Original Article

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Comparison between single and multiple adjunctive Er,Cr: YSGG application to scaling and root planing in periodontal maintenance patients with residual periodontal pockets: A 3-year follow-up

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Objective: To compare the long-term results between single and multiple adjunctive Er,Cr:YSGG application to scaling and root planing (SRP) in periodontal maintenance patients with residual periodontal pockets.

Materials and methods: Twelve periodontal maintenance patients treated with single Er,Cr:YSGG application + SRP in one tooth (group A) and multiple Er,Cr:YSGG application + SRP in the other tooth (group B) were evaluated 3 years after treatment. Plaque index (PI), bleeding on probing (BOP), probing depth (PD), relative probing attachment level (RPAL), and relative gingival recession (RGR) were examined.

Results: Percentage of plaque presence (PI=1) sites were consistent in both groups, with no significant difference between groups. Percentages of BOP sites at the 3-year follow-up were lower than the baseline in both groups. PD reduction at 3 years was significantly different from the baseline (group A; 2.00 ± 1.35 mm vs group B; 1.33 ± 1.23 mm), while RPAL gain was clinically significantly different from the baseline only in group A (1.42 ± 1.56 mm). In group B, gingival recession statistically significantly increased at 3 years (0.75 ± 0.75 mm) from the baseline. All changes of clinical parameters showed no statistically significant differences when compared between groups.

Conclusion: Both single and multiple applications of adjunctive Er,Cr:YSGG laser improved clinical results regarding decreased BOP and PD reduction. RPAL gain was only observed in the single application group. No statistically significant differences were found between the two treatment modalities 3 years after the initial treatment.

Keywords: Er,Cr:YSGG laser, periodontal maintenance patient, residual periodontal pockets, scaling and root planing

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Periodontal maintenance or supportive periodontal therapy (SPT) is necessary after the completion of active treatment to maintain periodontal health and prevent the recurrence of disease [1]. One of the risk indicators for tooth loss and progression of periodontitis during SPT is a residual probing pocket depth ≥ 6 mm [2]. One recommended predictor of recurrent periodontitis is loss of attachment level of at least 2 mm [3]. During SPT, non-surgical treatment should be the first choice for patients diagnosed with recurrent periodontitis, while further periodontal surgery may be necessary [4].

Adjunctive laser treatment, in addition to conventional mechanical methods, promotes the healing process by removing the epithelial lining in residual periodontal pockets. This has a beneficial bactericidal effect and allows detoxification of the root surface without producing a smear layer [5]. An Er,Cr:YSGG laser with a 2,780 nm wavelength

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can penetrate energy into more shallow tissue as it has a higher absorption coefficient in water than other lasers [6]. Previous short-term studies showed that Er,Cr:YSGG lasers could be used as an alternative or assistant therapy to scaling and root planing (SRP), providing additional efficacy [7-10]; however, some studies indicated opposite results [11-13], with controversial effectiveness of Er,Cr:YSGG lasers for periodontitis treatment. Meta-analysis results indicated significant differences for probing depth (PD) reduction between Er,Cr:YSGG laser adjunct/substitute to SRP and SRP alone at 1 and 3 months after treatment. PD reduction 6 months after treatment also showed no significant differences. Clinical attachment level (CAL) change at 1 month after treatment was not significantly different between Er,Cr:YSGG laser adjunct/substitute to SRP and SRP alone. A significant difference in CAL was recorded at 3 months after treatment but with no significant difference at 6 months [14].

Some previous clinical studies using an Er,Cr:YSGG laser involved a single application [10,15], while others used multiple applications [7, 8]. Only one short-term study compared the clinical results between single and multiple laser applications and indicated that both resulted in PD reduction. Single Er,Cr:YSGG applications achieved higher attachment level gain, while multiple applications resulted in increased gingival recession; however, no statistically significant differences were apparent between these two treatment modalities [16]. The purpose of this investigation was to identify long-term results after single or multiple adjunctive Er,Cr:YSGG applications to SRP in periodontal maintenance patients with residual periodontal pockets.

