 DOI: **10.21608/adjalexu.2022.162422.1313**

THE EFFECT OF INTRA-POCKET APPLICATION OF DIODE LASER ON THE MOBILITY OF THE TEETH WITH GRADE C PERIODONTITIS

Amira M. Hafez[1*] BDS, Fatma R. Mohamed[2] PhD,
Souzy K. Anwar[3] PhD

ABSTRACT

INTRODUCTION: Increased tooth mobility as a consequence of untreated periodontitis leads to tooth loss due to increased periodontopathogens. The use of metronidazole in combination with spiramycin is one of the effective conventional treatments of severe periodontitis (grade C), but it has several side effects. On the other hand, diode laser (980 nm) is also recommended to treat severe periodontitis (grade C) due to its bactericidal and detoxifying effects.
OBJECTIVE: Measure and compare the grade of teeth mobility after intra-pocket application of diode laser therapy versus systemic antibiotic in severe periodontitis (stage 3 grade C).
MATERIALS AND METHODS: A Randomized controlled clinical trial was conducted on 50 patients with stage 3 grade C periodontitis divided equally into two groups. Group I (test group) treated by scaling and root planing (SRP) together with intra-pocket application of diode laser. Group II (control group) treated by SRP and systemic antibiotic administration. Patients were evaluated in terms of mobility degree at baseline, 4th and 12th week postoperatively.
RESULTS: The degree of teeth mobility decreased significantly from baseline to the end of the treatment in each group individually. However, there was no significant difference between both groups at the end of the treatment.
CONCLUSION: Laser therapy and systemic antibiotic are effective treatment modalities in decreasing the degree of mobility of teeth with stage 3 grade C periodontitis. However, to avoid the systemic antibiotic side effects and bacterial resistance of long term use, intra-pocket laser therapy can be recommended.
KEYWORDS: Diode laser, Mobility, Scaling and root planing, Stage 3 grade C periodontitis, Systemic antibiotic.

---

1 BDS, 2013, Faculty of Dentistry, Alexandria University, Egypt.
2 Professor of Oral Medicine, Periodontology, Oral Diagnosis and Radiology, Department of Oral Medicine, Periodontology, Oral Diagnosis and Radiology, Faculty of Dentistry, Alexandria University, Egypt.
3 Lecturer of Oral Medicine, Periodontology, Oral Diagnosis and Radiology, Department of Oral Medicine, Periodontology, Oral Diagnosis and Radiology, Faculty of Dentistry, Alexandria University, Egypt.

**Corresponding author:*
amirahafez91@gmail.com

INTRODUCTION

Periodontitis is a multifactorial inflammatory disease initiated by dental plaque biofilm and results in periodontal supporting tissues destruction and eventually tooth loss (1).

The high frequency of periodontitis has made it a major public health issue. It has a negative impact on chewing function and aesthetics, contributes to social inequity, and reduces quality of life greatly. Periodontitis causes a large percentage of edentulism and masticatory dysfunction, has a severe impact on overall health, and costs a lot to treat (2).

Recently, at the World Workshop 2017 for Periodontitis Classification, it was categorized under a single category, "periodontitis" (3). This was further defined by a multidimensional grading and staging system that could be modified over time as new evidence became accessible. Management severity and complexity are factors in staging. Stage I is for early periodontitis, stage II is for moderate periodontitis, stage III is for severe periodontitis with potential risk of tooth loss, and stage IV is for advanced periodontitis with the potential for dentition loss. Grading is based on the rapid progression rate and the expected response to treatment. Grade A represents a slow progression rate, Grade B represents a moderate rate of progression, and Grade C represents a rapid rate of progression (4).

According to this periodontal disease classification (the World Workshop 2017), stage 3 grade C periodontitis (formerly called localized aggressive periodontitis) is characterized by rapid periodontal attachment loss of ≥ 5 mm and bone loss to the middle third of the root and beyond that can cause increasing tooth mobility with a rapid progression rate (bone loss of ≥ 2mm over 5 years) (5).

