

World Journal of *Clinical Cases*

World J Clin Cases 2021 November 16; 9(32): 9699-10051



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The *WJCC* is now indexed in Science Citation Index Expanded (also known as SciSearch®), Journal Citation Reports/Science Edition, Scopus, PubMed, and PubMed Central. The 2021 Edition of Journal Citation Reports® cites the 2020 impact factor (IF) for *WJCC* as 1.337; IF without journal self cites: 1.301; 5-year IF: 1.742; Journal Citation Indicator: 0.33; Ranking: 119 among 169 journals in medicine, general and internal; and Quartile category: Q3. The *WJCC*'s CiteScore for 2020 is 0.8 and Scopus CiteScore rank 2020: General Medicine is 493/793.

RESPONSIBLE EDITORS FOR THIS ISSUE

Production Editor: Jia-Hui Li; Production Department Director: Yu-Jie Ma; Editorial Office Director: Jin-Lai Wang.

NAME OF JOURNAL

World Journal of Clinical Cases

ISSN

ISSN 2307-8960 (online)

LAUNCH DATE

April 16, 2013

FREQUENCY

Thrice Monthly

EDITORS-IN-CHIEF

Dennis A Bloomfield, Sandro Vento, Bao-Gan Peng

EDITORIAL BOARD MEMBERS

<https://www.wjgnet.com/2307-8960/editorialboard.htm>

PUBLICATION DATE

November 16, 2021

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INSTRUCTIONS TO AUTHORS

<https://www.wjgnet.com/bpg/gerinfo/204>

GUIDELINES FOR ETHICS DOCUMENTS

<https://www.wjgnet.com/bpg/GerInfo/287>

GUIDELINES FOR NON-NATIVE SPEAKERS OF ENGLISH

<https://www.wjgnet.com/bpg/gerinfo/240>

PUBLICATION ETHICS

<https://www.wjgnet.com/bpg/GerInfo/288>

PUBLICATION MISCONDUCT

<https://www.wjgnet.com/bpg/gerinfo/208>

ARTICLE PROCESSING CHARGE

<https://www.wjgnet.com/bpg/gerinfo/242>

STEPS FOR SUBMITTING MANUSCRIPTS

<https://www.wjgnet.com/bpg/GerInfo/239>

ONLINE SUBMISSION

<https://www.f6publishing.com>

Retrospective Study

Treatment effects and periodontal status of chronic periodontitis after routine Er:YAG laser-assisted therapy

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Author contributions: Gao YZ and Li Y designed the experiment; Gao YZ drafted the work; Chen SS and Feng B collected the data; Wang H and Wang Q analyzed and interpreted the data; Gao YZ, Li Y and Chen SS wrote the paper.

Supported by Qiqihar Science and Technology Bureau Social Development General Instruction Project, No. SFGG-201965.

Institutional review board

statement: The study design was approved by the First Affiliated Hospital of Qiqihar Medical University Ethics Committee.

Informed consent statement: All study participants, or their legal guardian, provided informed written consent prior to study enrollment.

Conflict-of-interest statement: The authors declare that they have no conflicting interests.

Data sharing statement: No additional data are available.

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Abstract**BACKGROUND**

Routine preclinical interventions for patients with chronic periodontitis such as supragingival cleaning and subgingival curettage, establishing a balanced occlusal relationship, and irrigation with 3% hydrogen peroxide can relieve the symptoms to some extent. However, there is room for improvement in the overall effect. For example, Er:YAG lasers can quickly increase the temperature of the irradiated tissue, effectively eliminate dental plaque and calculus, reduce periodontal pockets, adjust periodontal microecology, and reduce the gingival sulcus. The content of factors in the liquid, and then achieve the purpose of treatment.

AIM

The aim was evaluate the effect of Er:YAG laser-assisted routine therapy on the periodontal status in chronic periodontitis.

