Original Article

Erbium, Chromium:Yttrium-Scandium-Gallium-Garnet (Er, Cr:YSGG) Laser Versus Diode Laser in the Treatment of Pericoronitis

CN Eroglu, SK Tunc[1], MN Yuksek[1], S Elasan[2]

Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Akdeniz University, Antalya, Departments of [1]Oral and Maxillofacial Surgery and [2]Biostatistics, Yuzuncu Yil University Faculty of Dentistry, Van, Turkey

Received: 25-Nov-2022;
Revision: 28-Feb-2023;
Accepted: 28-Apr-2023;
Published: 03-Aug-2023

Abstract

Background: There are limited number of studies about the lasers used for the treatment of pericoronitis infection. **Aim:** To compare the Er, Cr:YSGG laser and diode laser applications clinically in the treatment of pericoronitis infection. **Patients and Methods:** Sixty patients with pericoronitis infection were divided into three groups using block randomization: Er, Cr:YSGG + antibiotic group, n = 20 (mean age: 24.20 ± 6.13; 14 females, 6 males); diode group + antibiotic, n = 20 (mean age: 23.45 ± 2.96; 14 females, 6 males); and antibiotic, n = 20 (mean age: 22.45 ± 3.02; 11 females, 9 males). In addition, laser application was performed for patients in the Er, Cr:YSGG and diode laser groups on the 1st and 2nd days until the extraction day. Tooth extractions were performed on the 3rd day for all patients. Patients' pain (with visual analog scale [VAS]), lymphadenopathy, and local edema were clinically evaluated in the first 3 days and on the 7th day of treatment. **Results:** Pain score on the 2nd day of treatment was determined to be significantly lower in the Er, Cr:YSGG + antibiotic laser group as compared with the other two groups (P = 0.019). Although regression of lymphadenopathy on the 3rd day was highest (P = 0.025) in the Er, Cr:YSGG group, there was no significant difference between the groups regarding local edema. **Conclusion:** Er, Cr:YSGG laser improved the healing process in the treatment of pericoronitis and made an important contribution to the treatment.

Keywords: *Diode laser, disinfection, Er, Cr:YSGG, laser treatment, pericoronitis*

Introduction

Pericoronitis is an inflammatory problem associated with infection of the hard and soft tissues around the tooth.[1] Pericoronitis has two types as acute and chronic pericoronitis, of which acute type requires treatment for its clinical symptoms. The clinical strategy in acute type consists of extraction of the relevant tooth after at least 3 days of antibiotic treatment, whereas the clinical strategy in chronic type consists of using analgesics and antimicrobial mouth wash to improve oral hygiene as the first step, which is followed by tooth extraction in case the problem persists.[2] Extraction of the relevant tooth provides a radical and clear solution for potential recurrence of infection in the future.[3] Prior to extraction, indication for antibiotic use may emerge depending on the extent of infection.[4,5]

There are reports on the application of different types of lasers alone or in combination with auxiliary medical agents for infection of many parts of the body.[6,7] High-power laser light is known to have bactericidal effect on the target tissue, cell, or organism and is used in the treatment of inflammatory dental diseases.[8] This antibacterial effect occurs via photothermal, photochemical, or photoablative route.[9] Elimination of pathogens from periodontal pockets, peri-implantitis, and root canal disinfection with erbium, chromium: yttrium-scandium-gallium-garnet

Access this article online

Quick Response Code:

Website: www.njcponline.com

DOI: 10.4103/njcp.njcp_822_22

Address for correspondence: Dr. CN Eroglu, Akdeniz Üniversitesi, Diş Hekimliği Fakültesi, Dumlupınar Bulvarı, Kampus, 07058 Konyaaltı/Antalya Turkey.
E-mail: neslihanakca2003@yahoo.com

How to cite this article: Eroglu CN, Tunc SK, Yuksek MN, Elasan S. Erbium, Chromium:Yttrium-scandium-gallium-garnet (Er, Cr:YSGG) laser versus diode laser in the treatment of pericoronitis. Niger J Clin Pract 2023;26:980-5.

