Efficacy of Er:YAG laser on periodontitis as an adjunctive non-surgical treatment: a split-mouth randomized controlled study

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Abstract

Aim: To evaluate the adjunctive efficacy of Er:YAG laser use with mechanical scaling and root planing (SRP) for non-surgical treatment of periodontitis.

Materials and Methods: In a randomized, single-blinded, controlled trial, 27 patients were recruited. Using a split-mouth design, two quadrants were randomly allocated into either a test group or a control group. The test quadrants received Er:YAG laser (ERL) (100 mJ/pulse;15 Hz to hard tissue and 50 mJ/pulse; 30 Hz to soft tissue) plus SRP treatment, while the control quadrants received SRP only. We evaluated periodontal indexes, including probing depth (PD), clinical attachment level (CAL), bleeding index (BI), and plaque index (PLI) at baseline, 3 months, and 6 months.

Results: The PD and CAL means in the ERL+SRP group were significantly lower than those in the SRP group at 3-month follow-up (PD: 2.98±0.38 mm vs. 3.09±0.35 mm; CAL: 4.51±0.69 mm vs. 4.72±0.67 mm) and 6-month follow-up (PD: 2.91±0.31 mm vs. 3.02±0.30 mm; CAL: 4.52±0.65 mm vs. 4.72±0.66 mm) (p=0.03 for both PD and CAL). There were no significant differences in BI and PLI between two groups.

Conclusions: The Er:YAG laser treatment combined with conventional SRP significantly improved PD and CAL compared to SRP therapy alone; however, these differences were very small and, as a result, the adjunctive effect of Er:YAG laser is likely to be minimal clinically important.

Clinical Relevance:

Scientific rationale for study: It remains unclear whether Er:YAG laser is effective as an adjuvant treatment for periodontitis due to inconsistent results from limited randomized controlled trials.

Principal findings: The use of Er:YAG laser combined with conventional SRP provided more effective adjunctive treatment outcome than SRP alone in terms of probing depth reduction and clinical attachment gain at 3 months and 6 months with statistical significance, but the magnitudes of differences were very small.

Practical implications: The adjunctive effect of Er:YAG laser seemed minimal for patients with periodontitis who already received SRP therapy.

Introduction

The most common non-surgical periodontal therapy is mechanical scaling and root planing (SRP) using ultrasonic scalers or hand instruments. However, SRP alone is often inefficient in completely eradicating pathogenic microbes and their products from periodontal pockets. After further evaluation, surgical procedures may be necessary to eliminate remaining etiological factors.

In recent years, many types of dental lasers have become commercially available for nonsurgical treatment of periodontal diseases. The commonly used wavelengths include 2,940 nm for the erbium-doped: yttrium, aluminum and garnet (Er:YAG) lasers (Lopes et al. 2010, Schwarz et al. 2001); 2,780 nm for erbium, chromium-doped: yttrium, scandium, gallium, garnet (Er, Cr:YSGG) lasers (Kelbauskiene et al. 2011); 1,064 nm for the neodymium-doped: yttrium, aluminum and garnet (Nd:YAG) lasers (Eltas & Orbak 2012, Miyazaki et al. 2003); and 810, 940, 980 nm for diode lasers (Kamma et al. 2009, Kreisler et al. 2005, Saglam et al. 2014). All types of lasers have a thermal effect on dental soft tissue, reduce the amount of bacteria in the periodontal pocket, and coagulate the inflamed sulcular epithelium. However, only the wavelengths of the two erbium lasers are appropriate for use on hard tissues by removing dental calculus and bacterial endotoxins from the root surface without giving thermal side effects in adjacent tissues. Others kinds of laser devices do not have the capability to remove calculus from the root surface. Consequently, the clinical outcomes after Er-based treatment are not really comparable to the results after other laser irradiation (for example, diode laser). With use of erbium lasers, vaporization of the water in calculus usually occurs at a temperature higher than 100°C by rapid accumulation of light energy within the calculus (Mizutani et al. 2016). The 2011 American Academy of Periodontology statement on lasers in the nonsurgical treatment of periodontitis (American Academy of Periodontology Workgroup 2011), suggested that erbium lasers show the greatest potential for effective root debridement.

