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Medical Comparison of Scaling and Root Planning (SRP) and Er, Cr: YSGG Laser for Chronic Periodontitis Treatment

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ABSTRACT

Purpose: Chronic periodontitis is the most common form of periodontal disease. The present study assessed the clinical effects of scaling and root planing (SRP) and Er,Cr:YSGG laser for chronic periodontitis treatment.
Methods: 16 chronic periodontitis patients were treated with two different methods (SRP and laser). Each method was implemented on one posterior sextant. Clinical parameters including CAL, BOP, PPD, GR, and PI were measured before the intervention**.**
Results: The mean percentage of BOP in SRP and laser groups was 46% and 62%, respectively, one month after the intervention (P<0.05). The laser group's minimum and maximum mean CAL were midlingual and mesiolingual, respectively (P<0.05). The minimum and maximum mean PPD values of the teeth one month after the treatment with the laser were obtained by the midlingual and mesiolingual, respectively. The mean PPD values were significantly different between midlingual and mesiobuccal areas (P<0.05). The mean GR value in SRP and laser group one month after the intervention was 1.63 and 1.19, respectively (P<0.05). The PI in both groups before and after the intervention was similar; however, the differences before and after treatment were significant in both groups.
Conclusion: The value of BOP, CAL, PD, and GR decreased in the two groups, and the decrease was more in the laser group. In addition, PI remained unchanged in the two groups before and after the intervention.

GRAPHICAL ABSTRACT

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Introduction

Periodontal disease is a prevalent and complicated inflammatory disease that destroys soft and hard tissues supporting the teeth and results in the gingival and bone recession and formation of pockets [1]. The complication is called periodontitis when inflammatory changes progress along with the roots and through periodontal pockets toward the apical [2]. Periodontitis is an inflammatory disease that damages the teeth supporting tissue caused by one or a group of specific microorganisms. The symptoms are extensive damage to the periodontal ligament and alveolar bones, formation of pockets, gingival recession, or both. Without medical intervention, the disease may lead to tooth loss (Figure 1). The disease is considered a significant factor in losing tooth or edentulism in adults [3,4]. The most common periodontal disease factors are local factors such as dental plaque and calculus [5]. While the mechanical treatment of periodontal disease through the standard method is applicable, the disease may recur because of the penetration of bacteria into the gum tissue of periodontal pockets [4]. In such cases, periodontal surgery or local use of antibacterial drugs is recommended to decrease pockets' dept and control the disease. Finding more efficient and less invasive treatment for the disease constitutes a significant part of dentistry research.

Figure 1: Scaling and root planing

The introduction of lasers to dentistry over the past years and the availability of various laser devices with different wave lengths for dentistry treatment is promising. Laser has several advantages such as less pain, less inflammation, and faster recovery compared to that of the periodontal surgeries. In addition, the laser has antibacterial effects (bactericide) [4-6]. Erbium, Chromium: Yttrium- Scandium- Gallium- Garnet laser (Er, Cr; YSGG) is a far-infrared laser at 2780 wavelength, which can remove soft and hard tissues with antibacterial effects [6]. The device has a radial firing tip perio (RFTP) at 9 and 14mm sizes capable of radiating 360° light, which can be used in periodontal treatment.

Dakhil *et al*. evaluated the effect of diode laser (940 nm) as a supplementary treatment o periodontal pockets and revealed a reduction in plaque index (PI), gingival index (GI), and probing depth after three months in the control and test groups. They also indicated that as a supplementary treatment, diode laser had no advantage over SRP for treating periodontal plaques [6].

Matarese *et al*. showed that diode laser can be used as a supplementary scaling and root planning treatment for invasive periodontal treatment, and it improved periodontal parameters over a year. The intervention group demonstrated a notable improvement of PPD and CAL compared to the control group. They also found a significant decrease in the clinical parameters in the intervention group after one year compared to the control group. At the same time, there was no difference between the two groups in terms of microbial and inflammatory mediators [7].

