence [46].

5. CONCLUSİON

In our study, all teeth treated at the end of 1 year compared to the beginning; it was observed that DH in 6 teeth decreased enough to be tolerated by the patient but continued (VAS score: 3-9 [min-max]) and completely disappeared in the other 84 teeth. Based on these findings, it can be thought that Nd: YAG laser is effective in the treatment of DH when appropriate parameters are applied together with a correct differential diagnosis. Comparing other laser types as well as other desensitizing agents in more detailed studies to be done in the future may reveal more successful responses in the treatment of DH.

DISCLAIMER

The products used for this research are commonly use products in treatment of DH in our country. There is absolutely no conflict of interest between the authors. The research was not founded by any company.

CONSENT

All authors declare that written informed consent was obtained from the patients.

ETHICAL APPROVAL

The research reported in the paper was undertaken in compliance with the Helsinki Declaration and the protocol of this study was previously approved by the Research Ethics Committee of Ondokuz Mayis University (OMU KAEK 2020/452).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Dababneh RH, Khouri AT, Addy M. Dentine hypersensitivity - an enigma: A review of terminology, mechanisms, aetiology and management BrDent J. 1999;187:606-611.
2. Addy M. Dentine hypersensitivity: new perspectives on an old problem. International Dental Journal. 2002; 52(S5P2):367-375.
3. Holland G, Narhi M, Addy M, Gangarosa L, Orchardson R. Guidelines for the design and conduct of clinical trials on dentine hypersensitivity. Journal of clinical periodontology. 1997;4(11):808-813.
4. Pashley DH. Clinical correlations of dentin structure and function. J prosthet Dent. 1991;66(6):777–781.
5. Dowell P, Addy M. Dentine hypersensitivity-a review. Aetiology, symptoms and theories of pain production J ClinPeriodontol. 1983;10:341-350.
6. Krauser JT. Hypersensitive teeth. Part I: Etiology. J ProsthetDent. 1986;56:153-156.
7. Addy M. Etiology and clinical implications of dentine hypersensitivity. DentClin North Am. 1990;34:503-514
8. Trowbridge HO, Silver DR. A review of current approaches and in-office management of tooth hypersensitivity. DentClin North Am. 1990;34:561-581.
9. Akca T, Yazici A, Celik C, Özgünaltay G, Dayangaç B. The effect of desensitizing treatments on the bond strength of resin composite to dentin mediated by a self-etching primer. OperDent. 2007;32(5): 451-456.
10. Närhi M, Kontturi-Närhi V, Hirvonen T, Ngassapa D. Neuro physiological mechanisms of dentin hypersensitivity. ProcFinnDentSoc. 1992;88(Supp 1):15-22.
11. Absi E, Addy M, Adams D. Dentine hypersensitivity, a study of the patency of dentinal tubules in sensitive and non-sensitive cervical dentin. J ClinPeriodont. 1987;14(5):280-284.
12. Saraç D, Külünk S, Saraç YS, Karakas Ö. Effect of fluoride-containing desensitizing agents on the bond strength of resin-based cements to dentin. J Appl Oral Sci. 2009; 17(5):495-500.
13. Huh JB, Kim JH, Chung MK, Lee HY, Choi YG, Shim JS. The effect of several dentin desensitizers on shear bond strength of adhesive resin luting cement using self-etching primer. J Dent. 2008;36(12):1025-1032.
14. Sgolastra F, Petrucci A, Severino M, Gatto R, Monaco A. Lasers for the treatment of dentine hypersensitivity: a meta-analysis. J DentRes. 2013;92(6):492-499.
15. Matsumoto K, Funai H, Shirasuka T, Wakabayashi H. Effects of Nd: YAG-laser in treatment of cervical hyper sensitive dentine. Jpn J ConservDent. 1985;28:760-765
16. Asnaashari M, Moeini M. Effectiveness of lasers in the treatment of dentin hypersensitivity. J LasersMedSci. 2013; 4(1):1-7.
17. Dilber E ÇP, Akpınar YZ, Öztürk AN. The Effect of Different Dentin Hypersensitivity Treatments on the Shear Bond Strength Between Adhesive Composite Resinand Dentin. ClinDentandRes. 2014;38(1):11-20.
18. Kurt S, Kırtıloğlu T, Yılmaz NA, Ertaş E, Oruçoğlu H. Evaluation of the effects of Er:YAG laser, Nd:YAG laser, and two different desensitizers on dentin permeability: in vitro study. Lasers Med Sci. 2018;33(9):1883-1890.
19. Namour A, Nammour S, Peremans A, Heysselaer D, De Moor RJ Treatment of dentinal hypersensitivity by means of Nd:YAG laser: a preliminary in vitro study. Scientific World Journal. 2014;323604.
20. Biagi R, Cossellu G, Sarcina M, Pizzamiglio IT, FarronatoG. Laser-assisted treatment of dentinal hypersensitivity: A literatüre review. AnnalidiStomatologia. 2015;6(3-4):75-80.