Previous clinical studies have examined Er:YAG laser debridement treatment, but yielded inconsistent results regarding whether it has additional benefits over conventional mechanical debridement (Crespi et al. 2007, Sağlam M et al. 2017, Schwarz et al. 2001,2003b, 2003c, Sculean et al. 2004). Schwarz et al.'s systematic review reported that

Er:YAG laser seems more suitable for the non-surgical treatment of periodontitis compared to CO_2 laser, Nd:YAG laser, or diode laser (Schwarz et al. 2008). Lopes et al.'s study found that Er:YAG laser (ERL) plus SRP provided additional reduction of microorganisms compared to SRP alone (Lopes et al. 2010). In contrast, a randomized split-mouth clinical trial study by Rotundo et al. observed 27 patients for six months. Four nonsurgical therapies were randomly assigned and performed in one of the four quadrants: supragingival debridement; Er:YAG laser; SRP; Er:YAG laser + SRP. The study showed that the effect of Er:YAG laser alone was less than that of SRP alone, but found no difference between Er:YAG laser+SRP and SRP alone (Rotundo et al. 2010). Subsequently, Sgolastra et al.'s meta-analysis did not find any statistically significant difference between Er:YAG laser therapy and conventional SRP in reducing pocket depth (PD) or increasing clinical attachment level (CAL) (Sgolastra et al. 2012). Similarly, a recent meta-analysis of 12 randomized controlled trials (RCTs) by Zhao et al. suggested that Er:YAG laser monotherapy produced similar clinical improvement in PD reduction and CAL compared with SRP at 3 months. The long-term clinical benefits of Er:YAG laser as adjuvant to SRP was still lacking (Zhao et al. 2014).

Taken together, the evidence suggests that Er:YAG laser has excellent capability for effectively ablating hard tissue, removing calculus and plaque, providing a smooth and homogeneous root surface with good biocompatibility for soft tissue attachment. However, the clinical effectiveness of the Er:YAG laser on periodontitis remains controversial. We hypothesized that Er:YAG laser combined with conventional SRP provides more effective treatment than SRP alone. The purpose of this study, therefore, was to compare the use of Er:YAG laser with mechanical scaling and root planing in the non-surgical treatment of periodontitis in a Chinese population.

Materials and Methods

Study population

This study was a randomized, single-blinded, controlled trial. In this split-mouth design, each patient served as his or her own control. The patient population consisted of 27 systemically healthy periodontitis patients between 35 and 70 years of age who were recruited from the Department of Stomatology of Beijing Chao-Yang Hospital from

March 2015 to April 2017. The study protocol was approved by the ethics committee of the Beijing Chao-Yang Hospital, and each patient provided written informed consent before enrollment. The study was registered with the ISRCTN Register (ISRCTN18400416).

Participants were eligible if they met the following inclusion criteria: 1) a minimum of 16 teeth (four per quadrant); 2) at least two teeth with at least one site with probing depths (PD) ≥4mm in each quadrant with bleeding on probing; 3) 35-70 years old, in good general health; and 4) non smoker.

Possible participants were excluded if they 1) had received periodontal treatment within the previous 6 months; 2) had received systemic antibiotic therapy within the previous 6 months; 3) had suffered systemic diseases that could influence the outcome of therapy, such as diabetes mellitus or blood disease; 4) were pregnant; or 5) were smokers.

Randomization and allocation concealment

Patients were assigned consecutive ascending numbers at the enrolment visit. For each patient, the two treatments were randomly assigned to either the right or the left side. Before the study began, the order of the treatment quadrants was randomized by an independent statistical programmer not directly involved with the examination or treatment procedures using random sequences generated by the Microsoft® Excel software application. One half of random number sequences were defined as group A: left side with Er:YAG laser+SRP and right side with SRP alone; and another half of random number sequences were defined as group B: left side with SRP alone and right side with Er:YAG laser+SRP. Allocation concealment was performed by opaque sealed envelopes, sequentially numbered. Allocation remained concealed to the examiner throughout the study. The envelope was opened to the operator until the first treatment visit.