Materials and methods

This split-mouth, double-blinded, randomized clinical trial followed study protocol that was reviewed and approved by the Ethics Review Committee for Human Research at the Faculty of Dentistry and Faculty of Pharmacy, Mahidol University (MU-DT/PY-IRB 2021/002.0401) and the Thai Clinical Registry Committee (TCTR 20210216005). Seventeen subjects who had participated in a previous experiment [16] were invited to enroll in this study. Informed consent was obtained from all participants. Exclusion criteria included (1) the use of systemic antibiotics and anti-inflammatory drugs within the previous 3 months, and (2) exposure to previous periodontal surgery or extraction. Admission criteria and the experimental design were as previously reported [16]. In brief, 17 periodontal maintenance patients who had two single-rooted teeth with PD 5-9 mm, bleeding on probing (BOP), and full mouth plaque score <30% were enrolled. One blinded and calibrated examiner (NW) carried out all the measurements at the baseline, 3 months, and 6 months after treatment. The variables recorded were as follows: 1) presence/absence of supragingival plaque at the gingival margin (PI 1/0); 2) presence/absence of BOP (GBI 1/0). Clinical parameters were measured using a personalized acrylic stent as 3) PD; 4) Relative probing attachment level (RPAL) measured from the apical border of the stent to the most apical part of the sulcus and 5) Relative gingival recession (RGR) measured from the apical border of the stent to the gingival margin. All studied teeth were treated under local anesthesia (2% mepivacaine, 1:100,000 epinephrine) by an experienced periodontist (TTB). An Er,Cr:YSGG device (Waterlase, Biolase, USA) with wavelength 2,780 nm was used to treat group A (single Er,Cr:YSGG application + SRP) and group B

(multiple Er,Cr:YSGG applications + SRP). Treatment methods were as previously reported [16]. In brief, the laser system was set to power output 1.5 W, pulse 30 Hz, 40% air, 50% water, and H-mode. Outer and inner gingival epithelial lining was removed by a radial firing periodontal tip (RFPT). Then, the laser system setting was changed to power output of 1.5 W, pulse 30 Hz, 10% air, 10% water and H-mode to induce blood coagulation. At the end of the 1st visit, studied teeth were divided randomly into group A (single Er,Cr:YSGG application + SRP) and group B (multiple Er,Cr:YSGG applications + SRP) by a research assistant. For group B, the same procedures were performed for outer and inner epithelial lining removal at the 2nd, 3rd and 4th week, respectively. After 6 months, all patients were enrolled for a 3-month interval SPT course. Three years after the initial treatment, twelve patients agreed to participate in this study, while 5 patients dropped out. One was excluded because periodontal surgery was performed on the treated tooth, while the other 4 patients failed to attend the evaluation appointment (1 had brain surgery and 3 had moved to other cities) (Figure 1). All patients were re-assessed by the same examiner, with all variables recorded, and full mouth SRP was performed.

Statistical analysis

Statistical analysis was conducted using SPSS for Windows version 23. The null hypothesis was rejected at a 0.05 level of significance. Intragroup differences of PD, RPAL and RGR were analyzed by the Friedman test. Intergroup differences of PD, RPAL, RGR and changes between groups were compared using the Wilcoxon matched-pairs signed-rank test. Both inter-group and intra-group GBI and PI were compared by the related sample McNemar's test.