Vaziri *et al*. investigated the influence of diode laser 980 nm on periodontal clinical parameters after non-operational periodontal treatment. Their findings showed a significant change in clinical parameters of PI and pocket depth. On the

other hand, they reported no significant difference between the intervention and control groups in terms of clinical attachment level (CAL) and pocket depths 3-5 mm and <5mm [8] (Figure 2).

Figure 2: Scaling and Root Planing

Ge L. *et al*. studied the effects of Er, Cr:YSGG laser and subgum debridement using manual devices to treat furcal lesions in chronic periodontitis patients and concluded that both methods were effective decreasing BOP, PD, and CAL. Still, the decrease in BOP and PD in the laser group was significantly higher than subgum debridement using manual devices [9].

Pavone C *et al*. investigated the effect of Er, CR: YSGG laser with and without SRP and medical devices to experiment treatment of periodontitis in rats and concluded that formation of bone following laser and SRP treatment was notable. On the other hand, the level of bone formation in the short term, particularly in the group that received laser therapy with the court along with SRP, was higher than the group that only received SRP treatment [10].

Al-Falaki R. *et al*. studied the treatment of infra-bone lesions using two lasers with different wavelengths. They concluded that the pocket depth decreased notably after SRP and laser therapy at two wavelengths (Er, Cr: YSGG and Diode). In addition, there was a notable increase in apicocoronally bone formation and bone fill [11].

A case series by Ishan (2016) examined the effects of Er, Cr: YSGG on the treatment of infra-bone lesions in chronic periodontitis using most minor invasive surgery and closed flap and found a considerable decrease in pocket depth and a notable mean bone fill score [12]. A retrospective cohort study on using ER, Cr:YSGG to treat periodontitis without flap concluded that the pockets depth and BOP decreased considerably one year after using the laser [13].

Material and Methods

Data gathering Tool, Validity, and Reliability

In addition to the participants' demographical specifications, the treatment results were measured for each posterior sextant teeth (except for wisdom teeth) by a periodontist twice (before treatment and one month after treatment) using the University of Michigan O probe. The periodontist was not aware of the types of treatment.

A one-month follow-up was adequate since only the clinical effects were examined without examining radiographical effects. This also increased the chance of having more candidates for participation. Three- and six-months follow-ups were also performed for the interested participants, which was not in the objectives list of the study.

Sampling

After selecting 16 participants, the effects of the two treatments were examined in each participant so that each participant was considered as their pair using the splitmouth method for performing the intervention. For each participant, all teeth were scaled, and root planning mainly was done using a piezoelectric scaling device with a pointy probe (SPR). Afterward, Er,Cr:YSGG laser (1.5w, 30hz H, 40%A, 70%w) with RFTP 14 tip was implemented on a randomly selected sextant at 1mm distance from the depth of pocket through up/down sweeping movement followed by orderly and overlapping mesiodistal movements at an angle less than 15° parallel to the longitude axis of the tooth. To blind the patients, the whole SRP + laser process was repeated for the rest of the teeth without laser radiation. Given that the pen head had 360°

radiation, the whole root surface and plaque wall were debridemented.

Using the same setting and at 3 mm from the sulcus, the external surface of the epithelium was de-epithelialized. This gave cells with PDL or bone sources more chance to enter the root surface before epithelial cells.

To blind the patients about the type of treatment, the SPR group underwent the same process as the SPR+laser group with the laser beam OFF. The whole treatment process was carried out using a periodontist. The measured parameters were the percentages of PI and BOP and PD, CAL, and GR values.

Sample size

As participations had to be voluntarily and following [14], 16 patients with moderate-severe periodontitis entered the study. The Inclusion criteria were: Patients older than 20 years; No systemic disease; Not pregnant or breastfeeding; Not using Tabacco products; Diagnosed with generalized moderate-severe chronic periodontitis; and Pockets 4-7mm deep with no angular bone lesions. The Exclusion criteria were: Developing a systemic disease during the study (one month); Becoming pregnant during the study (one month), and using antibiotics during the study.