(Er, Cr:YSGG) lasers and diode lasers have been commonly studied.[10-14]

Other studies have demonstrated that laser treatment of pericoronitis either by making a laser incision in the soft tissue over the tooth (operculectomy), photodynamic therapy, or by photobiomodulation therapy.[15-17] Unlike these previous studies, in this study, we aimed to investigate the clinical efficacy of Er, Cr:YSGG and diode lasers in the treatment of pericoronitis.

Material and Methods

A total of 72 patients who were admitted to the Department of Oral and Maxillofacial Surgery with acute pericoronitis were included in the study within a 12 month period. Two clinicians confirmed the pericoronitis treatment need.

Inclusion criteria were, patients' age (18–40 years), had no systemic diseases, did not receive antibiotic or anti-inflammatory drugs in the last month, were not smoking, were not pregnant or on breast feeding, and were observed to have acute pericoronitis and pericoronitis-related lymphadenopathy in the distal and buccal aspects of the vertical positioned partially impacted mandibular third molars. The teeth used in the study were teeth that had previously complained of pericoronitis infection and were in the acute stage of pericoronitis infection at the time of presentation to the clinic. Operculum coverage level was accepted as 1/2-2/3 of the tooth surface.

Patients with any disease (sinusitis, aphthous stomatitis, herpes simplex, etc.) that could affect submandibular lymph nodes were excluded. Six female and six male patients were excluded from the study (due to not attending the appointment, using medication other than the prescribed medication, developing complaints from another tooth at the same time).

Accordingly, 60 eligible patients included were divided randomly into three groups: 1) antibiotic alone group (as the control group), 2) Er, Cr:YSGG + antibiotic group, and 3) diode laser + antibiotic group. The groups were formed using the block randomization. Patients were divided into two groups according to gender. Patients in these two groups were distributed to the three groups as Er, Cr:YSGG + antibiotic, diode + antibiotic, and control groups according to the numbers given from the computer program. All laser subjects and the physician performing the postoperative follow-up and measurements were blinded. Ethical approval for this study (Ethic No: 38-10/08.10.2015) was provided by the Clinical Researches Ethics Committee of the Faculty of Medicine of the University. Clinical Trial registration was done retrospectively and the registration number for this study is TCTR20230123004. All procedures were performed in conformity with the 1964 Helsinki Declaration and its later amendments. Written informed consent of all patients were obtained after informing them about the study objectives and methods.

The study procedure was performed as follows:

Day 1: Preoperative and postoperative clinical data (Proforma) were collected and standard prescription was administered to all subjects as amoxicillin 1,000 mg tablets (Largopen®, 1 g tablets; Bilim Pharmaceuticals, Tekirdag, Turkey) every 12 h via oral route, paracetamol 500 mg tablets (Parol®, 500 mg tablets; Atabay Pharmaceuticals, Istanbul, Turkey) every 8 h via oral route, and chlorhexidine gluconate 4% mouthwash (Klorhex® 200 mL; Drogsan Pharmaceuticals, Ankara, Turkey) 200 mL three times a day for 7 days. Subjects in the laser group underwent the treatment protocol according to the group they were in.

Day 2: According to the groups, laser application was performed on the patients in the laser groups and clinical data were collected. For the control group, no laser intervention was performed. Day 3: Inflamed tissues around tooth were removed with scalpel and the third molar was extracted on the 3rd day under local anesthesia (4% articaine hydrochloride + 1:100,000 epinephrine, 1 ampoule) by the same blinded surgeon. Day 7: Patients were followed up and clinical data were collected. Pain was measured using a 10-cm visual analog scale (VAS) scores. Pain on day 1 was recorded as VAS1, pain on day 2 as VAS2, pain on day 3 as VAS3, and pain on day 7 as VAS7. The subjects were monitored in the first 3 days and on the 7th day for lymphadenopathy regression (present = pain on palpation of lymph nodes, absent = no pain on palpation of lymph nodes). On days 1, 2, 3 and 7, the results of lymphadenopathy examination were evaluated as LAP1, LAP2, LAP3, and LAP7, respectively. Evaluation for local edema (3 = severe, 2 = moderate, 1 = mild, 0 = no edema) in days 1st and 3rd patients were scored.[18] Scoring on day 1 was recorded as Edema1 and scoring on day 3 was recorded as Edema2.