Normally physiologic tooth mobility is about 0.25 mm horizontally. Above this number is called abnormal or increasing tooth mobility which can be caused by pathological causes such as periodontal disease or physiological causes as primary tooth exfoliation and occlusal trauma (6).

Miller's mobility index (MMI) is still used for examination of tooth mobility. The extent of tooth mobility is commonly graded on a scale of 1 to 3, Class I; movement of the tooth is greater than normal but less than 1 mm horizontally. Class II; movement of the tooth up to 1 mm or more in horizontal direction (buccolingual or mesiodistal direction). Class III; movement of the crown of the tooth more than 1 mm in horizontal and vertical direction or rotation in its socket (7,8).

Many devices have been developed to assess tooth mobility like periodontometer developed in (1954) and periotest (1988) a dynamic device that provides an accurate measure for tooth mobility (9). These devices may help in measuring mobility, but they are not widely used. In general, clinical mobility is graded in a direct manner by firmly holding the tooth between the handles of two metal instruments (10).

Antibiotics, in addition to scaling and root planing (SRP), are the standard treatment for severe periodontitis (grade C) with favorable results (11). Metronidazole in conjunction with spiramycin has been demonstrated to be a beneficial treatment for active periodontitis (12). It has been shown that combining spiramycin with metronidazole has a synergistic impact against a wide range of infections. Furthermore, it has been approved to remove the majority of bacterial infections during treatment and at follow up (13). However, numerous studies have revealed slightly better clinical long-term outcomes and less microbial resistance as a consequence of antibiotic treatment (14,15).

For many years, diode laser therapy has been advocated as an additional or supplementary treatment for periodontal disease (16). In patients with severe periodontitis (grade C), using the diode laser in addition to SRP was more successful in terms of clinical and microbiological characteristics (17). In addition, when compared to surgical procedures, diode laser periodontal treatment has shown improved clinical, biochemical, and radiological results (18). The antibacterial and detoxifying actions of lasers have been presented as a potential adjunctive treatment technique to promote non-surgical periodontal treatment with good outcomes using a 980 nm diode laser (19).

After active therapy, maintenance care is essential to remove dental plaque biofilm and avoid recurrence of periodontitis (20).

According to aforementioned we were interested to measure and compare the degree of teeth mobility with severe periodontitis (stage 3 grade C) after intra-pocket application of diode laser therapy versus systemic antibiotic.

The null hypothesis is that, after a three months' follow-up, there would be no significant difference in improvement in mobility degree between diode laser and systemic antibiotic.

MATERIALS AND METHODS

The study was accepted by the Research Ethics Committee of the Faculty of Dentistry, Alexandria university (IRB NO:00010556 - IORG 0008839). Registration of the study was done at U.S National Institutes of Health Clinical Trials Registry (NCT05222737). It also followed the principles of modified Helsinki code for human clinical studies (2013) (21) and CONSORT 2010 guidelines for reporting randomized clinical trials (22).

Sample size

Sample size was estimated assuming alpha error= 5% and study power= 80% to detect outcome difference between both groups. Lobo et al. (23) concluded that an average percentage change at 6 months of tooth mobility was 0.31±0.30 in the laser group and 0.28 ± 0.24 in the control group. Based on comparison of means, the minimum sample size was calculated to be 23 per group which will be increased to 25 to make up for cases lost to follow-up. The total sample size required = number of groups × number per group = 2 × 25 = 50.

Sample size is calculated using two-sided independent samples t test at .05 significance level using R software (24).

Study design

A total number of fifty patients diagnosed with severe periodontitis (stage 3 grade C) were included in the study according to the criteria of the AAP and EEP 2017 workshop. Patients were recruited from the outpatient clinic of the Department of Oral Medicine, Periodontology, Oral Diagnosis and Oral Radiology. Faculty of Dentistry, Alexandria University. Group I (test group): included twenty-five patients treated with intra-pocket application of diode laser after SRP at baseline. Group II (control group): included twenty-five patients treated with systemic antibiotic administration of a combination of metronidazole and spiramycin after SRP for two weeks from baseline and 2 weeks antibiotic administration after 2 months. Inclusion criteria included patients of both sexes having severe periodontitis (stage 3 grade C) with clinical attachment loss (CAL) ≥ 5 and probing pocket depth (PPD) ≥ 6 mm. Age of the patients between 15 and 35 years old with rapid rate of bone loss confirmed by panoramic radiographs that were systemically healthy (3). Exclusion criteria included antibiotic use in the last three months, pregnancy, smoking, any systemic disease that could affect the study and the use of antimicrobial mouthwash in the previous 3 weeks (17).