Masking

The dentist who performed the periodontal examinations (D.Z.) were blinded to the treatment quadrant assignments of the patients.

Sample size calculation

We calculated the required sample size based on a two-sided hypothesis test with 5% type I error. To achieve 80% statistical power to detect a minimum clinically significant difference of 0.5mm in clinical attachment level (CAL) change between treatment groups and a SD of 0.6 mm (Sculean et al. 2004), a sample size of 24 patients was calculated. Considering a possible dropout rate of <10%, the final number of patients included in this trial was calculated to be 27.

Periodontal examination

During clinical visits at baseline (0), 3, and 6 months, periodontal examinations were taken by the same blinded examiner (D.Z.). Pressure calibration was performed before the periodontal probing. Clinical examination included measurement of pocket depth (PD), location of the cemento-enamel junction (CEJ) to calculate clinical attachment level (CAL), bleeding index (BI), and assessing of plaque index (PLI). PD and CEJ were measured with a Williams periodontal probe at six sites for each tooth. Recession was recorded as a positive value. CAL of the six sites per tooth will be calculated as PD+CEJ = CAL. BI on probing was scored on a scale of 0 to 5 using Mazza's method (Mazza et al. 1981). PLI for each tooth was determined on a scale of 0 to 3 (Silness & Löe 1964). The examiner reliability was assessed of all the periodontal measurement with 10 patients. The correlation coefficients of agreement of PD and CAL were 0.92 and 0.95, respectively. The Kappa values of agreement of BI and PLI were 0.82 and 0.85, respectively.

Periodontitis Stage

Criteria for periodontitis stage were based on the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions (Tonetti et al. 2018): 1)Stage Ⅰ: CAL 1 to 2mm, radiographic bone loss at coronal third (<15%), no tooth loss due to periodontitis; 2)Stage Ⅱ: CAL 3 to 4mm, radiographic bone loss at coronal third (15% to 33%), no tooth loss due to periodontitis; 3) Stage Ⅲ: CAL≥5mm, radiographic bone loss extending to middle or apical third of the root, tooth loss due to periodontitis of ≤4 teeth; 4)StageⅣ: CAL≥5mm, radiographic bone loss extending to middle or apical third of the root, tooth loss due to periodontitis of ⩾5 teeth.

Oral hygiene instructions and supragingival scaling

At the beginning of the study, all patients received oral hygiene instructions consisting of how to use a soft manual toothbrush, floss, and inter-proximal brushes. Patients were also taught the Bass brush method. Patients also received full-mouth supragingival scaling using ultrasonic instruments. Oral hygiene instructions were provided at each examination and treatment visit, again according to individual requirements.

Treatments

One week after professional oral hygiene instruction and supragingival scaling, patients were recalled to collect clinical data. After the baseline measurements, patients received treatments (by X.Z. or M.L.). Using a split-mouth design, two quadrants (one quadrant from each jaw) were randomly allocated to either the test or control group. The quadrants in the test group received ERL + SRP, while the quadrants in the control group received SRP. All SRP comprised both using an ultrasonic scaler and hand instruments. Local anaesthesia was used only if needed.

Control quadrants: scaling and root planing (SRP) only

SRP was carried out using an EMS Piezon® Mini-Master ultrasonic scaler (EMS, Nyon, Switzerland) and Gracey curettes. SRP treatments were terminated when the operator was satisfied that the root surfaces were smooth and thoroughly debrided as assessed using a sharp-ended probe.