METHODS

Between October 2018 and January 2020, 106 patients with chronic periodontitis in our hospital were randomly assigned to either the study or control group, with 53

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Specialty type: Dentistry, oral surgery and medicine

Country/Territory of origin: China

Peer-review report's scientific quality classification

Grade A (Excellent): 0
Grade B (Very good): B
Grade C (Good): C
Grade D (Fair): 0
Grade E (Poor): 0

Received: June 17, 2021

Peer-review started: June 17, 2021

First decision: July 16, 2021

Revised: July 28, 2021

Accepted: August 16, 2021

Article in press: August 16, 2021

Published online: November 16, 2021

P-Reviewer: Mizuno N, Reynolds EC

S-Editor: Wang JL

L-Editor: Filipodia

P-Editor: Wu RR



patients in each group. The control group underwent routine therapy, and the study group underwent Er:YAG laser therapy in addition to routine therapy. We evaluated the treatment outcome in both groups. Periodontal status was determined by clinical attachment loss (CAL), gingival index (GI), periodontal probing depth (PD), dental plaque index (PLI), and sulcular bleeding index (SBI), inflammatory factors in the gingival crevicular fluid, tumor necrosis factor- α (TNF- α), interleukin-6 (IL-6), IL-8], and colony forming units (CFUs).

RESULTS

Total effectiveness in the study group (94.34%) was higher than that in the control group (79.25%, $P < 0.05$). The clinical parameters in the study group (PD, 5.28 ± 1.08 mm; CAL, 4.81 ± 0.79 mm; SBI, 3.37 ± 0.59 ; GI, 1.38 ± 0.40 ; PLI, 2.05 ± 0.65) were not significantly different from those in the control group (PD, 5.51 ± 1.14 mm; CAL, 5.09 ± 0.83 mm; SBI, 3.51 ± 0.62 ; GI, 1.41 ± 0.37 ; PLI, 1.98 ± 0.70) before treatment ($P > 0.05$). However, after treatment, the parameters in the study group (PD, 2.97 ± 0.38 mm; CAL, 2.71 ± 0.64 mm; SBI, 2.07 ± 0.32 ; GI, 0.51 ± 0.11 ; PLI, 1.29 ± 0.34) were lower than those in the control group (PD, 3.71 ± 0.42 mm; CAL, 3.60 ± 0.71 mm; SBI, 2.80 ± 0.44 ; GI, 0.78 ± 0.23 ; PLI, 1.70 ± 0.51) ($P < 0.05$). Differences in crevicular TNF- α , IL-6, and IL-8 levels in the study (TNF- α , 7.82 ± 3.43 ng/mL; IL-6, 11.67 ± 2.59 ng/mL; IL-8, 12.12 ± 3.19 pg/mL) and control groups (TNF- α , 9.06 ± 3.89 ng/ml, IL-6, 12.13 ± 2.97 ng/mL, IL-8, 10.99 ± 3.30 pg/mL) before therapy ($P > 0.05$) were not significant. Following treatment, the parameters were significantly lower in the study group (TNF- α , 2.04 ± 0.89 ng/mL; IL-6, 4.60 ± 1.26 ng/mL; IL-8, 3.15 ± 1.08 pg/mL) than in the control group (TNF- α , 3.11 ± 1.07 ng/mL; IL-6, 6.25 ± 1.41 ng/mL; IL-8, 4.64 ± 1.23 pg/mL, $P < 0.05$). The difference in the CFU of the study group [$(367.91 \pm 74.32) \times 10^4$ /mL and control group (371.09 ± 80.25) $\times 10^4$ /mL] before therapy was not significant ($P > 0.05$). The CFU decreased in both groups following therapy, however, the CFU values were lower in the study group [$(36.09 \pm 15.26) \times 10^4$ /mL] than in the control group [$(45.89 \pm 18.08) \times 10^4$ /mL] ($P < 0.05$).

CONCLUSION

Combining Er:YAG lasers with routine measures significantly improved the overall periodontal therapy outcomes by improving periodontal status and reducing oral levels of inflammatory factors and CFUs.

Key Words: Er:YAG laser therapy; Chronic periodontitis; Periodontal status; Oral inflammatory factors

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Core Tip: It was confirmed that in the treatment of chronic periodontitis, the use of Er:YAG laser therapy as an auxiliary treatment can reduce the level of inflammatory factors and oral colony forming units, which is beneficial to overall improvement of treatment effectiveness.

Citation: Gao YZ, Li Y, Chen SS, Feng B, Wang H, Wang Q. Treatment effects and periodontal status of chronic periodontitis after routine Er:YAG laser-assisted therapy. *World J Clin Cases* 2021; 9(32): 9762-9769

URL: <https://www.wjgnet.com/2307-8960/full/v9/i32/9762.htm>

DOI: <https://dx.doi.org/10.12998/wjcc.v9.i32.9762>

INTRODUCTION

Chronic periodontitis is a clinically multiple disease, and its incidence has continued to increase in recent years. It has gradually become an important cause of tooth loss in adults and has a great impact on patients' daily life and facial esthetics[1-3]. Therefore, timely, and effective intervention is essential for patients with chronic periodontitis.