Intervention

Prior to initiating treatment, patients in both groups provided a complete medical and dental history. Phase I therapy was undertaken. Patients were encouraged to maintain proper oral hygiene.

The degree of mobility was measured at baseline by firmly holding the tooth between the handles of two metal instruments (6) and the extent of tooth mobility was recorded following miller's mobility index (8). Class I; movement greater than normal but less than 1 mm. Class II; movement of the crown up to 1 mm or more in lateral direction (buccolingual or mesiodistal direction). Class III; movement of the crown more than 1 mm in lateral and vertical direction or rotation in its socket.

Laser treated group (Figures 1,2)

After scaling and root planing (18), a 980-nm diode laser (Medency Primo, Piazza della Libertà, 49, 36077 Altavilla Vicentina VI, Italy) was used in continuous contact focused mode at 2 Watt of power with a flexible glass fiberoptic of a 300-m spot diameter (16,25), The laser fiber was inserted one mm below the pocket depth to allow absorption of laser energy around its tip (16). From the base of the pocket upward, the laser fiber was inserted in light contact with a sweeping motion that covered the entire epithelial lining, parallel to the root surface toward the diseased soft tissue (16,17). The treatment was repeated until the root's entire circumference was irradiated (17). When signs of a new wound site (fresh bleeding) show, lasing was accomplished (16). The total irradiation time for the entire treatment was around 30 seconds each pocket, with saline solution rinse to avoid root surface heat injury (16).

Antibiotic treated group

The patients were given a combination of Spiramycin 1.5 minimum inhibitory concentration (MIC) and Metronidazole 250 mg (Spirazole forte®, pharoina pharmaceuticals, Helioplis - Cairo, Egypt) at a dosage of 17 mg per Kg (13), taken on an empty stomach for two weeks. The antibiotic was then discontinued for a period of eight weeks and then re-administered three times daily for the following two weeks (13). Patients were given oral hygiene guidelines, which included brushing their teeth twice a day using proper technique.

Clinical evaluation

Patients' oral hygiene status was reassessed after four and twelve weeks after therapy.

The degree of mobility was measured after four and twelve weeks.

Statistical analysis

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. **(**Armonk, NY: IBM Corp**).** The Kolmogorov-Smirnov was used to verify the normality of distribution of variables, Comparisons between groups for categorical variables were assessed using **Chi-square test (Monte Carlo).** While Friedman test for abnormally distributed quantitative variables, to compare between more than two periods or stages and followed by Post Hoc Test (Dunn's) for pairwise comparisons. Significance of the obtained results was judged at the 5% level.

RESULTS

The present study was conducted on fifty individuals with age ranging from 15 to 35 years, divided into two groups. Each group consist of twenty-five patients suffering from severe periodontitis (grade C) (CAL≥5). None of the subjects stated any oral health problems during the study time.

There was highly statistically significant decrease in the degree of teeth mobility in both groups from baseline to the end of the treatment. Yet, there was no statistically significant difference between test and control groups at baseline, 1 month and 3 months (P= 0.239, 0.461, 0.156 respectively). (Table 1, Figure 3)

Although the control group showed an early rapid improvement in mobility after 1 month ($P=0.002^{*}$) in comparison with steady decrease in test group ($P=0.011^{*}$), at the 3rd month the test group showed a more decreased mobility (P=0.003*) in comparison to the control group (P=0.028*). (Table 1, Figure 3)

However, both groups showed a highly statistically significant improvement in the mobility of teeth from base line to the end of treatment ($P<0.001^{*}$). (Table 1, Figure 3)

Figure (1): (A) Medency diode laser device **(B, C)** Intra pocket diode laser application in test group application in test group.