Test quadrants: Er:YAG + scaling and root planing (ERL + SRP)

A combination of an Er:YAG laser and SRP were used in the test quadrants. The two quadrants were debrided using an Er:YAG laser (LITETOUCH, Syneron, Yokneam Elite, Israel). Laser parameters were set at an energy level of 100 mJ/pulse and a repetition rate of 15 Hz (Hard Tissue / Calculus removal mode) according to the manufacturer’s instructions. A chisel-shaped fibre tip of 17mm of length was adopted. Treatment was performed in a coronal-to-apical direction in slow parallel paths at an inclination of 15–20° to the root surface (Folwaczny et al. 2001). In particular, SRP was performed after the laser application in order to leave the root surface as smooth as possible. Then laser parameters were set at an energy level of 50 mJ/pulse and a repetition rate of 30 Hz (Soft Tissue / Periodontal Pocket Debridement mode) to debride granulation tissue in the periodontal pocket and reduce bacteria. A conic-shaped tip of 0.8mm of diameter (at the point)×17mm of length was adopted.

Outcomes

Primary outcomes were changes in PD and CAL after periodontal treatment. Secondary outcomes were changes in BI and PLI after periodontal treatment.

Statistical analysis

SPSS statistical package (Version 18.0, SPSS Inc., Chicago, IL, USA) was used for data analyses. The distributions of all outcome values were examined using the Kolmogorov-Smirnov normality test. Since they were all normally distributed, baseline characteristics between two treatment groups were compared using paired- *t* test. The significance of differences in periodontal indexes between groups over three time points were compared using a linear mixed model (fixed effects included treatments, time points, and treatment multiply by time points). Pair-wise comparisons within each treatment groups (three months vs. baseline and six months vs. baseline) were performed by least-significant-difference (LSD) method. χ^2 test were used to compare the proportions of sites showing ≥2mm change in PD and CAL. The level of significance was set at $p<0.05$.

Results

Subject retention

Figure 1 is a flow chart of the study design. All patients were treated by one experienced dentist at Beijing Chao-Yang Hospital. All 27 patients returned for the 3-month visit and only two did not return for the 6-month visit (one patient due to health problems and the other one due to job demands).

Demographics characteristics

Basic demographic characteristics of the study population are presented in Table 1. The mean age of the patients was 49.0±9.6 years, and 16 out of 27 were women. The mean BMI of patients was 24.9±3.3 kg/m^2. All 27 patients were non- smokers. 19 patients (70.4%) were periodontitis of Stage Ⅲ and 8 patients (29.6%) were periodontitis of Stage Ⅱ.

Value Distribution

The distributions of periodontal parameters, including PD, CAL, BI, and PLI, were formally examined in two groups and at three time points (using the Kolmogorov-Smirnov normality test).They were all normally distributed.

Baseline periodontal parameters

Baseline measurements of periodontal indexes are presented in Table 2. There were no statistically significant differences in baseline PD, CAL, BI, or PLI between the test and control groups (all p>0.05).

Follow-up periodontal parameters

Table 3 shows the means of the periodontal indexes by treatment groups at baseline, 3-month, and 6-month follow-up.

Within the groups, compared with baseline measurements, both therapies (ERL+SRP or SRP) produced significant reductions in the means of PD, CAL, BI, and PLI at 3-month and 6-month follow-up (all p<0.05). The differences between 3-month and 6-month follow-up were not statistically significant.

We used the analysis of linear mixed model to analyze the differences in periodontal indexes between groups. ERL+SRP quadrants had lower PD means at 3-month follow-up (2.98±0.38 vs. 3.09±0.35 mm) and at 6-month follow-up (2.91±0.31 vs. 3.02±0.30 mm) than the control quadrants (p=0.03). ERL+SRP quadrants also had lower CAL means at 3-month follow-up (4.51±0.69 vs. 4.72±0.67 mm) and at 6-month follow-up (4.52±0.65 vs. 4.72±0.66 mm) than the control quadrants (p=0.03) (Table 3, Figure 2). However, the magnitudes of such differences between the two groups were very small (0.11mm for PD and 0.20 mm for CAL at 6-month follow-up).

There were no significant differences in BI and PLI between ERL+SRP quadrants and control quadrants at 3-month or 6-month follow-up (Table 3).