16 participants who met the inclusion criteria were selected through convenient sampling. The participants expressed their informed consent to participate.

Data Analysis

Given the correlation between the observations, data analyses were done using repeated measures ANOVA and paired t-test with Bonferroni adjustment or GEE model. If needed, non-parametric tests like Wilcoxon ranks were used.

Results and Discussion

Sixteen patients with chronic periodontitis at the School of Dentistry, Hamedan-Iran, entered a clinical trial two-side blind study through convenient sampling. The participants were treated with SPR and SPR + laser so that scaling and root planning of one randomly selected posterior sextant of the jaw was treated with SPR, and the other side was treated with SPR + laser. In this way, all the participants received both treatments and each participant was his/her own pair.

One way of representing raw data as comprehendible information is to use tables and statistical indices. Using statistics, it is easier to conclude the findings.

Demographical information (age and gender) was analyzed using max, min, mean, SD, frequency, and frequency percentage. Given that each patient was their pair, the two groups were identical participant by participant. Descriptive statistics were used to compare the clinical effects of the two treatment methods. The clinical effects were the percentage of teeth with bleeding during probing, distance from CEJ to sulcus depth that could be probed, percentage of the teeth with visible plaque (grade 2 and 3), the distance between the gum margin to the depth of pocket, and distance from CEF to the gum margin, which were analyzed for both treatment methods using mean and SD scores. Study hypotheses and clinical effects assessment for the two treatment methods were tested using paired t-test. None of the participants left the study until the end, and data analyses were based on the data of all participants. In addition, data analyses were done in SPSS (v.23) with a confidence level of 0.95.

Demographical variables (age and gender)

The following tables briefly show the demographical information of the participants. As to gender, a qualitative variable, frequency and frequency percentages were used.

Table1: Participants in terms of age

Variable	Min	Max	Mean	SD
Age	23	52	36.79	7.18

As listed in Table 1, the youngest and older participants were 23 and 52 years old, and the mean age of the participants was 36.79±7.18.

Table2: Definite and relative frequency in terms of gender

Variable	Value	F	F (%)
Gender	M	9	56.30
	F	7	43.80
Total		16	100

As listed in Table 2, the majority of participants (56.30%) were men.

Clinical Effects of SPR and SPR + Laser before and one Month after Intervention

The clinical effects under consideration are bleeding during probing, the distance between CEF and sulcus depth that can be probed, percentage of teeth with visible plaque (grade 2 and 3), the distance between gum margin and depth of the pocket, and distance between CEJ to gum margin with SPR and SPR + llaser before and one month after the intervention. The variables were described using mean and SD scores.

Table 3: Percentage of teeth with bleeding during probing for both intervention groups before and one month before the intervention

Variable	Measurement	SPR + laser (n = 63)		SPR (n=63)	
		Mean	SD	Mean	SD
mesiobuccal	Before intervention	0.96	0.17	0.96	0.17
	One month after intervention	0.46	0.50	0.62	0.48
Midbuccal	Before intervention	0.96	0.17	0.96	0.17
	One month after intervention	0.46	0.50	0.62	0.48
Distobuccal	Before intervention	0.96	0.17	0.96	0.17
	One month after intervention	0.46	0.50	0.62	0.48
Mesiolingual	Before intervention	0.96	0.17	0.96	0.17
	One month after intervention	0.46	0.50	0.62	0.48
midlingual	Before intervention	0.96	0.17	0.96	0.17
	One month after intervention	0.46	0.50	0.62	0.48
distolingual	Before intervention	0.96	0.17	0.96	0.17
	One month after intervention	0.46	0.50	0.62	0.48

As listed in Table 3, the mean ± SD of the percentage of gum bleeding was the same with both treatments in all individuals and at all sites before the intervention and one month after the intervention. The mean ± SD of gum bleeding percentage was the same with both treatments in all individuals at all sites one month after the intervention. In general, the mean score of gum bleeding percentage was the same with both treatments before the intervention. One month after the intervention, the mean percentage of gum bleeding in SPR method was higher than that of SPR+ laser. Moreover, gum bleeding decreased one month after the intervention compared to before the intervention with both treatments.