Figure (2): Fresh bleeding after laser therapy.

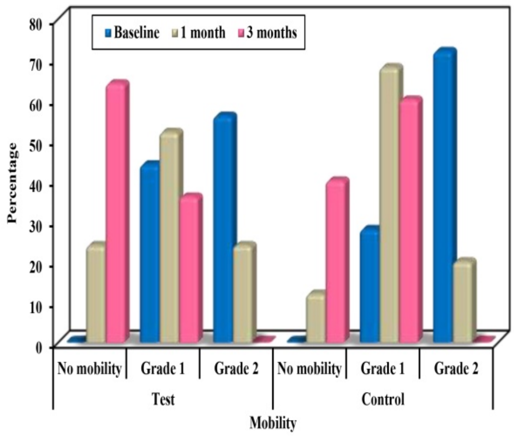

Figure (3): Comparison between the three studied periods according to mobility in each group.

Table (1): Comparison between the three studied periods according to mobility in each group.

Mobility	Baseline	1 month	3 months	p_0
Test	(n = 25)	(n = 25)	(n = 25)	
No mobility	0 (0%)	6 (24%)	16 (64%)	<0.001*
Grade 1	11 (44%)	13 (52%)	9 (36%)	
Grade 2	14 (56%)	6 (24%)	0 (0%)	
Sig. bet. periods	p_1=0.011*,p_2<0.001*,p_3=0.003*			
Control	(n = 25)	(n = 25)	(n = 25)	
No mobility	0 (0%)	3 (12%)	10 (40%)	<0.001*
Grade 1	7 (28%)	17 (68%)	15 (60%)	
Grade 2	18 (72%)	5 (20%)	0 (0%)	
Sig. bet. periods	p_1=0.002*,p_2<0.001*,p_3=0.028*			
(p)	(p=0.239)	(p=0.461)	(p=0.156)	

p: p value for comparing between **Test** and **Control** in each period

p_0: p value for comparing between the studied periods in each group

p_1: p value for comparing between **Baseline** and **1 month**

p_2: p value for comparing between **Baseline** and **3 months**

p_3: p value for comparing between **1 month** and **3 months**

*: Statistically significant at $p \leq 0.05$

DISCUSSION

The aim of the study was to evaluate the efficiency of intra-pocket diode laser therapy in decreasing mobility in cases of stage 3 grade C periodontitis versus systemic antibiotic administration.

The goal of periodontal therapy is to reduce or eliminate bacterial pathogens while also reducing and preventing the inflammatory disease progression (3). Clinicians face challenges in treating aggressive periodontitis because there are no proven protocols or guidelines for disease management (26). One of the first suggested treatment modalities for severe periodontitis (grade C) (previously aggressive periodontitis) is non-surgical scaling and root planing (27). However, due to periodontal pathogens ability to infiltrate within periodontal tissues, scaling and root planing (SRP) does not completely remove them in mild and deep periodontal pockets (28).

Antibiotics, in conjunction with SRP, are the conventional treatment for severe periodontitis (grade C) (previously aggressive periodontitis) (11). Metronidazole in combination with spiramycin has been shown in studies to be a successful therapy for active periodontitis (13). However, it has been established that the use of antibiotics leads to bacterial resistance and a variety of systemic side effects (15,29).

In recent years, laser periodontal therapy has been introduced as an alternative or adjunctive therapy to traditional, mechanical periodontal treatments. Numerous beneficial properties, such as hemostatic effects, calculus removal, or bactericidal activities and detoxification against microbial pathogens, may result in improved treatment outcomes (30).

The most commonly used lasers in periodontics are semiconductor diode lasers (wavelength 820-980), which are primarily utilized for laser-assisted subgingival curettage and periodontal pocket cleaning with varying degrees of success (31,32). However, diode lasers have been shown to be ineffective in eliminating calcified deposits from the root surface, thereafter it should only be used in conjunction with mechanical periodontal therapy (33,34).