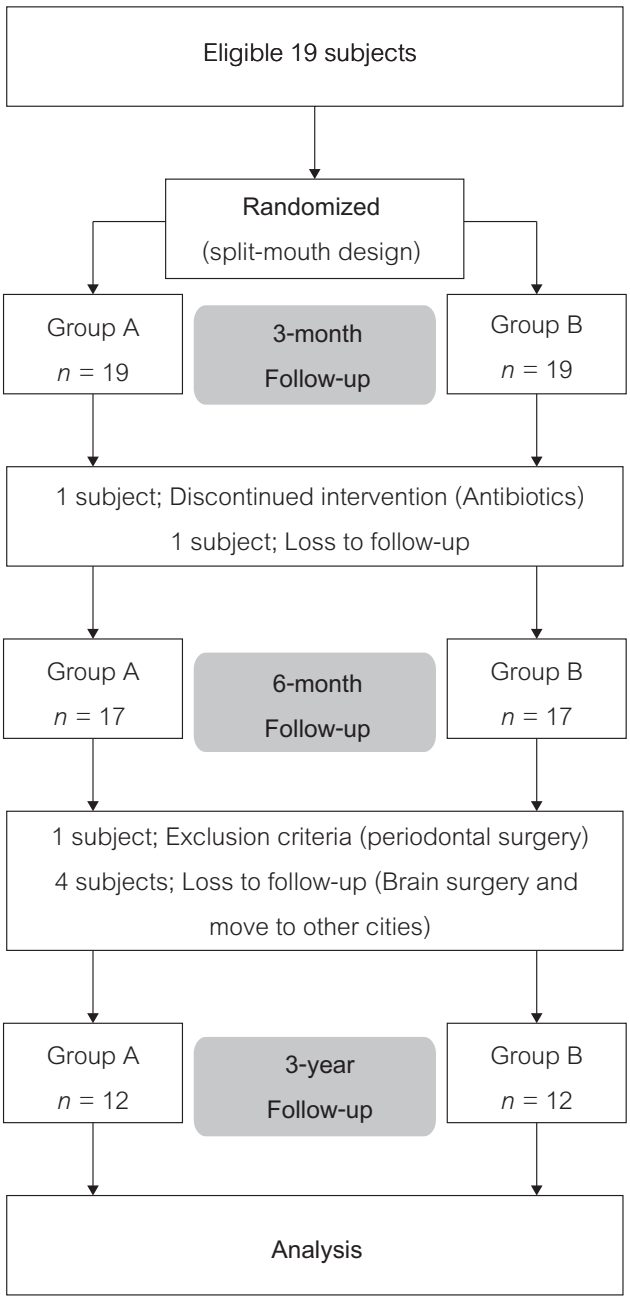

Fig. 1 Flowchart of the study design

Results

For the remaining 12 patients (10 females, 2 males), mean age was 57.17 ± 9.15 years. PI at baseline showed no statistically significant differences ($p>0.05$) between the two groups (Table 1). Percentages of plaque presence sites (PI=1) in groups A and B were unchanged

throughout the study with no statistically significant differences between groups (Table 1). Percentages of gingival bleeding sites (GBI=1) in both groups were lower at 3 years compared to the baseline and 6 months, with no statistically significant differences either at 6 months or 3 years between the two groups (Table 2).

PD at baseline showed no statistically significant differences ($p>0.05$) between the two groups (Tables 3). Mean PD values at the 3-year follow-up in groups A and B were 3.83 ± 1.19 mm and 4.00 ± 1.04 mm, respectively. Mean PD reductions at the 3-year follow-up compared to 6 months were 0.58 ± 0.09 mm (group A) and 0.42 ± 1.08 mm (group B). Mean PD values at the 3-year follow-up were significantly different from the baseline ($p<0.05$) in both groups (group A 2.00 ± 1.35 mm, and B 1.33 ± 1.23 mm), with no statistically significant differences between groups at all time points ($p>0.05$) (Tables 3 and 4).

RPAL values 3 years after treatment in groups A and B were 8.42 ± 2.11 mm and 9.58 ± 1.78 mm, respectively. Group A had RPAL gain of 1.42 ± 1.56 mm, which was clinically significantly different from the baseline, while group B gained 0.50 ± 1.00 mm which was clinically insignificant (Table 3). No statistically significant differences were recorded between the two groups ($p>0.05$) (Table 4).

The RGR of group B significantly increased (0.75 ± 0.75 mm) from the baseline, while the RGR in group A increased insignificantly (0.58 ± 0.67 mm) (Table 3). No statistically significant differences were recorded between the two groups ($p>0.05$) (Table 4).

Differences in PD, RPAL and RGR at 6 months and 3 years after treatment were not found in either of the two groups, while mean change values were not statistically different between the two groups.