Table 4: Distance from CEJ to teeth gum margin in the two groups before and one month after the intervention based on sites

Variable	Measurement	SPR+ laser (n=64)		SPR (n=64)	
		Mean	SD	Mean	SD
mesiobuccal	Before intervention	2.31	2.98	2.26	2.21
	One month after intervention	1.87	2.23	2.09	2.14
Midbuccal	Before intervention	1.34	2.24	0.92	1.62
	One month after intervention	1.17	2.05	0.92	1.63
Distobuccal	Before intervention	2.14	2.96	2.28	2.52
	One month after intervention	1.76	2.22	2.13	2.43
Mesiolingual	Before intervention	1.96	2.17	1.92	2.05
	One month after intervention	1.67	1.81	1.72	2.07
midlingual	Before intervention	0.50	0.89	0.46	1.09
	One month after intervention	0.36	0.80	0.25	0.83
distolingual	Before intervention	1.52	2.11	1.79	2.18
	One month after intervention	1.18	1.70	1.64	2.11

As listed in Table 4, the min and max mean distance from CEJ to the gum margin in SPR + laser group before and one month after the intervention was seen at midlingual and mesiobuccal sites, respectively. The min and max mean distance from CEF to the gum margin in the SPR method before and one month after the intervention were seen at midlingual and distobuccal sites. Before the intervention, the mean distance from CEJ to the gum margin with SPR treatment method at mesiobuccal, Mesiolingual, midlingual, and Midbuccal sites was less than that of with SPR + laser. The mean distance from CEJ to the gum margin in the SPR method at Distobuccal and distolingual sites was higher than that of the SPR + laser method. After the intervention, the mean distance from CEJ to the gum margin at the site mesiobuccal, distobuccal, Mesiolingual, and distolingual with SPR method was higher than that with SPR + laser method. The mean distance from CEJ to the gum margin at Midbuccal and midlingual sites with SPR method was less than with SPR + laser method [after the intervention]. One month after the intervention, the mean distance from CEJ to the gum margin in both intervention methods at all sites was lower than that before the intervention. The mean distance from CEJ to the gum margin with SPR method decreased at all sites except for Midbuccal one month after the intervention compared to before the intervention. The mean distance from CEJ to the gum margin with the SPR method did not change before and one month after the intervention at the Midbuccal site.

Table 5: Distance from the gum margin to the dept of teeth pockets in the two groups before and one month after the intervention based on sites

Variable	Measurement	SPR + laser (n=64)		SPR (n=64)	
		Mean	SD	Mean	SD
mesiobuccal	Before intervention	3.75	2.61	3.50	2.26
	One month after intervention	3.26	2.10	3.51	2.45
Midbuccal	Before intervention	1.89	1.89	2.03	1.54
	One month after intervention	1.75	1.64	1.83	1.39
Distobuccal	Before intervention	3.39	2.38	3.59	2.51
	One month after intervention	3.21	2.13	3.35	2.41
Mesiolingual	Before intervention	3.56	2.18	3.23	2.11
	One month after intervention	3.33	1.87	3.15	2.05
midlingual	Before intervention	1.86	1.19	1.39	0.94
	One month after intervention	1.73	1.10	1.37	0.88
distolingual	Before intervention	3.20	2.13	3.00	2.33
	One month after intervention	2.91	1.84	2.95	2.28