Thus, we were interested to investigate the clinical efficiency of laser versus conventional antibiotic therapy on mobility degree in stage 3 grade C (aggressive periodontitis).

Though in our study regarding mobility degree, there was no statistically significant difference between test and control group in decreasing mobility level yet there was an improvement in mobility degree in test group more than control group.

In agreement of our study results, although they worked on chronic periodontitis patients, Kreisler et al. (35) stated that there was a greatest reduction in the tooth mobility degree and probing depth in the group that underwent SRP plus Gallium-Aluminum-Arsenide semiconductor laser (809 nm) therapy in 3 months follow up (35).

The decrease in the degree of mobility was due to complete removal of infected sulcular epithelium and de-epithelialization of the periodontal pockets, which leads to enhanced connective tissue attachment rather than bacterial reduction in the periodontal tissues (35).

Other studies stated that, the removal of infected granulation tissue by laser therapy enhances connective tissue healing with a lowering of probing depth, gingival index, and tooth mobility, as well as a significantly higher recovery of clinical attacks than the initial preparation alone (35–38).

Although Lobo et al. (23) used the 940-diode laser in open flap debridement in severe periodontitis patients they reached the same our study results in decreasing mobility degree significantly over six months.

In previous studies, a diode laser application has been proven to reduce the bacteria in pockets, due to the high absorption of specific laser wavelengths by chromophores. Also diode laser is highly absorbed by haemoglobin and other pigments, making it ideal for soft tissue surgery and removing biofilm from pocket wall (39).

Other researchers reported that using a diode laser in combination with ultrasonic scaling for periodontitis treatment demonstrated a significantly lower incidence of bacteremia in the diode plus ultrasonic group than in the ultrasonic group only. They advocated the use of diode lasers to prevent bacteremia. A 980 nm diode laser has been also used to reduce periodontal pathogenic bacteria in aggressive periodontitis patients (40). Kamma et al. have proven that the total bacterial load in pockets could be reduced by applying laser therapy without the use of systemic antibiotic therapy (16).

Other authors used metronidazole tablets and drops of liquid aplun (a complex compound of lanthanum nitrate and tri-ethylene glycol in glycerol) complexed with teva bone applied inside the periodontal pocket in rapidly progressing periodontitis. The results revealed a marked decrease in tooth mobility following the 30 days of treatment, this was in agreement with our study although they used different complex of medications which may be attributed to anti-inflammatory and antimicrobial activity (40).

In the current study, though the control group showed an early rapid enhancement in mobility by the first month in comparison to the steady enhancement in test group. Yet the late enhancement in mobility between one and three months in laser group was better than antibiotic group. So, laser therapy gave better results than antibiotic on avoiding the systemic side effect of the antibiotics. Taking into consideration the bacterial resistance to the frequent antibiotic administration, we are recommending using laser therapy to reduce the degree of mobility in severe periodontitis (stage3 grade C) with increasing the times for laser application.

The decline in the degree of mobility following intra pocket diode laser therapy indicates that laser therapy is one of the successful treatments of stage 3 grade C periodontitis (aggressive periodontitis). However, reduction in mobility degree in the current study cannot be directly compared to other studies because of shortage of knowledge concerning the exact mechanism by which laser therapy decreases mobility degree also because of the different methodology and drugs delivery used. Hence, additional studies supported by clinical and microbiological analysis are needed to give convincing evidence regarding the advantageous effect of intra-pocket laser therapy in treatment of stage 3 grade C periodontitis.

CONCLUSION

Despite the deficiency of data concerning evaluation of mobility degree in stage 3 grade C periodontitis. In addition to the results of present study that both laser and systemic antibiotic are effective treatment modalities in stage 3 grade C periodontitis. we concluded that intra-pocket laser therapy is better than systemic antibiotic because of antibiotic resistance and systemic side effects.