At present, the overall goal of periodontitis treatment is to eliminate dental plaque and periodontal inflammation, control progression of the disease, and prevent recurrence. Although basic periodontal treatment can relieve the symptoms to a certain extent, it lacks intervention measures directed toward the host's functional state and involves treatment of the symptoms rather than the root cause. It is unable to effectively eliminate the factors that promote periodontitis, which prevents the achievement of an ideal therapeutic effect and results in limitations of clinical application[3-6]. In recent years, with advances in laser technology, the use of lasers has become a principal practice in periodontal therapy. Er:YAG lasers are low-intensity lasers that cause minimal injury of the surrounding tissues, can be easily absorbed by water, and maintain comfort. Based on this background, the study planned to select 106 inpatients with chronic periodontitis for evaluation of the effectiveness of Er:YAG laser-assisted routine therapy in experimental and control groups.

MATERIALS AND METHODS

Inclusion criteria

The inclusion criteria were; (1) Conformance to the diagnostic criteria with chronic periodontitis or parodontology; (2) No history of antibiotic, glucocorticoid, or immunosuppressant treatment in the 3 mo before participation in the study; (3) Excellent compliance, communication skills, and cooperation with the study protocol; And (4) Provision of informed content.

Exclusion criteria

The exclusion criteria were; (1) Presence of acute periodontitis or pulpitis; (2) History of orthodontal treatment; (3) Diabetes; (4) Gestation or menstrual period; (5) Oral contraceptive use; (6) Cardiovascular or cerebrovascular disease; And (7) Speech communication barriers, cognitive impairment, or mental disorder.

Methods

The study design was approved by the ethics of committee of our hospital. Between October 2018 and January 2020, 106 patients with chronic periodontitis treated at our hospital were selected based on the inclusion criteria. They were assigned to the study and control groups according to a simple random number table method, with 53 patients in each group.

Treatment

The control group underwent routine therapy, including supragingival cleaning and subgingival curettage, establishment of balanced occlusal relationship, periodontal rinsing with 3% hydrogen peroxide water, and so on. The study group underwent Er:YAG laser therapy in addition to the control group treatment. Dual-wavelength laser therapy (Fidelis AT D M021-3AF/3) was performed with a ChiSel working tip. The parameter settings were water volume, 90%; frequency, 15 Hz; and pulse energy, 100 MJ. During treatment, the angle between the working tip and the long axis of the teeth was maintained at 15° and a lifting movement was performed from the base of the periodontal pocket bottom toward the crown, maintaining light contact between the working tip and the tooth surface to remove subgingival calculus. After the calculus was removed, the working tip was adjusted to 0.8 × 17 mm, water volume was 100%, frequency was 30 Hz, and the energy was 50 MJ. The working tip was positioned, as much as possible, parallel to the long axis of the teeth, and a circular movement was performed from the base of the periodontal pocket to the crown for simultaneous periodontal sterilization and removal of the infected pocket epithelium.

Evaluation of parameters

The following parameters were evaluated. (1) In both groups, the study treatment was assessed according to the curative-effect standard for periodontitis. Absence of bleeding and gingival erythema and edema, with normal gingiva, > 2 mm decrease in periodontal pocket depth, > 60% plaque bacteria clearance rate were significant effects, with significant improvement of symptoms and signs. A > 1 mm decrease in periodontal pocket depth and a > 20% plaque bacteria clearance rate were considered effective. Treatment was not effective if the criteria above were not met. Total effectiveness (%) = significant effectiveness (%) + effectiveness(%); (2) Periodontal status was evaluated in both groups before and after treatment, including clinical attachment

loss (CAL), gingival index (GI), periodontal probing depth (PD), dental plaque index (PLI), and sulcular bleeding index (SBI); (3) The levels of inflammatory factors in the gingival crevicular fluid, tumor necrosis factor- α (TNF- α), interleukin-6 (IL-6), and IL-8, were assayed in both groups before and after treatment. The samples were tested by an enzyme-linked immunosorbent assay; And (4) Colony forming units (CFU) were measured in both groups before and after treatment. Samples were collected from the periodontal pocket and cultured.