In Er, Cr:YSGG laser + antibiotic group, underside of the operculum of the third molar and inside of the distal and buccal pockets were treated with Er, Cr:YSGG laser (WaterLase iPlus™; USA Biolase® technology Inc., Irvine, CA, USA) on the 1st and 2nd days in the mode of closed pocket therapy with an PT/MZ5 tip at the 1.5 W, 30 Hz, 20% water, and 11% air settings. Total energy dose was 31.5 J per session.

In diode laser + antibiotic group, underside of the operculum of the third molar and inside of the distal and buccal pockets were treated and disinfected with diode laser (Ezlase 940; USA Biolase Technology Inc., Irvine, CA, USA) on the 1st and 2nd days at 940 nm wavelength and 1.5 W power in the continuous mode for three times, each for 7 s. Diode laser was applied at a total energy dose of 31.5 J per session using a laser tip of E4-9 mm and with a pulse length of 0.1 ms and pulse interval of 0.1 ms.

Statistical analysis

The IBM SPSS Statistics for Windows, Version 24.0. (IBM Corp., Armonk, NY, USA) was used for data analysis. The Kolmogorov–Smirnov test was used to test the normality of data. Descriptive statistics for continuous variables was expressed as median, mean, standard deviation, minimum, and maximum. The Kruskal–Wallis H test was used to compare groups for continuous (quantitative) nonparametric variables, and the Bonferroni-corrected post hoc (multiple) test was used to examine between group differences in VAS scores. The Wilcoxon test was used to determine the significance of pre-post measurements. For dichotomous nominal variable analysis, a Chi-square test was used. Spearman's correlation coefficients were calculated separately for each group to determine the relationship between variables. The statistical significance level (α) was set at 5%.

Results

The normality test was used to test the normality of data and revealed non-normal distribution of the variables; thus, nonparametric tests were used. Each group in the study consisted of 20 individuals: Er, Cr:YSGG + antibiotic group (mean age: 24.20 ± 6.13; 14 females, 6 males), diode group + antibiotic (mean age: 23.45 ± 2.96; 14 females, 6 males), and antibiotic (mean age: 22.45 ± 3.02; 11 females, 9 males). No statistically significant difference was found when the mean age between the groups was analyzed (Kruskal–Wallis, $P = 0.439$).

A statistically significant relationship was observed in the comparison of data regarding pain (Day 1, Day 2, Day 3, and Day 7) between the groups. In VAS1, the difference between the diode and antibiotic groups was significant ($P = 0.040$). According to Bonferroni correction as a post hoc test, the mean VAS1 scores of the control group and Er; Cr:YSGG + antibiotic group were similar, but there was a statistically significant difference between the mean VAS1 scores of the control group and the diode + antibiotic group against the diode + antibiotic group (The mean VAS1 score of the diode + antibiotic group was higher than that of the control group). However, the mean VAS1 scores of the Er; Cr:YSGG + antibiotic and diode + antibiotic groups were similar [Table 1].

In VAS2, a significant difference was found between the diode and Er, Cr:YSGG groups ($P = 0.019$). The mean VAS2 score of the Er, Cr:YSGG + antibiotic group was lower than the diode + antibiotic group. According to the Bonferroni correction results performed to determine the source of the difference, there is no statistical difference between the mean VAS2 of the control group and the mean VAS2 of the diode + antibiotic group. Similarly, no statistical difference was observed between the mean VAS2 of the control group and Er, Cr:YSGG + antibiotic group [Table 1]. There is no statistically significant difference between the mean VAS3 ($P = 0.393$) and VAS7 ($P = 0.099$) scores between the groups.