CONFLICT OF INTEREST
The authors declare that they have no conflict of interest
FUNDING
The authors received no specific funding for this work

REFRENCES

1. Sorsa T, Tjäderhane L, Konttinen YT, Lauhio A, Salo T, Lee H, et al. Matrix metalloproteinases: contribution to pathogenesis, diagnosis and treatment of periodontal inflammation. Ann Med. 2006;38:306-21.
2. Tonetti MS, Jepsen S, Jin L, Otomo-Corgel J. Impact of the global burden of periodontal diseases on health, nutrition and wellbeing of mankind: A call for global action. J Clin Periodontol. 2017;44:456-62.
3. Tonetti MS, Greenwell H, Kornman KS. Staging and grading of periodontitis: Framework and proposal of a new classification and case definition. J Clin Periodontol. 2018;45:149-61.
4. Caton JG, Armitage G, Berglundh T, Chapple ILC, Jepsen S, Kornman KS, et al. A new classification scheme for periodontal and peri-implant diseases and conditions - Introduction and key changes from the 1999 classification. J Clin Periodontol. 2018;45:S1-8.
5. Papapanou PN, Sanz M, Buduneli N, Dietrich T, Feres M, Fine DH, et al. Periodontitis: Consensus report of workgroup 2 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions. J Periodontol. 2018;89:S173-82.
6. Ramfjord SP, Ash MM. Significance of occlusion in the etiology and treatment of early, moderate and advanced periodontitis. J Periodontol. 1981;52:511-7.
7. Glargia M, Lindhe J. Tooth mobility and periodontal disease. J Clin Periodontol. 1997;24:785-95.
8. Miller SC. Textbook of Periodontia (Oral medicine). Philadelphia, USA: Blakiston Co; 1950.
9. Schulte W. The new Periotest method. Compend Suppl. 1988;(12):S410-5.
10. Mühlemann HR, Savdir S, Rateitschak KH. Tooth mobility--its causes and significance. J Periodontol (1930). 1965;36:148-53.
11. Mongardini C, Van Steenberghe D, Dekeyser C, Quirynen M. One stage full-versus partial-mouth disinfection in the treatment of chronic adult or generalized early-onset periodontitis. I. Long-term clinical observations. J Periodontol. 1999;70:632-45.
12. Loesche WJ. The antimicrobial treatment of periodontal disease: changing the treatment paradigm. Crit Rev Oral Biol Med. 1999;10:245-75.
13. Genco RJ, Ciancio SG, Rosling B: Treatment of localized juvenile periodontitis. J Dent Res 60;1981
14. Teughels W, Feres M, Oud V, Martín C, Matesanz P, Herrera D. Adjunctive effect of systemic antimicrobials in periodontitis therapy: a systematic review and meta-analysis. J Clin Periodontol. 2020;47:257-81.
15. Rotzetter P, Le Liboux A, Pichard E, Cimasoni G. Kinetics of spiramycin/metronidazole (Rodogyl®) in human gingival crevicular fluid, saliva and blood. J Clin Periodontol. 1994;21:595-600.
16. Kamma JJ, Vasdekis VGS, Romanos GE. The effect of diode laser (980 nm) treatment on aggressive periodontitis: Evaluation of microbial and clinical parameters. Photomed Laser Surg. 2009;27:11-9.
17. Matarese G, Ramaglia L, Cicciu M, Cordasco G, Isola G. The effects of diode laser therapy as an adjunct to scaling and root planing in the treatment of aggressive periodontitis: A 1-Year Randomized Controlled Clinical Trial. Photomed Laser Surg. 2017;35:702-9.
18. Sopi M, Koçani F, Bardhoshi M, Meqa K. Clinical and Biochemical Evaluation of the Effect of Diode Laser Treatment Compared to the Non-surgical and Surgical Treatment of Periodontal Diseases. Open Dent J. 2020;14:281-8.
19. Borrajo JLL, Varela LG, Castro GL, Rodriguez-Nunez I, Torreira MG. Diode laser (980 nm) as adjunct to scaling and root planing. Photomed Laser Ther. 2004;22:509-12.
20. Axelsson P, Lindhe J. The significance of maintenance care in the treatment of