Table 4 and Table 5 show the proportions of sites showing ≥2mm change in PD and CAL, respectively. Each group had about 13-15% sites with initial PD=5-6mm and 2.7-3% sites with initial PD≥7mm. These sites were moderate or severe pockets, most of which needed treatment. In the ERL+SRP group, the percentages of sites showing ≥2mm improved in PD tended to be higher than those in the SRP group from baseline to 3 and 6 months (Table 4). However, these differences did not reach statistical significance (all p>0.05). The percentages of sites showing ≥2mm gain or loss in CAL from baseline to 3 months and 6 months showed similar trends without statistical significance (Table 5).

In addition, the sites reaching the successful treatment endpoint of PD ≤ 4 mm were called ‘‘pocket closure’’ (Wennström et al. 2005). In the ERL+SRP group, the percentages of sites showing ‘‘pocket closure’’ appeared to be higher than those in the SRP group at two examination intervals but the differences were not statistically significant for pockets initially 5-6mm deep (72.4% vs. 68.9% at 3 months; 77.6% vs. 73.4% at 6 months) and those initially ≥7mm deep (35.5% vs. 29.4% at 3 months; 47.7% vs. 42.9% at 6 months) (all p>0.05).

Discussion

In this split-mouth randomized controlled study of 27 Chinese patients with periodontitis (stage Ⅲ or stage Ⅱ), quadrants treated with a combination of Er:YAG laser and mechanical SRP (ERL + SRP) had lower measurements of PD and CAL than the control quadrants at 3-month and 6-month follow-up.

In recent years, there have been many clinical studies of dental lasers for nonsurgical treatment of periodontal disease. However, their results are inconclusive regarding whether laser therapy has additional benefits over conventional SRP. Even when the type of laser used was limited to Er:YAG, findings were inconsistent. A recent meta-analysis including 11 RCTs and 1 quasi-RCT by Cheng et al. suggested that adjunctive laser therapy significantly reduced PD at 3 months (Cheng et al. 2016). Their summary effects are in agreement with the results of our study, although the differences we observed are only statistically significant and may not be clinically meaningful. In addition, our data also support the findings of Yilmaz et al., who observed that positive changes in clinical parameters such as attachment gain and PD reduction were significantly greater in the ERL+SRP group than the SRP group (Yilmaz et al. 2012, 2013). Likewise, Saglam et al. showed superior results for their laser group in terms of PD and CAL at 3 months and 6 months (Saglam et al. 2014). Ratka-Krüger et al. suggested that Er:YAG laser and sonic scaler had similar clinical and microbiological outcomes during supportive periodontal care (Ratka-Krüger et al. 2012). On the other hand, several studies have suggested that compared to SRP, Er:YAG laser lacked adjunctive benefit in non-surgical periodontal treatment (Feng et al. 2011, Malali et al. 2012, Rotundo et al. 2010, Schwarz et al. 2003b, Soo et al. 2012). These inconsistent results might have been produced by study heterogeneity due to differences in study design, statistical handling of the clinical data, patient populations, patients' response to treatment, laser parameters, and application time.

Several mechanisms have been proposed as underlying the possible beneficial effect of Er:YAG laser in non-surgical periodontal treatment. First, Er:YAG lasers are well absorbed in water. As dental calculus has a moderate water content, Er:YAG lasers are indicated for its removal. Unlike Nd:YAG lasers used for soft tissues only, Er:YAG lasers can be used for both hard and soft tissues. Second, Er:YAG lasers can safely and effectively remove granulation tissue, even from bone defects, which are difficult to access without harming the osseous tissue (Mizutani et al. 2006). Third, Er:YAG lasers can also remove bacterial endotoxins from the root surface (Folwaczny et al. 2003). Finally, these wavelengths, when used in nonsurgical therapy, can improve fibroblast (Crespi et al. 2006) and periodontal ligament fibroblast attachment (Schwarz et al. 2003a) to root surfaces and support the formation of new connective tissue attachment (Aoki et al. 2015, Schwarz et al. 2007). In addition, it is worth noting that the majority of previous studies only introduced a single set of laser parameters (such as an energy level of 160 mJ/pulse and a repetition rate of 10 Hz). When Er:YAG lasers are used for hard tissue or soft tissues, different laser mode parameters should be used for specific purposes (e.g., for calculus removal or periodontal pocket debridement).