From the analysis, in the Er, Cr:YSGG + antibiotic group, lymphadenopathy regression started earlier than the other two groups and statistically significant

Table 1: Cross-group comparison results of VAS scores

	Group	Median	Mean	Std. Dev.	Min.	Max.	*P
VAS1	Control	4.50	4.39[b]	2.33	1	8	0.040
	Er, Cr:YSGG + antibiotic	5.00	4.90[ab]	2.38	1	9	
	Diode + antibiotic	7.00	6.20[a]	2.17	1	9	
VAS2	Control + antibiotic	5.00	3.89[ab]	2.59	0	8	0.019
	Er, Cr:YSGG + antibiotic	2.00	2.45[b]	2.26	0	9	
	Diode + antibiotic	4.50	4.40[a]	1.90	1	8	
VAS3	Control	2.00	2.44	2.36	0	7	0.393
	Er, Cr:YSGG + antibiotic	1.50	1.90	2.29	0	7	
	Diode + antibiotic	2.00	2.80	2.46	0	8	
VAS7	Control	0.00	0.61	1.72	0	7	0.099
	Er, Cr:YSGG + antibiotic	0.00	0.90	1.48	0	4	
	Diode + antibiotic	1.00	1.35	1.93	0	8	

[a, b, c]: indicates the difference between the groups (Bonferroni corrected post hoc test result). *Kruskal–Wallis Test

difference was observed on day 3 (Chi square test, LAP3 $P = 0.025$) [Table 2]. In all groups, LAP7 data showed statistically significant regression [Table 2].

Evaluation of the change between the edema scores intergroup comparisons on the 1st and 3rd days of the research showed that there was a significant difference in the control group ($P = 0.049$) and in the diode laser group ($P = 0.047$) [Table 3]. No significant difference was observed in the edema scores between the groups (Edema1 $P = 0.589$, Edema2 $P = 0.401$) [Table 4].

From the collection of patients' preoperative data (day 1) until the completion of recovery, no complication, no healing problem, or other side effect due to drugs were experienced by the patients.

Table 2: Analysis of within-group lymphadenopathy data

Groups	LAP	Outcome	*n*	%	**P*
Antibiotic	LAP1	Absent	0	0.0%	.
		Present	20	100.0%	
	LAP2	Absent	7	35.0%	0.059
		Present	13	65.0%	
	LAP3	Absent	12	60.0%	0.346
		Present	8	40.0%	
	LAP7	Absent	18	90.0%	0.001
		Present	2	10.0%	
Er, Cr:YSGG + Antibiotic	LAP1	Absent	0	0.0%	.
		Present	20	100.0%	
	LAP2	Absent	8	40.0%	0.371
		Present	12	60.0%	
	LAP3	Absent	15	75.0%	0.025
		Present	5	25.0%	
	LAP7	Absent	15	75.0%	0.025
		Present	5	25.0%	
Diode + Antibiotic	LAP1	Absent	0	0.0%	.
		Present	20	100.0%	
	LAP2	Absent	7	35.0%	0.180
		Present	13	65.0%	
	LAP3	Absent	12	60.0%	0.371
		Present	8	40.0%	
	LAP7	Absent	15	75.0%	0.025
		Present	5	25.0%	

*One sample Chi-Square test

Discussion

In this study, we investigated whether two different lasers would have a clinically favorable effect in the treatment of pericoronitis, one of the common infections of the oral region. According to our study results, Er, Cr:YSGG laser was found to be highly effective in the regression of infection findings of pericoronitis.