As listed in Table 5, the min and max mean teeth pocket depth in SPR + laser treatment before the intervention was at midlingual and mesiobuccal sites, respectively. The min and max mean teeth pocket depth in SPR treatment before the intervention was at midlingual and Distobuccal sites, respectively. The min and max mean teeth pocket depth in the SPR + laser treatment group one month after the intervention was at midlingual and Mesiolingual sites. The min and max mean teeth pocket depth in the SPR treatment group one month after the intervention was at midlingual and mesiobuccal sites. The mean depth of teeth pocket in SPR treatment group at mesiobuccal, Mesiolingual, midlingual, and distolingual sites was less than that in SPR + laser group. The mean teeth pocket depth in SPR group at distobuccal and Midbuccal sites was higher than that in SPR + laser group. The mean teeth pocket depth in the SPR + laser group decreased one month after the intervention at all sites compared to before the intervention. The mean teeth pocket depth in the SPR group decreased at all sites except for mesiobuccal one month after the intervention compared to before the intervention. Mean teeth pocket depth in the SPR group increased at mesiobuccal site one month after the intervention compared to before the intervention.

Table 6: The gingival recession in the participants with two treatment methods before and one month after the intervention

Variable	Measurement	SPR + laser (n=16)		SPR (n=16)	
		Mean	SD	Mean	SD
Gingival recession	Before intervention	2.13	0.62	2.13	0.62
	After intervention	1.18	0.75	1.63	0.81

As listed in Table 6, the mean and SD of gingival recession in the participants were the same for the two treatment groups before the intervention. One month after the intervention, gingival recession in the SPR group was higher than that in SPR + laser group. The mean score of gingival recession in the two treatment groups after the intervention decreased in general compared to before the intervention.

Table 7: Plaque index of teeth in the participants of the two groups before and one month after the intervention

Variable	Measurement	SPR + laser (n=16)		SPR (n=16)	
		Mean	SD	Mean	SD
PI (%)	Before intervention	72.68	28.91	27.68	28.91
	After intervention	27.31	9.27	27.31	9.27

As listed in Table 7, the mean and SD of PI percentage of teeth in the participants of the two groups were the same before the intervention. In addition, there was a decrease in the mean and SD of PI percentage one month after the intervention with the two treatments.

Comparing the clinical effect of SPR and SPR + laser

The clinical effects of SPR and SPR+laser treatments were examined using the data collected from 16 patients. To this end, the jaw under treatment was compared before the treatment using paired t-test. The mean percentage of teeth with bleeding during probing, distance from CEJ to the depth of sulcus that could be probed, the percentage of teeth with visible plaque (grade 2 and 3), the distance between the gum margin to the depth of the pocket, and distance from CEJ to the gum margin were compared using paired t-test before and one month after the intervention.

Table 8: Mean percentage of teeth with bleeding during probing in the participants with SPR and SPR+ laser method before and one month after the intervention

Variable	Measurement	SPR + laser (n=63)		SPR (n = 63)	
		Mean	SD	Mean	SD
Percentage of gum bleeding	Before intervention	0.96	0.17	0.96	0.17
	One month after bleeding	0.46	0.50	0.62	0.48
Difference between before and after the treatment		0.51	0.50	0.35	0.48
Paired t-test		8		5.76	
P_value		<0.001		<0.001	

As seen in Table 8, the mean and SD of the percentage of gum bleeding at all sites were the same with the two intervention methods before and one month after the intervention. Therefore, the results for one site can be generalized to all sites. Given the results in Tables 1-4-5 and 1-3-3, the mean and SD of the percentages of gum bleeding with the two intervention methods were the same in all participants. One month after the intervention, the mean percentage of gum bleeding in the participant with SPR was higher than that in SPR + laser group. Gum bleeding percentage in the two intervention groups decreased compared to before the intervention. Based on paired t-test, the decrease in gum bleeding percentage was significant with both intervention methods.