periodontal disease. J Clin Periodontol. 1981;8:281-94.
21. Aresté N, Salgueira M, World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. JAMA. 2013;310:2191-4.
22. Schulz KF, Altman DG, Moher D. CONSORT 2010 statement: updated guidelines for reporting parallel group randomised trials. J Pharmacol Pharmacother. 2010;11:1-8.
23. Lobo TM, Pol DG. Evaluation of the use of a 940 nm diode laser as an adjunct in flap surgery for treatment of chronic periodontitis. J Indian Soc Periodontol. 2015;19:43-8.
24. Team RC. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. http://www. R-project. org/. 2013.
25. Manjunath S, Singla D, Singh R. Clinical and microbiological evaluation of the synergistic effects of diode laser with nonsurgical periodontal therapy: A randomized clinical trial. J. Indian Soc. Periodontol. 2020:24:2:145.
26. Carvalho LH, D'Avila GB, Leão A, Haffajee AD, Socransky SS, Feres M. Scaling and root planing, systemic metronidazole and professional plaque removal in the treatment of chronic periodontitis in a Brazilian population: I. Clinical results. J Clin Periodontol. 2004;31:1070-6.
27. Teughels W, Dhondt R, Dekeyser C, Quirynen M. Treatment of aggressive periodontitis. Periodontol 2000. 2014;65:107-33.
28. Lafaurie GI, Mayorga-Fayad I, Torres MF, Castillo DM, Aya MR, Barón A, et al. Periodontopathic microorganisms in peripheric blood after scaling and root planing. J Clin Periodontol. 2007;34:873-9.
29. Quee TC, Roussou T, Chan EC. In vitro activity of rodogyl against putative periodontopathic bacteria. Antimicrob Agents Chemother. 1983;24:445-7.
30. Aoki A, Sasaki KM, Watanabe H, Ishikawa I. Lasers in nonsurgical periodontal therapy. Periodontol 2000. 2004;36:59-97.
31. Centty IG, Blank LW, Levy BA, Romberg E, Barnes DM. Carbon dioxide laser for de-epithelialization of periodontal flaps. J Periodontol. 1997;68:763-9.
32. Cobb CM, McCawley TK, Killoy WJ. A preliminary study on the effects of the Nd: YAG laser on root surfaces and subgingival microflora in vivo. J Periodontol. 1992;63:701-7.
33. Tucker D, Cobb CM, Rapley JW, Killoy WJ. Morphologic changes following in vitro CO2 laser treatment of calculus-ladened root surfaces. Lasers Surg Med. 1996;18:150-6.
34. O'Leary TJ. The impact of research on scaling and root planing. J Periodontol. 1986;57:69-75.
35. Kreisler M, Al Haj H, d'Hoedt B. Clinical efficacy of semiconductor laser application as an adjunct to conventional scaling and root planing. Lasers Surg Med. 2005;37:350-5.
36. Giannelli M, Formigli L, Lorenzini L, Bani D. Combined photoablative and photodynamic diode laser therapy as an adjunct to non-surgical periodontal treatment. A randomized split-mouth clinical trial. J Clin Periodontol. 2012;39:962-70.
37. Caruso U, Nastri L, Piccolomini R, d'Ercole S, Mazza C, Guida L. Use of diode laser 980 nm as adjunctive therapy in the treatment of chronic periodontitis. A randomized controlled clinical trial. New Microbiol. 2008;31:513-8.
38. Angelov N, Pesevska S, Nakova M, Gjorgoski I, Ivanovski K, Angelova D, et al. Periodontal treatment with a low-level diode laser: clinical findings. Gen Dent. 2009;57:510-3.
39. Schwarz F, Aoki A, Becker J, Sculean A. Laser application in non-surgical periodontal therapy: a systematic review. J. Clin. Periodontol. 2008 ;35:29-44.
40. Kachesova ES, Shevchenko EA, Uspenskaya OA. A New Regimen of Complex Therapy for Aggressive Periodontitis. Sovrem Tehnol Med. 2017;9:209-15.