Statistical methods

Data were analyzed with SPSS 21.0. Results were reported as means \pm SD or number and percentage (%) and compared by *t*-tests and χ^2 tests. *P* values of < 0.05 were considered statistically significant.

RESULTS

Patient characteristics

The control group included 29 men and 24 women 37–66 years of age (average of 51.68 ± 9.77 yr). The disease course was of 1.5–5.3 years (average of 3.61 ± 1.11 yr). The study group had 32 men and 21 women 35–68 years of age (average of 53.05 ± 10.67 yr). The disease course was 1.2–6.1 years (average of 3.73 ± 1.22 yr). The baseline data of both groups were comparable ($P > 0.05$).

Treatment effectiveness

The total effectiveness in the study group (94.34%) was higher than that in the control group (79.25%, $P < 0.05$; [Table 1](#)).

Periodontal status

The clinical parameters in the study group (PD, 5.28 ± 1.08 mm; CAL, 4.81 ± 0.79 mm; SBI, 3.37 ± 0.59 ; GI, 1.38 ± 0.40 ; and PLI, 2.05 ± 0.65) were not significantly different from those in the control group (PD, 5.51 ± 1.14 m; CAL, 5.09 ± 0.83 mm; SBI, 3.51 ± 0.62 ; GI, 1.41 ± 0.37 ; and PLI, 1.98 ± 0.70) before treatment ($P > 0.05$). However, after treatment, the parameters in the study group (PD, 2.97 ± 0.38 mm; CAL, 2.71 ± 0.64 mm; SBI, 2.07 ± 0.32 ; GI, 0.51 ± 0.11 ; and PLI, 1.29 ± 0.34) were lower than those in the control group (PD, 3.71 ± 0.42 mm; CAL, 3.60 ± 0.71 mm; SBI, 2.80 ± 0.44 ; GI, 0.78 ± 0.23 ; and PLI, 1.70 ± 0.51 , $P < 0.05$, [Table 2](#)).

Levels of inflammatory factors in the gingival crevicular fluid

There were no significant differences in the crevicular TNF- α , IL-6, and IL-8 levels in the study (TNF- α , 7.82 ± 3.43 ng/mL; IL-6, 11.67 ± 2.59 ng/mL; IL-8, 12.12 ± 3.19 pg/mL) and control (TNF- α , 9.06 ± 3.89 ng/mL, IL-6, 12.13 ± 2.97 ng/mL, IL-8, 10.99 ± 3.30 pg/mL) groups before therapy ($P > 0.05$). Following treatment, the parameters were significantly lower in the study group (TNF- α , 2.04 ± 0.89 ng/mL; IL-6, 4.60 ± 1.26 ng/mL; IL-8, 3.15 ± 1.08 pg/mL) than in the control group (TNF- α , 3.11 ± 1.07 ng/mL; IL-6, 6.25 ± 1.41 ng/mL; il-8, 4.64 ± 1.23 pg/mL, $P < 0.05$; [Table 3](#)).

CFU

There was no significant difference in the CFU of the study group [$(367.91 \pm 74.32) \times 10^4$ /mL] and control group [$(371.09 \pm 80.25) \times 10^4$ /mL] before therapy ($P > 0.05$). The CFU decreased in both groups following therapy, but, the CFU values were lower in the study group [$(36.09 \pm 15.26) \times 10^4$ /mL] than in the control group [$(45.89 \pm 18.08) \times 10^4$ /mL] ($P < 0.05$) ([Table 4](#)).

DISCUSSION

Chronic periodontitis is a common chronic inflammatory clinical disease of the periodontal tissues. Most patients have tooth mobility, alveolar bone resorption, and persistent inflammation of the periodontal pocket and pocket wall[7]. Chronic periodontitis is associated with increased morbidity and has gradually become the main cause of tooth loss in adults in recent years. The development of safe and effective treatments for chronic periodontitis remains a hot topic. At present, routine practices for treating clinical chronic periodontitis, such as tidging up the root surface, removal of

Table 1 Comparison of treatment effectiveness in the two groups, *n* (%)

Groups	Cases	Significant effect	Valid	Invalid	Total effectiveness
Study group	53	27 (50.94)	23 (43.40)	3 (5.66)	50 (94.34)
Control group	53	20 (37.74)	22 (41.51)	11 (20.75)	42 (79.25)
χ^2					5.267
<i>P</i> value					0.022

Table 2 Comparison of periodontal status in the two groups (mean \pm SD)