In longitudinal studies, measurements are grouped in subjects who are followed over time. As longitudinal observations may not be truly independent because of a higher-level clustering unit, the data used for analysis will include observations that are measured at repeated times and correlated within the clustering time unit (Shek & Ma 2011). Therefore, in our study, we performed analyses using a linear mixed model to compare the overall differences in periodontal indexes between two comparison groups over time.

In the present study, the statistically significant differences of PD and CAL between treatments are relatively small. The ERL+SRP group and SRP group showed a mean CAL gain of 0.86 mm and 0.58 mm at 6 months, respectively (baseline CAL: 5.38mm and 5.30mm respectively). In previous study, the periodontal disease in patients were relatively severe than those in our study population. It maybe explain the small difference magnitude. Since the difference between the two groups for PD was 0.1mm and for CAL was 0.2mm only at 6 months follow-up, the adjunctive effect of Er:YAG laser to SRP may be minimal clinically meaningful, even statistically significant.

The present study has several limitations that merit consideration. First, our follow-up time is relatively short. Second, types of data collected and compared were not comprehensive. If micro-organism and inflammatory factors had been observed at the same time, the results might be more convincing. In addition, the laser parameters used in our study were not those most commonly used (many studies use an energy level of 160 mJ/pulse and a repetition rate of 10 Hz). That may have increased heterogeneity when compared with other studies. However, because the mechanisms by which Er:YAG lasers act on hard and soft tissue are different, we prefer to choose different laser mode parameters to remove calculus and debride periodontal pockets.

In conclusion, our split-mouth randomized controlled trial suggests that Er:YAG laser, as an adjunctive treatment to SRP, generated better results than SRP alone in terms of significant PD reduction and clinical attachment gain at 3 months and 6 months. However, the differences are relatively small, even statistically significant. Our results suggest that the adjunctive effect of Er:YAG laser to SRP is clinically minimal. Future long-term, large-scale randomized controlled trials are needed to provide definitive evidence to confirm the efficacy and safety of Er:YAG laser in the adjunctive treatment of periodontitis.

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Figure 1. Flow chart of the study design and conduct. SRP: scaling and root planing

Table 1. Baseline characteristics of the study population

Characteristic	n=27
Age (years) (mean ±SD)	49.0±9.6
Gender [n (%)]	
Male	11(40.7)
Female	16(59.3)
BMI (kg/m^2) (mean ± SD)	24.9±3.3
Smoking status	
Non-smoker	27(100%)
Marriage status	
Single	2(7.4%)
Married	25(92.6%)
Living status	
Living alone	1(3.7%)
Living with family	26(96.3%)
Periodontitis stage [n (%)]	
Stage Ⅱ	8(29.6)
Stage Ⅲ	19(70.4)

BMI: body mass index

Table 2. Means (± SD) of the periodontal indexes at baseline among all 27 patients participating in the trial

Periodontal index	ERL+SRP group (Test quadrants) n=27	SRP group (Control quadrants) n=27	*p* value
Probing depth (PD)	3.60±0.41	3.58±0.42	0.52
Clinical attachment level (CAL)	5.38±0.71	5.30±0.77	0.13
Bleeding index (BI)	2.68±0.58	2.67±0.54	0.84
Plaque index (PLI)	1.92±0.43	1.94±0.42	0.23

The significance of differences between groups was assessed using analyses of Paired-Sample *t* test.