Table 1 Percentage of plaque presence sites in group A and B at baseline, 6 months and 3 years after treatment

Group	Baseline	6 months	3 years	*p*-value 3 years vs. baseline	*p*-value 3 years vs. 6 months
A	16.7 %	33.3%	33.3 %	0.625	1.00
B	33.3 %	33.3 %	33.3 %	1.00	1.00
p-value	0.50	1.00	1.00		

Table 2 Percentage of bleeding on probing (BOP) sites in group A and B at baseline, 6 months and 3 years after treatment

Group	Baseline	6 months	3 years	*p*-value 3 years vs. baseline	*p*-value 6 months vs. 3 years
A	100 %	91.7 %	33.3 %	0.008	0.016
B	100 %	83.3 %	25.0 %	0.004	0.039
p-value		1.00	1.00		

Table 3 Clinical parameters of group A and B at baseline, 6 months and 3 years after treatment

Variables	Group	Baseline	6 months	3 years	Δ 6 months-3 years	Δ 0-3 years
PD (mm)	A	5.83 ± 0.84	4.42 ± 1.08	3.83 ± 1.19	-0.58 ± 0.90	-2.00 ± 1.35*
	B	5.33 ± 0.65	4.42 ± 1.08	4.00 ± 1.04	-0.42 ± 1.08	-1.33 ± 1.23*
Difference between groups		NS	NS	NS		
RPAL (mm)	A	9.83 ± 2.13	8.92 ± 1.78	8.42 ± 2.11	-0.50 ± 1.38	-1.42 ± 1.56*
	B	10.08 ± 1.56	9.83 ± 1.64	9.58 ± 1.78	-0.25 ± 1.06	-0.50 ± 1.00
Difference between groups		NS	NS	NS		
RGR (mm)	A	4.00 ± 1.65	4.50 ± 1.98	4.58 ± 1.93	0.08 ± 1.51	0.58 ± 0.67
	B	4.75 ± 1.42	5.42 ± 1.51	5.50 ± 1.38	0.08 ± 1.00	0.75 ± 0.75*
Difference between groups		NS	NS	NS		

Probing depth (PD); relative probing attachment level (RPAL); relative gingival recession (RGR); Not statistical significance (NS).

*Statistical significance set at $p<0.05$

Table 4 Change values of probing depth (PD), relative probing attachment level (RPAL) and relative gingival recession (RGR) between baseline and 3 years after treatment in both groups

Change values	Group A	Group B	*p*-value
PD reduction (mm)	2.00 ± 1.35	1.33 ± 1.23	0.099
RPAL gain (mm)	1.42 ± 1.56	0.50 ± 1.00	0.072
Increased RGR (mm)	0.58 ± 0.67	0.75 ± 0.75	0.516

Probing depth (PD); relative probing attachment level (RPAL); relative gingival recession (RGR)

*Statistical significance set at $p<0.05$

Discussion

Previous clinical studies reported using the Er,Cr:YSGG laser for non-surgical periodontal treatment in both single and multiple applications. Adjunctive application of an Er,Cr:YSGG laser to SRP is a minimally invasive procedure. Only one study compared single and multiple laser applications [16] and presented short-term results. This is the first study reporting long-term results comparing single and multiple laser applications. Percentages of sites with the presence of plaque in both groups were unchanged at all time points, and no statistically significant differences were recorded between the treatment modalities. This implied that the outcomes of laser treatment did not result from the patient's plaque control. Lower percentages of bleeding sites were found at the 3-year follow-up compared to the baseline in both

groups, concurring with other short-term studies [7-10].

Results demonstrated that mean PD reduction, attachment level gain and gingival recession were unchanged at 6 months and 3 years after treatment in both groups, with no statistically significant differences between groups at the long-term follow-up.

Some clinical studies reported using the Er,Cr:YSGG laser as an adjunct to SRP. Magaz *et al.* [15] conducted a comparative study between SRP by curette and SRP followed by Er,Cr:YSGG laser application. Six months after treatment, PD reduction and GR were recorded in both groups, with no statistically significant differences between groups but improved clinical attachment level (CAL) gain in the SRP group. By contrast, a study using Er,Cr:YSGG as an adjunct to SRP in SPT patients determined different results. SRP combined with Er,Cr:YSGG showed better PD reduction and CAL gain than SRP alone at 3 months after treatment [10]. A meta-analysis of randomized controlled trials reported additional effectiveness with Er,Cr:YSGG lasers in PD reduction and CAL gain at short-term follow-up (1-3 months) [14].