As listed in Table 9, the mean distance from CEJ to gum margin in SPR + laser group decreased at all sites after the intervention. The decrease was significant at mesiobuccal, distobuccal, Mesiolingual, midlingual, and distolingual sites. The mean distance from CEJ to the gum margin in SPR decreased at all sites one month after the intervention except for Midbuccal site. The decrease was significant at Distobuccal, Mesiolingual, and midlingual sites. The mean distance from CEJ to the gum margin with the SPR method remained unchanged before and one month after the intervention

Table 9: Mean distance from CEJ to the gum margin with the two intervention methods before and one month after the intervention based on the sites

Variable	Measurement	SPR + laser (n=64)		SPR (n=64)	
		Mean	SD	Mean	SD
mesiobuccal	Before intervention	2.31	2.98	2.26	2.21
	After intervention	1.87	2.23	2.09	2.14
Difference before and after the intervention		0.44	1.25	0.17	0.10
Paired t-test		2.87		1.66	
P_value		0.007		0.101	
Midbuccal	Before intervention	1.34	2.24	0.92	1.62
	One month after intervention	1.17	2.05	0.92	1.63
Difference before and after the intervention		0.17	1.13	0	0.5
Paired t-test		1.21		0	
P_value		0.23		1	
Distobuccal	Before intervention	2.14	2.96	2.28	2.52
	One month after intervention	1.76	2.22	2.13	2.43
Difference before and after the intervention		0.38	0.93	0.16	0.51
Paired t-test		3.21		2.45	
P_value		0.002		0.017	
Mesiolingual	Before intervention	1.96	2.17	1.92	2.05
	One month after intervention	1.67	1.81	1.72	2.07
Difference before and after the intervention		0.30	0.79	0.20	0.07
Paired t-test		3.05		2.72	
P_value		0.004		0.008	
midlingual	Before intervention	0.50	0.89	0.45	1.09
	One month after intervention	0.36	0.80	0.25	0.83
Difference before and after the intervention		0.14	0.56	0.20	0.78
Paired t-test		2.01		2.09	
P_value		0.048		0.041	
distolingual	Before intervention	1.51	2.11	1.79	2.18
	One month after intervention	1.18	1.70	1.64	2.11
Difference before and after the intervention		0.33	0.96	0.15	0.08
Paired t-test		2.73		1.79	
P_value		0.008		0.076	

As listed in Table 10, the mean distance from the gum margin to the depth of pocket in the SPR + laser method decreased after the intervention at all sites. Based on paired t-test, the decrease was

significant. The mean distance from the gum margin to the depth of pocket in the SPR method decreased one month after the intervention at all sites except for mesiobuccal site. The mean distance from the gum margin to the depth of pocket in the SPR method increased at mesiobuccal site one month after the intervention compared to before the intervention. As shown by paired t-test, the distance of the gum margin to the depth of pocket before and one month after the intervention with the SPR method was not significant at any site.

Table 10: Mean distance from gum margin to the depth of pocket before and one month after intervention with the two methods based on sites

Variable	Measurement	SPR + laser (n=64)		SPR (n=64)	
		Mean	SD	Mean	SD
mesiobuccal	Before intervention	3.75	2.61	3.50	2.26
	One month after intervention	3.26	2.10	3.51	2.45
Difference before and after the intervention		0.48	1.11	-0.01	1.33
Paired t-test		3.48		-0.09	
P_value		<0.001		0.925	
Midbuccal	Before intervention	1.98	1.89	2.03	1.54
	One month after intervention	1.75	1.64	1.83	1.39
Difference before and after the intervention		0.23	0.84	0.20	0.82
Paired t-test		2.21		1.98	
P_value		0.031		0.051	
Distobuccal	Before intervention	3.39	2.38	3.59	2.51
	One month after intervention	3.21	2.13	3.35	2.41
Difference before and after the intervention		0.17	0.95	0.23	0.90
Paired t-test		1.44		2.07	
P_value		0.154		0.042	
Mesiolingual	Before intervention	3.56	2.18	3.23	2.11
	One month after intervention	3.33	1.87	3.15	2.05
Difference before and after the intervention		0.23	0.97	0.07	0.27
Paired t-test		1.92		2.31	
P_value		0.058		0.024	
midlingual	Before intervention	1.86	1.19	1.39	0.94
	One month after intervention	1.73	1.10	1.37	0.88
Difference before and after the intervention		0.13	0.52	0.02	0.22
Paired t-test		1.92		0.57	
P_value		0.058		0.568	
distolingual	Before intervention	3.20	2.13	3.00	2.23
	One month after intervention	2.91	1.84	2.95	2.28
Difference before and after the intervention		0.29	0.66	0.05	0.37
Paired t-test		3.60		1	
P_value		<0.001		0.321	