ERL: Er:YAG laser; SRP: scaling and root planing

Table 3. Means (± SD) of the periodontal indexes by treatment groups at both baseline and follow-up periods at 3 months and 6 months among 27 patients

Periodontal index	ERL+SRP group (Test quadrants) n=27	SRP group (Control quadrants) n=27	*p* value
PD			0.03*
Baseline	3.60±0.41	3.58±0.42	
3 months	2.98±0.38 [a]	3.09±0.35 [a]	
6 months	2.91±0.31 [b]	3.02±0.30 [b]	
CAL			0.03*
Baseline	5.38±0.71	5.30±0.77	
3 months	4.51±0.69 [a]	4.72±0.67 [a]	
6 months	4.52±0.65 [b]	4.72±0.66 [b]	
BI			0.18
Baseline	2.68±0.58	2.67±0.54	
3 months	2.19±0.32 [a]	2.24±0.40 [a]	
6 months	2.13±0.30 [b]	2.22±0.36 [b]	
PLI			0.34
Baseline	1.92±0.43	1.94±0.42	
3 months	1.43±0.26 [a]	1.46±0.26 [a]	
6 months	1.42±0.21 [b]	1.48±0.20 [b]	

The significance of differences between groups was assessed using analyses of the linear mixed model (*: $p<0.05$).

The pair-wise comparisons within groups were performed by the least-significant-difference (LSD) method (a: indicate significant differences between baseline & 3 months follow-up; b: indicate significant differences between baseline & 6 months follow-up).

ERL: Er:YAG laser; SRP: scaling and root planing; PD: probing depth; CAL: clinical attachment level; BI: bleeding index; PLI: plaque index.

Figure 2. Means (± SD) of the PD and CAL at baseline, 3 months, and 6 months
*: p<0.05, significance of differences between treatment groups

Table 4. Percentage of sites showing ≥2mm change in PD between baseline and follow-up periods at 3 months and 6 months [n (%)]

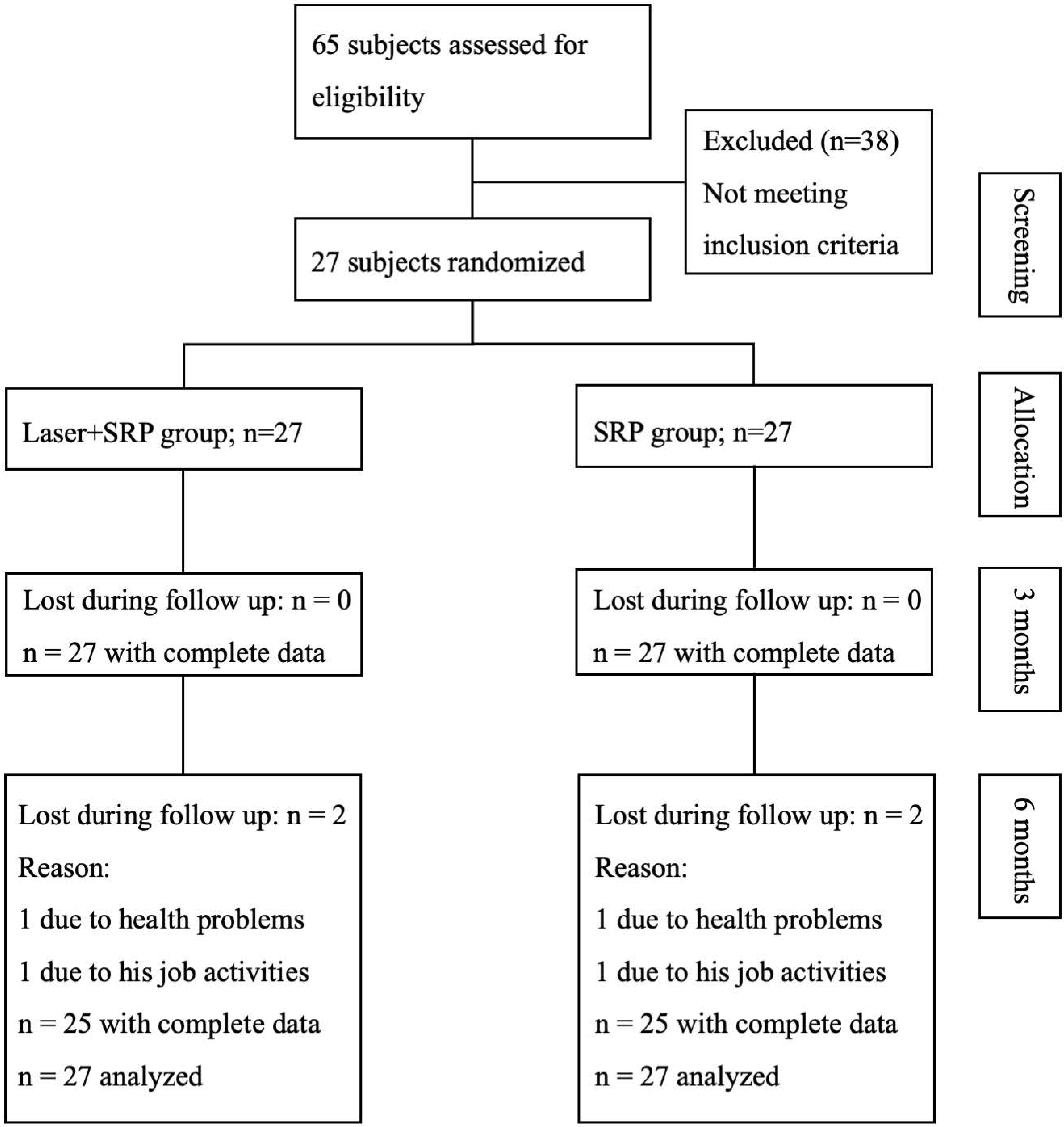
	ERL+SRP group			SRP group		
	n	improved	worsened	n	improved	worsened
Initial PD (5-6mm)						
3 months	352	170(48.3)	2(0.6)	296	136(45.9)	4(1.4)
6 months	326	175(53.7)	3(0.9)	274	138(50.4)	6(2.2)
Initial PD (≥7mm)						
3 months	62	46(74.2)	0(0)	68	48(70.6)	0(0)
6 months	57	44(77.3)	1(1.8)	63	46(73.0)	1(1.5)