There are very few studies in the literature on the use of lasers to treat pericoronitis infection. In the study by Sezer *et al*.,[17] 1,064 nm wavelength Nd:YAG laser and 808 nm and 606 nm diode lasers were used as photobiomodulation therapy for treatment of pain and trismus but not for the treatment of pericoronitis infection. In this particular study, trismus and oral health-related quality of life data collected 24 h after laser application showed that the 1,064 nm Nd:YAG laser and 808 nm wavelength diode laser showed significantly better results in trismus and oral health-related quality of life compared with the 606 nm wavelength diode laser and control group. Moreover, all groups were reported to show similar pain findings.[17] In contrast to Sezer *et al*., in the present study, in Er, Cr:YSGG and diode laser groups, a significant reduction was observed in the pain on day 2 (VAS2) as compared with the pain on day 1 (VAS1). The reason for the decrease in pain may be the photobiomodulation effects of the lasers in the surrounding tissues, although their antimicrobial efficacy was targeted.

Table 3: Findings of intergroup comparison of edema value

	Control				Er, Cr:YSGG + antibiotic				Diode + antibiotic			
	Differences		*n*	**P*	Differences		*n*	**P*	Differences		*n*	**P*
	Mean	Std. Dev.			Mean	Std. Dev.			Mean	Std. Dev.		
Edema1-Edema2	0.389	0.778	20	0.049	0.450	1.191	20	0.107	0.500	1.051	20	0.047

*Wilcoxon Signed Ranks Test

Table 4: Cross-group comparison results of edema values

	Group	Median	Mean	Std. Dev.	Min.	Max.	**P*
Edema1	Control	1.00	1.00	0.69	0	2	0.589
	Er, Cr:YSGG + antibiotic	1.00	1.20	0.77	0	2	
	Diode + antibiotic	1.00	1.00	0.73	0	2	
Edema2	Control	0.50	0.61	0.70	0	2	0.401
	Er, Cr:YSGG + antibiotic	1.00	0.75	0.64	0	2	
	Diode + antibiotic	0.00	0.50	0.69	0	2	

*Kruskal–Wallis Test

There are studies reporting diode laser as a successful treatment in the periodontal pockets, which is an anaerobic environment, and in cases of periimplantitis.[19,20] In a review, different types of laser (Nd:YAG, CO2, Er, Cr:YSGG, Er:YAG, and diode laser) therapies were compared in the surgical and nonsurgical treatment of peri-implantitis.[20] The study reported that diode laser was quite effective in peri-implantitis in terms of bactericidal efficacy. It has been stated that diode laser and low-power pulsed Nd:YAG laser used in the treatment of chronic periodontitis in combination with scaling and root planing result in better bacterial elimination from periodontal pockets and have an impact on the areas that could not be reached by scaling and root planing alone.[21,22] But some authors also stated that laser application provided no additional benefit as compared with surgical therapy and laser application had no effect in reducing gingival inflammation in the treatment of chronic periodontitis.[23,24] In this study, unlike the literature, edema decreased faster in the laser groups than in the control group.

In the present study, antibiotic + diode laser group showed poorer outcomes in terms of VAS scores as compared with the other groups. It was observed that the disinfection mode that we used in the diode laser was insufficient for the areas covered with soft tissue where pericoronitis occurred. Anaerobic organisms have been demonstrated to be the causative factor in most of the pericoronitis cases.[25] For this reason, the region's being unavailable for mechanical cleaning might be effective in the microbiological media's returning back to the former state. Moreover, increased heat in the region during laser application could provide positive microbiological effect on existing pathogenic anaerobic flora. In the current study, it was observed that diode laser application did not make a difference in lymphadenopathy regression. In contrast, disinfection of the pocket with laser in the antibiotic + Er, Cr;YSGG laser group provided anaerobic media to be destroyed and allowed abscess drainage, which resulted in regression of the infection. Hence, regression of lymphadenopathy was evaluated as clinical data and the fastest regression was observed in the Er, Cr:YSGG + antibiotic group. On the other hand, the wavelength and disinfection strength of the Er, Cr:YSGG laser may have provided a more effective antimicrobial effect as compared with the diode laser. Indeed, in the literature, the Er, Cr:YSGG laser has been shown to be more effective in nonsurgical periodontal therapy as compared with 940 nm diode laser.[26] Our study results are consistent with the literature in this regard.