Group	Cases	PD in mm	CAL in mm	SBI	GI	PLI
Before therapy						
Study group	53	5.28 \pm 1.08	4.81 \pm 0.79	3.37 \pm 0.59	1.38 \pm 0.40	2.05 \pm 0.65
Control group	53	5.51 \pm 1.14	5.09 \pm 0.83	3.51 \pm 0.62	1.41 \pm 0.37	1.98 \pm 0.70
<i>t</i>		1.344	1.779	1.280	0.401	0.533
<i>P</i> value		0.182	0.078	0.204	0.689	0.595
After therapy						
Study group	53	2.97 \pm 0.38	2.71 \pm 0.64	2.07 \pm 0.32	0.51 \pm 0.11	1.29 \pm 0.34
Control group	53	3.71 \pm 0.42	3.60 \pm 0.71	2.80 \pm 0.44	0.78 \pm 0.23	1.70 \pm 0.51
<i>t</i>		9.512	6.778	9.768	7.710	4.605
<i>P</i> value		0.000	0.000	0.000	0.000	0.000

CAL: Clinical attachment loss; GI: Gingival index; PD: periodontal probing depth; PLI: Dental plaque index; SBI: Sulcular bleeding index;

Table 3 Comparison of inflammatory factors in gingival crevicular fluid from the two groups (mean \pm SD)

Groups	Cases	TNF- α in ng/mL	IL-6 in ng/mL	IL-8 in pg/mL
Before therapy				
Study group	53	7.82 \pm 3.43	11.67 \pm 2.59	12.12 \pm 3.19
Control group	53	9.06 \pm 3.89	12.13 \pm 2.97	10.99 \pm 3.30
<i>t</i>		1.741	0.850	1.792
<i>P</i> value		0.085	0.397	0.076
After therapy				
Study group	53	2.04 \pm 0.89	4.60 \pm 1.26	3.15 \pm 1.08
Control group	53	3.11 \pm 1.07	6.25 \pm 1.41	4.64 \pm 1.23
<i>t</i>		5.597	7.182	6.627
<i>P</i> value		0.000	0.000	0.000

IL: Interleukin; TNF- α : Tumor necrosis factor- α .

foreign bodies and bacteria in the dental cavity, and cleaning the oral cavity are effective, but over time there is a risk of disease relapse that can cause severe injury to periodontal tissues. Er:YAG laser therapy is an important modality for treating chronic periodontitis that uses a hydrodynamic biologic laser that cuts hard tissue, and at the same time kills periodontal actinomycetes and *Porphyromonas gingivalis* and decreases the amount of surviving *Porphyromonas gingivalis* and *Aggregatibacter actinomycetem-comitans* to achieve therapeutic outcomes[3,8-12]. According to some studies[13], treatment of chronic periodontitis with an Er:YAG laser was effective in promoting patient periodontal status. some studies have shown that treatment of chronic period-

Table 4 Comparison of colony forming units in the two groups (mean \pm SD, $\times 10^4$ /mL)

Groups	Cases	Before therapy	After therapy	<i>t</i>	<i>P</i> value
Study group	53	367.91 \pm 74.32	36.09 \pm 15.26	31.840	0.000
Control group	53	371.09 \pm 80.25	45.89 \pm 18.08	28.780	0.000
<i>t</i>		0.212	2.988		
<i>P</i> value		0.833	0.004		

ontitis with an Er:YAG laser improved therapeutic effectiveness by decreasing the level of Dickkopf-1 and the activity of alkaline phosphatase in gingival crevicular fluid. The results of this study indicated that the periodontal status of the study group was better than that of the control group after treatment and the total effectiveness (94.34%) was higher (79.25%, $P < 0.05$), which was consistent with previous studies. The findings show that combining laser Er:YAG therapy with conventional interventions improved periodontal status in chronic periodontitis, leading to a good outcome.

Moreover, in chronic periodontitis there are abnormal increases in the levels of inflammatory factors. IL-6, participates in the regulation of acute inflammatory protein production, exacerbate, the degree of the inflammatory response, slows periodontal tissue repair, and further exacerbate alveolar bone damage. IL-8 is a strong chemotactic agent that recruits and activates neutrophils, induces superoxide generation, and causes damage to periodontal tissues. IL-8 is also a dual regulatory factor, and its serum level is closely associated with the inflammatory state of periodontal tissues. TNF- α is a low molecular weight protein with a wide range of biological activities. TNF- α activates inflammatory response transmitters and chemokines, stimulates fibroblasts and stromal cells, damages bone and connective tissue, which lead to damage of periodontal tissues.