Multiple application Er,Cr:YSGG as an adjunct to SRP was reported in two studies. Kelbauskiene *et al.* [7] used Er,Cr:YSGG once a week for 3-4 weeks. Results showed PD reduction and CAL gain but gingival margin level did not change. Another study, that used three Er,Cr:YSGG cycles every third day, reported similar results [9]. Watchanasanout & Teparat-Burana were the first to compare single and multiple applications as an adjunct to SRP at the 6-month follow-up. Results showed PD reduction and increased RGR in both treatment modalities but with no significant differences. Single applications showed increased RPAL gain over multiple applications [16]. Our study evaluated results at 3 years after the initial treatment. Comparisons between single and multiple Er,Cr:YSGG laser application sites showed a trend toward greater attachment level gain at single application sites. However, differences between the two treatment modalities were not apparent in PD reduction, RPAL gain and increased RGR.

Decreased percentages of bleeding on probing in both groups were recorded at 3 years compared to the baseline and 6 months, with no significant differences between the two groups either at 6 months or 3 years, possibly as a result of the resolution of inflammation in periodontal tissue. Results in the literature suggest low GCF volume in healthy periodontal tissue [17] and this significantly decreased in the adjunctive Er,Cr:YSGG laser with SRP at up to 6 months after treatment, with no statistical significance between treatments with and without laser [18]. Some studies showed that the level of IL-1β, which directly regulates several gene expressions during inflammation [19], decreased significantly at 6 months versus the baseline in both with and without adjunctive Er,Cr:YSGG laser treatment with SRP [18, 20-21].

A histological study in bone and soft tissue of rabbit jaws after irradiation with Er,Cr:YSGG laser reported that the alveolar mucosa had completely healed by the seventh day but reconstruction of collagen fiber was not complete at 28 days [22]. The healing process of surrounding tissues may be disturbed by repeated laser applications. Further studies should investigate multiple laser applications only at the outer surface, without disturbing the healing process in the gingival sulcus. This might retard epithelial migration and result in better clinical outcomes. The outcome variables in this study were clinically evaluated and no histologic samples were taken. A previous study evaluated the histological outcome of laser-assisted new attachment procedure (LANAP). Nine months after treatment, 10 teeth were extracted and histologically analyzed. The majority showed new cementum

formation and insertion of collagen fiber, while the others presented a long junctional epithelium [23]. Further histological evaluation in healing after non-surgical periodontal treatment by Er,Cr:YSGG should be conducted. Limitations of this study included the small number of participants and lack of a dedicated SRP group.

Conclusion

Results demonstrated that adjuncive single and multiple Er,Cr:YSGG laser applications improved clinical results, with decrease in BOP and PD but RPAL gain. However, no statistically significant differences were recorded between the two treatment modalities 3 years after the initial treatment. This laser procedure may be of benefit for recurrent periodontitis patients during periodontal maintenance.