ERL: Er:YAG laser; SRP: scaling and root planing; PD: probing depth

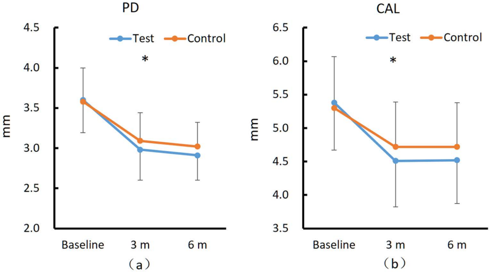
Table 5. Percentage of sites showing ≥2mm gain or loss of CAL between baseline and follow-up periods at 3 months and 6 months [n (%)]

	ERL+SRP group			SRP group		
	n	gain	loss	n	gain	loss
Initial PD (5-6mm)						
3 months	352	192(54.5)	5(1.4)	296	124(41.9)	5(2.1)
6 months	326	197(60.4)	9(2.8)	274	143(52.2)	10(3.6)
Initial PD (≥7mm)						
3 months	62	44(71.0)	1(1.6)	68	35(51.5)	1(1.5)
6 months	57	39(68.4)	1(1.8)	63	40(63.5)	2(3.2)

ERL: Er:YAG laser; SRP: scaling and root planing; PD: probing depth; CAL: clinical attachment level



65 subjects assessed for eligibility
Excluded (n=38)
Not meeting inclusion criteria
27 subjects randomized
Screening
Laser+SRP group; n=27
SRP group; n=27
Allocation
Lost during follow up: n = 0
n = 27 with complete data
Lost during follow up: n = 0
n = 27 with complete data
3 months
Lost during follow up: n = 2
Reason:
1 due to health problems
1 due to his job activities
n = 25 with complete data
n = 27 analyzed
Lost during follow up: n = 2
Reason:
1 due to health problems
1 due to his job activities
n = 25 with complete data
n = 27 analyzed
6 months


PD
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