A decrease at a similar level was observed on the 3rd day local edema evaluations as compared with the 1st day evaluations in the diode and Er, Cr:YSGG laser groups. The decrease in edema was lower in the control group as compared with the laser groups, through which the anti-inflammatory effects of lasers may have positively affected our results.

One of the limitations of this study can be considered that the evaluations were conducted based only on clinical level. It is possible that a microbiological or histological examination can result in different outcomes. Histological evaluation of inflammatory findings could be considered. However, in pericoronitis cases patients generally apply to clinics after waiting a couple of days in case of disappearance of the disease by itself. Therefore, we treat many patients in the period that their diseases slowly begin to become chronic from acute phase due to body defense system or physiological-mechanical reasons during this waiting period. Accordingly, initial acute phase of the disease course could not be evaluated, only late acute phase could be evaluated. This could have been another limitation for inflammatory evaluation.

In the current study, using the laser systems alone could not be used due to the strict rules of the Local Ethics Committee. We think that drawbacks on this issue can be compensated in further studies and we believe that the present study will guide future studies aiming at laser treatment of pericoronitis without antibiotic therapy. The outcomes of the present study indicated Er, Cr:YSGG laser as the effective step.

Nevertheless, we could have created another group in which both Er, Cr:YSGG laser and diode laser are used. The combined use of Er, Cr:YSGG and diode lasers could have been more effective; however, the concomitant use of these laser systems may not always be cost-effective.

Conclusions

In conclusion, within the limitations of the present study, Er, Cr:YSGG laser improved the healing process in the treatment of pericoronitis and made an important contribution to the treatment.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Nitzan DW, Tal O, Sela MN, Shteyer A. Pericoronitis: A reappraisal of its clinical and microbiologic aspects. J Oral Maxillofac Surg 1985;43:510-6.
2. Renton T, Wilson NH. Problems with erupting wisdom