After treatment, TNF- α , IL-6, and IL-8 levels in the gingival crevicular fluid and CFUs in the study group were lower than those in the control group ($P < 0.05$). The results indicate that the combined Er:YAG laser and conventional intervention had significant advantages in downregulating inflammatory factors in gingival crevicular fluid and relieving the degree of inflammation in chronic periodontitis. Laser treatment was effective in reducing CFU levels and improving therapeutic outcomes. The reason is that the Er:YAG solid-pulse laser increases the temperature at spot irradiation by the laser light spot, induces tissue vaporization separation, cleans dental plaque and calculus, shrinks the periodontal pocket, regulates periodontal microecology, reduces the levels of the inflammatory factors in gingival crevicular fluid, and prevents repeated inflammation. The Er:YAG laser helps eliminate subgingival calculus without causing heat-induced injury of the surrounding tissues. It causes minimal injury to the adjacent hard tissues and has the ability to kill periodontal bacteria, which ensures therapeutic efficacy[7,15]. Furthermore, bacteria are aqueous organisms, and the Er:YAG laser vaporizes them very quickly by increasing the pressure in the target cell and producing microexplosions that lead to bacterial death and achieve sterilization. Furthermore, lipopolysaccharides present in the outer membrane of gram-negative bacteria induce the production of various inflammatory mediators that promote production of white blood cells involved in periodontal tissue damage. The Er:YAG laser spectrum peak is close to the lipopolysaccharide spectrum peak wavelength, laser treatment can therefore remove root surface lipopolysaccharides, thereby reducing the levels of inflammatory factors and microbes in the mouth[16]. Other studies have shown that traditional root planing can form a stain layer on the root surface that slows or inhibits the reattachment of cells to the root surface, which is not conducive to periodontal healing. Er:YAG laser treatment does not form a stain layer on the root surface, which favors the attachment of periodontal tissues and accelerates the regeneration or repair of periodontal tissues[17-20].

CONCLUSION

In conclusion, chronic periodontitis can be treated with integrated therapies, including routine therapy combined with Er:YAG laser therapy. Combination treatment improved periodontal status, downregulated inflammatory factor levels, reduced the number CFUs in the mouth, and was beneficial in improving overall treatment effect-

iveness. However, the study has some limitations. The parameters evaluated are all short-term indicators. Therefore, the effect of conventional treatment combined with Er:YAG laser on the maintenance of long-term treatment outcomes in chronic periodontitis requires further investigation with a longer follow-up.

ARTICLE HIGHLIGHTS

Research background

Patients with chronic periodontitis often undergo routine treatment by supragingival cleaning and subgingival curettage, establishing a balanced occlusal relationship, and irrigation with 3% hydrogen peroxide. Treatment relieves the symptoms to some extent, but, there is room for improvement in the overall effectiveness. Er:YAG lasers quickly increase the temperature of the irradiated tissue, eliminate dental plaque and calculus, reduce periodontal pockets, adjust periodontal microecology, and reduce the gingival sulcus.

Research motivation

The study motivation was to reduce the impact of chronic periodontitis on periodontal health.

Research objectives

This study aimed to evaluate the effect of Er:YAG laser-assisted routine therapy on periodontal status in patients with chronic periodontitis.

Research methods

At our hospital, 106 patients with chronic periodontitis were randomly assigned to either a study or control group, with 53 patients in each group. The control group underwent routine therapy, and the study group underwent Er:YAG laser therapy in addition to routine therapy. The treatment outcome, including the periodontal status, inflammatory factors in the gingival crevicular fluid, and colony forming units were evaluated in both groups.

Research results

Total effectiveness in the study group was higher than that in the control group. The clinical parameters in the study group and in the control group were not significantly before treatment. However, after treatment, the values in the study group were lower than those in the control group. There was no significant difference in crevicular TNF- α , IL-6, and IL-8 levels in the study and control groups before therapy.

Research conclusions

Combining Er:YAG lasers with routine treatment method significantly improve the overall periodontal therapy outcomes by improving the periodontal status and reducing oral levels of inflammatory factors and colony forming units.

Research perspectives

Er:YAG lasers represent a new treatment direction for periodontitis.

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