As listed in Table 11, the mean and SD of gingival recession were the same in all participants before the intervention. One month after the intervention, the gingival recession in the SPR group was higher than that with SPR + laser. Gum recession decreased one month after the

intervention with the two intervention methods. Based on paired t-test results, the decrease in gingival recession was significant one month after the intervention in the two intervention groups.

Table 11: Mean score of gingival recession with the two intervention methods before and after the intervention

Variable	Measurement	SPR + laser (n=64)		SPR (n=64)	
		Mean	SD	Mean	SD
Gingival recession	Before intervention	2.13	0.62	2.13	0.62
	One month after intervention	1.18	0.75	1.63	0.81
Difference before and after the intervention		0.94	0.68	0.50	0.73
Paired t-test		5.51		2.73	
P_value		<0.001		0.015	

As listed in Table 12, the mean and SD scores of PI percentage were the same before the intervention in the two treatment groups. One month after the intervention, the mean and SD of PI percentage in the two groups were also the same in the two groups. The percentage of PI decreased in the two intervention groups one month after the intervention. As indicated by paired t-test, the decrease was significant.

Periodontal diseases are among the most prevalent mouth and teeth diseases and affect the patient's life by disrupting function and ease. Therefore, it is essential to treat these diseases [1,15]. Dental calculus and plaque are the main factors in developing periodontal diseases. Over the past few years, the laser has been introduced as a more conservative treatment for periodontitis.

Table 12: Mean percentage of PI before and one month after the intervention with the two intervention methods

Variable	Measurement	SPR + laser (n=64)		SPR (n=64)	
		Mean	SD	Mean	SD
PI percentage	Before intervention	72.68	28.91	72.68	28.91
	One month after intervention	27.31	9.27	27.31	9.27
Difference before and after the intervention		45.37	27.31	45.27	27.31
Paired t-test		6.65		6.65	
P_value		<0.001		<0.001	

Given the complications of using antibiotics for periodontal diseases such as resistance to antibiotics, uneasy access to the site using mechanical scaling tools in the case of deep pockets, and event failure to remove all teeth calculus after scaling and root planning, there is a need to improve the efficiency of mechanical methods. According to the studies, using laser holds considerable potentials compared to mechanical methods to improve scaling in deep pockets. For the first time, this study used a long RFTP tip (14 mm).

Erbium lasers cause ablation and vaporization of internal epithelium coverage at periodontal pockets. On the other hand, cauterization of blood vessels, neural terminals, and lymphatic glands, hemostasis, pain control, and recovery after the operation is improved. Er,Cr:YSGG laser (2780nm) enables practitioners to perform selective scaling [11,16]. In addition, the technique is recommended given its bactericidal

effect and no thermal damage to the root surface and the adjacent tissues [18]. Another point is that the most common method for periodontal tissue recovery after scaling and root planning is to create long epithelium contact as epithelial cells are the first that arrive at the wounded tissue and with increasing the distance of epithelial cells from the sulcus area during recovering, PDL cells would have more time to reach first to the root surface to form new connections. Using the laser, the gum margin is de-epithelialized, which creates a delay in the migration of epithelial cells and consequently, new connective, bone, and alveolar tissues find a chance to form [19].