teeth: Signs, symptoms, and management. Br J Gen Pract 2016;66:e606-8.
3. Hendek MK, Şenses F, Kisa Ü, Aksoy N, Tekin U. Is the level of nitric oxide in the dental follicular tissues of impacted third molars with a history of recurrent pericoronitis a true marker of oxidative stress? J Oral Maxillofac Surg 2017;75:2058-62.
4. Sixou JL, Magaud C, Jolivet-Gougeon A, Cormier M, Bonnaure-Mallet M. Evaluation of the mandibular third molar pericoronitis flora and its susceptibility to different antibiotics prescribed in France. J Clin Microbiol 2003;41:5794-7.
5. Chan Y, Lai CH. Bactericidal effects of different laser wavelengths on periodontopathic germs in photodynamic therapy. Lasers Med Sci 2003;18:51-5.
6. Gutknecht N, Van Betteray C, Ozturan S, Vanweersch L, Franzen R. Laser supported reduction of spesific microorganisms in the periodontal pocket with the aid of an Er, Cr:YSGG laser: A pilot study. ScientificWorldJournal 2015;2015:450258.
7. Dahlén G. Microbiology and treatment of dental abscesses and periodontal-endodontic lesions. Periodontol 2000 2002;28:206-39.
8. Türkün M, Türkün LS, Celik EU, Ateş M. Bactericidal effect of Er, Cr:YSGG laser on Streptococcus mutans. Dent Mater J 2006;25:81-6.
9. Wilson M. Bactericidal effect of laser light and its potential use in the treatment of plaque-related diseases. Int Dent J 1994;44:181-9.
10. Fenol A, Boban NC, Jayachandran P, Shereef M, Balakrishnan B, Lakshmi P. A qualitative analysis of periodontal pathogens in chronic periodontitis patients after nonsurgical periodontal therapy with and without diode laser disinfection using benzoyl-dl arginine-2-naphthylamide test: A randomized clinical trial. Contemp Clin Dent 2018;9:382-7.
11. Monzavi A, Fekrazad R, Chinipardaz Z, Shahabi S, Behruzi R, Chiniforush N. Effect of various laser wavelengths on temperature changes during periimplantitis treatment: An *in vitro* study. Implant Dent 2018;27:311-6.
12. Wang X, Cheng X, Liu X, Wang Z, Wang J, Guo C, *et al*. Bactericidal effect of various laser irradiation systems on Enterococcus faecalis biofilms in dentinal tubules: A confocal laser scanning microscopy study. Photomed Laser Surg 2018;36:472-9.
13. Ustun K, Hatipoglu M, Daltaban O, Felek R, Firat MZ. Clinical and biochemical effects of erbium, chromium: yttrium, scandium, gallium, garnet laser treatment as a complement to periodontal treatment. Niger J Clin Pract 2018;21:1150-7.
14. Betancourt P, Merlos A, Sierra JM, Camps-Font O, Arnabat-Dominguez J, Viñas M. Effectiveness of low concentration of sodium hypochlorite activated by Er, Cr:YSGG laser against Enterococcus faecalis biofilm. Lasers Med Sci 2019;34:247-54.
15. Barak S, Katz J, Kaplan I. The use of the CO 2 laser in oral surgery in the military. J Clin Laser Med Surg 1992;10:31-5.
16. Elsadek MF, Ahmed BM, Eskandrani RM. Level of pain intensity, cytokine profiling and microbial load after photodynamic therapy in acute severe pericoronitis. Photodiagnosis Photodyn Ther 2020;31:101830.
17. Sezer U, Eltas A, Ustün K, Senyurt SZ, Erciyas K, Aras MH. Effects of low-level laser therapy as an adjunct to standard therapy in acute pericoronitis, and its impact on oral health-related quality of life. Photomed Laser Surg 2012;30:592-7.
18. Kaufman KL, Mann FA, Kim DY, Lee S, Yoon HY. Evaluation of the effects of topical zinc gluconate in wound healing. Vet Surg 2014;43:972-82.
19. Crispino A, Figliuzzi MM, Iovane C, Del Giudice T, Lomanno S, Pacifico D, *et al*. Effectiveness of a diode laser in addition to non-surgical periodontal therapy: Study of intervention. Ann Stomatol (Roma) 2015;6:15-20.
20. Natto ZS, Aladmawy M, Levi PA Jr, Wang HL. Comparison of the efficacy of different types of lasers for the treatment of peri-implantitis: A systematic review. Int J Oral Maxillofac Implants 2015;30:338-45.
21. Dixit S, Doshi Y, Shah MU, Dabholkar CS. Management of chronic generalized periodontitis using diode laser. J Indian Soc Periodontol 2016;20:88-90.
22. Neill ME, Mellonig JT. Clinical efficacy of the Nd: YAG laser for combination periodontitis therapy. Pract Periodontics Aesthet Dent 1997;9 (6 Suppl):1-5.
23. Yadwad KJ, Veena HR, Patil SR, Shivaprasad BM. Diode laser therapy in the management of chronic periodontitis-A clinico-microbiological study. Interv Med Appl Sci 2017;9:191-8.
24. Liu CM, Hou LT, Wong MY, Lan WH. Comparison of Nd: YAG laser versus scaling and root planing in periodontal therapy. J Periodontol 1999;70:1276-82.
25. Sixou JL, Magaud C, Jolivet-Gougeon A, Cormier M, Bonnaure-Mallet M. Microbiology of mandibular third molar pericoronitis: Incidence of beta-lactamase-producing bacteria. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2003;95:655-9.
26. Ertugrul AS, Tekin Y, Talmac AC. Comparing the efficiency of Er, Cr;YSGG laser and diode laser on human β-defensin-1 and IL-1β levels during the treatment of generalized aggressive periodontitis and chronic periodontitis. J Cosmet Laser Ther 2017;19:409-17.