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References

1. Shick RA. Maintenance phase of periodontal therapy. *J Periodontol* 1981; 52: 576-83.
2. Matuliene G, Pjetursson BE, Salvi GE, Schmidlin K, Brägger U, Zwahlen M, *et al*. Influence of residual pockets on progression of periodontitis and tooth loss: results after 11 years of maintenance. *J Clin Periodontol* 2008; 35: 685-95.
3. Lindhe J, Haffajee AD, Socransky SS. Progression of periodontal disease in adult subjects in the absence of periodontal therapy. *J Clin Periodontol* 1983; 10: 433-42.
4. Chace R. Retreatment in periodontal practice. *J Periodontol* 1977; 48(7): 410-12.
5. Aoki A, Sasaki KM, Watanabe H, Ishikawa I. Lasers in nonsurgical periodontal therapy. *Periodontol 2000* 2004; 36: 59-97.
6. Cobb CM, Low SB, Coluzzi DJ. Lasers and the treatment of chronic periodontitis. *Dent Clin N Am* 2010; 54: 35-53.
7. Kelbauskiene S, Baseviciene N, Goharkhay K, Moritz A, Machiulskiene V. One-year clinical results of Er,Cr:YSGG laser application in addition to scaling and root planing in patients with early to moderate periodontitis. *Laser Med Sci* 2011; 26: 445-52.
8. Gupta M, Lamba A, Verma M, Faraz F, Tandon S, Chawla K, *et al*. Comparison of periodontal open flap debridement versus closed debridement with Er,Cr:YSGG laser. *Aust Dent J* 2013; 58: 41-9.
9. Gutknecht N, Van Betteray C, Ozturan S, Vanweersch L, Franzen R (2015) Laser supported reduction of specific microorganisms in the periodontal pocket with the aid of an Er,Cr:YSGG laser: a pilot study. *Sci World J* 2015; 2015: 450258.
10. Sappipattana Y, Teparat-Burana T. Efficacy of adjunctive Er,Cr:YSGG laser application to scaling and root planing in periodontal maintenance patients with residual periodontal pockets. *Laser Dent Sci* 2017; 3: 169-74.
11. Noori ZT, Fekrazad R, Eslami B, Etemadi A, Khosravi S, Mir M. Comparing the effects of root surface scaling with ultrasound instruments and Er,Cr:YSGG laser. *Lasers Med Sci* 2008; 23: 283–7.
12. de Oliveira GJ, Pavone C, Sampaio JE, Marcantonio RA. Influence of the angle of irradiation of the Er,Cr:YSGG laser on the morphology, attachment of blood components, roughness, and root wear: in vitro study. *Lasers Surg Med* 2010; 42: 683–91.
13. de Oliveira GJ, Sampaio JE, Marcantonio RA. Effects of Er,Cr:YSGG laser irradiation on root surfaces for adhesion of blood components and morphology. *Photomed Laser Surg* 2010; 28: 751–56.
14. Li MM, Jia JH, Wu MX, Zhao CY, Jia LY, Shi H, *et al*. Clinical effectiveness of Er,CR:YSGG lasers in non-surgical treatment of chronic periodontitis: a meta-analysis of randomized controlled trials. *Lasers Med Sci* 2020; Oct 9: Online ahead of print. https://doi.org/10.1007/s10103-020-03156-2
15. Magaz V, Alemany A, Alfaro F, Molina J. Efficacy of adjunctive Er,Cr:YSGG laser application following scaling and root planing in periodontally diseased patients. *Int J Periodontics Restorative Dent* 2016; 36: 715-21.
16. Watchanasanout N, Teparat-Burana T. Single versus multiple adjunctive Er,Cr:YSGG application to scaling and root planing in periodontal maintenance patients

with residual periodontal pockets. ***Laser Dent Sci*** 2020; 4: 187–93.

17. Hancock EB, Cray RJ, O'Leary TJ. The relationship between gingival crevicular fluid and gingival inflammation: a clinical and histologic study. ***J Periodontol*** 1979; 50: 13-9.
18. Sezen D, Hatipoglu M, Üstün K. Evaluation of the clinical and biochemical efficacy of erbium, chromium:yttrium-scandium-gallium-garnet (ER,CR:YSGG) laser treatment in periodontitis. ***Lasers Med Sci*** 2020; 35: 1567-75.
19. Graves DT, Cochran D. The contribution of interleukin-1 and tumor necrosis factor to periodontal tissue destruction. ***J Periodontol*** 2003; 74: 391-401.
20. Üstün 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: 1150-57.
21. Talmac AC, Calisir M, Eroglu EG, Ertugrul AS. Effects of Er,Cr:YSGG and diode lasers on clinical parameters and gingival crevicular fluid IL-1β and IL-37 levels in generalized aggressive periodontitis. ***Mediators Inflamm*** 2019; 2019: 2780794.
22. Wang X, Zhang C, Matsumoto K. In vivo study of the healing processes that occur in the jaws of rabbits following perforation by an Er,Cr:YSGG laser. ***Lasers Med Sci*** 2005; 20: 21-7.
23. Nevins ML, Camelo M, Schupbach P, Kim DM, Nevins M. Human clinical and histological evaluation of laser-assisted new attachment procedure. ***Int J Periodontics Restorative Dent*** 2012; 32: 497-507.