When the conical tip RFTP14 is entered into the pocket, the radial laser energy affects the pocket and root at 1mm diameter or more. The tip's small size concentrates energy on a smaller surface and removes calculus from the root surface. By transferring energy to the depth of pocket and bone at this region, bacteria in the pocket are also eliminated, and granulation tissue is formed. In addition, a halo of low energy is formed around the tip known as a cold laser that, through photo modulation, stimulates regrowth of the lost tissue and faster recovery. By placing the tip parallel to the root surface at 15-20°, the laser beam can penetrate down to the epical pocket.

Dyer *et al*. (2012) examined using Er,Cr:YSGG laser for periodontal treatments. The parameters examined by them were PD and CAL, and the patients were examined every three months for two years after laser therapy (1W). They demonstrated that using the laser and standard periodontal treatment had a significant effect on improving PD and CAL. Their findings are consistent with our in terms of the positive effect of using Er, Cr:YSGG laser on improving PD and CAL [20].

Zhou *et al*. (2019) examined the effects of Er:YAG laser as a non-surgical periodontitis treatment. The patients were allocated to two scaling groups (control) and scaling plus laser (test). The beam power for hard and soft tissues was 100mJ/puls and 50mg/puls, respectively and PD, CAL, BI, and PI were examined immediately three months, and six months after the intervention. They revealed that the laser and scaling intervention decreased PD and significantly improved CAL. Similar to the present study, Er laser and its effect on PD, PI, CAL, and GI were examined [21-23].

Lei Ma *et al*. (2018) conducted a metanalysis study to examine the effect of Er:YAG laser as a supplementary non-surgical treatment for chronic periodontitis in papers published before 2018. The variables under study were PD, CAL, and VAS immediately, three to six, and six to twelve months after the intervention. They showed that using laser and scaling and root planning had a positive synergic effect on clinical parameters in the short term. In addition, patients in the test group felt less pain than the control group. As the results showed, there was no significant difference in medium and long terms [23-25].

Conclusions

The results by the four mentioned studies indicated the positive effects of erbium laser on improving clinical parameters such as PD, CAL, BOP, and PI. Standard scaling tools cannot reach deep pockets in periodontal patients and the subgum is not completely debridement. On the other hand, the laser beam can transfer energy to the inter-cellular dental calculus matrix and destroythe inter-cellular dental calculus matrix. The dental calculus is removed by destroying the matrix, and the root is planned. The present study showed a new path of using supplementary methods and standard periodontal treatments. Birang *et al*. (2017) compared Er:YAG laser and ultrasonic waves for periodontitis treatment. The patients participating in the study received one quadrant of ER:YAG laser (2390nm) and one quadrant of sonic scaler at treatment. The parameters under study were PD, CAL, and BI before and six weeks and 12 weeks after the treatment. The results indicated improvement of clinical parameters in the patients who received one quadrant of the laser beam and sonic scaler and there was no difference between the two groups. The results showed that using Er,Cr:YGSS laser significantly decreased PH, BOP, PI, GI, and gingival recession. In addition, the laser improved the clinical attachment level.

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Future research

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Authors' contributions
Janet Moradi Haghgoo and Sahar Hematian assisted with the design of the study, carried out the experiments, and participated in manuscript preparation. Banafshe Poormoradi and Morad Hedayatipanah carried out the design and coordinated the study and participated in most of the experiments. Leila Gholami and Zahra Chraghi participated in data collection, manuscript preparation and correction. All authors read and approved the final manuscript.

Conflict of Interest
The authors declare that there are no conflicts of interest.

Availability of data and material (data transparency)
The data is available based on reasonable request.

Ethics approval
The ethics committee of Hamadan University of Medical Sciences approved the study.

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