21. Kobayashi CA, Fujishima A, Miyazaki T, Kimura Y, Matsumoto K, Osada T. Effect of Nd: YAG laser irradiation on shear bond strength of glass-Ionomer luting cement to dentin surface. Int J Prosthodont. 2003; 16(5):493-498. 44.
22. Lan W-H, Liu H-C, Lin C-P. The combined occluding effect of sodium flüoride varnish and Nd: YAG laser irradiation on human dentinal tubules. J Endod. 1999;25(6):424-426.
23. Birang R, Poursamimi J, Gutknecht N, Lampert F, Mir M. Comparative evaluation of the effects of Nd: YAG and Er:YAG laser in dentin hypersensitivity treatment. LasersMedSci. 2007;22(1):21-24.
24. Smith WA, Marchan S, Rafeek RN. The prevalence and severity of non-carious cervical lesions in a group of patients attending a university hospital in Trinidad. J Oral Rehabil. 2008;35(2):128-134.
25. Addy M. Dentine hypersensitivity: Definition, prevalence, distribution and etiology .Clinical advances in restorativedentistry. London: Martin Dunitz. 2000;239-248.
26. Chu CH, Pang KL, Yip HK. Dietary behavior and dental erosion symptoms of Hong Kong people. J DentRes. 2008; 87(specissue C):41.
27. Brannstrom M, Johnson G, Nordenvall K-J. Transmission and control of dentinal pain: resin impregnation for the desensitization of dentin. The Journal of the American Dental Association. 1979;99(4):612-618.
28. West N, et al. Dentin hypersensitivity: pain mechanisms and aetiology of exposed cervical dentin. Clinical oral investigations. 2013;17(1):9-19.
29. Fischer C, Fischer RG, Wennberg A. Prevalenceb and distribution of cervical dentine hypersensitivity in a population in Rio de Janiero, Brazil. J Dent. 1992; 20:272-276.
30. Flynn J, Galloway R, Orchardson R. The incidence of “hyper-sensitive” teeth in the west of Scotland. J Dent. 1985;13:230-236.
31. Wang Y, Que K, Lin L, Hu D, Li X. The prevalence of dentine hypersensitivity in the general population in China. J Oral Rehabil. 2012;39(11):812-820.
32. Tillis TSI, Keating JG. Understanding and managing dentin hypersensitivity. J DentHygiene. 2002;76:296-310.
33. Ash MM. Quantification of stimuli. DentalTraumatology. 1986;2(4):153-156.
34. Branstrom ML, Linden A, Astrom A.The hydrodynamics of dentin and pulp fluid:it is significiance in relation to dental pain. Caries Res.1967;1:310-7
35. Holland G, Narhi M, Addy M, Gangarosa L, Orchardson R.Guidelines for the design and conduct of clinical trials on dentine hypersensitivity. J ClinPeriodontol. 1997; 24(11):808–813.
36. Ide M, Wilson R, Ashley F. The reproducibility of methods of assessment for cervical dentine hypersensitivity. Journal of ClinicalPeriodontology. 2001; 28(1):16- 22.
37. Gillam D, Newman H. Assessment of pain in cervical dentinal sensitivity studies. A review. Journal of clinical periodontology. 1993;20(6):383-394.
38. Kimura Y, Wilder-Smith P, Yonaga K, Matsumoto K.Treatment of dentine hypersensitivity by lasers: a review. J ClinPeriodontol. 2000;27(10):715-21.
39. Orchardson R, Gillam DR. Managing dentin hypersensitivity. J AmDentAssoc 2006; 137:990–8.
40. Sgolastra F, Petrucci A, Gatto R, Monaco A. Effectiveness of laser in dentinal hypersensitivity treatment: a systematic review. J Endod. 2011;37(3):297-303.
41. Kimura Y, Wilder-Smith P, Yonaga K, Matsumoto K. Treatment of dentine hypersensitivity by lasers: a review. J ClinPeriodontol. 2000;27(10):715-21.
42. Zapletalova Z, PerinaJr J, Novotný R, Chmelickova H. Suitable conditions for sealing of open dentinal tubules using a pulsed Nd: YAG laser. Photomedicine andlaser surgery. 2007;25(6):495-9.
43. Farmakis ETR, Kozyrakis K, Khabbaz MG, Schoop U, Beer F, Moritz A.Invitroevaluation of dentin tubule occlusion by Den shield and Neodymium-dopedyttrium-aluminum-garnet laser irradiation. Journal of Endodontics. 2012; 38(5):662-6.
44. Gelskey S, White J, Pruthi V. The effectiveness of the Nd: YAG laser in the treatment of dental hypersensitivity. J Can DentAssoc. 1993;59(4):377-8, 83-6.
45. Gutknecht N, Moritz A, Dercks H, Lampert F. Treatment of hypersensitive teeth using neodymium: yttrium-aluminum-garnet lasers: a comparison of the use of various settings in an in vivo study. Journal of

Clinical Laser Medicine & Surgery. 1997; 15(4):171-4.

46. Márcia T Ciaramicoli , Rubens CR Carvalho, Carlos P Eduardo.Treatment of cervical dentin hypersensitivity using neodymium: Yttrium-aluminum-garnet laser. Clinicalevaluation Lasers Surg Med. 2003;33(5):358-62.

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