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Original Research Article

Clinical efficacy of semiconductor laser-assisted minocycline in moderate-to-severe chronic periodontitis patients with type 2 diabetes mellitus

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Abstract

Purpose: *To study the clinical efficacy of semiconductor laser-assisted minocycline in the treatment of moderate-to-severe chronic periodontitis (CP) in type 2 diabetes mellitus (T2DM) patients.*
Methods: *A total of 109 cases of CP combined with T2DM and obesity admitted to The First Affiliated Hospital, Medical School of Xi'an Jiaotong University, Xi'an, China, from November 2016 to November 2017 were included in the study. Among them, 54 patients in the study group were treated with semiconductor laser-assisted minocycline, while 55 patients in the control group were treated with minocyclin injection. Periodontitis, blood glucose and blood lipid levels were compared between the two groups before and after treatment.*
Results: *Post-treatment (12 weeks), bleeding on probing, gingival index, periodontal probing depth (PD), plaque index (PLI), clinical attachment loss (CAL), and sulcus bleeding index (SBI) in the two groups of patients were significantly improved ($p < 0.05$). The levels of PD, BOP, PLI, and CAL in the positive SBI group (4.06 ± 0.25, 20.37 %, 0.50 ± 0.28, 3.42 ± 0.27, and 1.43 ± 0.26, respectively) were significantly lower than the corresponding levels in the control group ($p < 0.05$. Fasting plasma glucose (FPG) and HbA1c for the two groups were significantly improved, when compared with values prior to treatment ($p < 0.05$), but there was no significant difference in FPG level between the two groups. Significantly lower HbA1c levels were found in the treatment group than in the control group ($t = 4.2360$, $p = 0.0001$). Post-treatment, triglyceride (TG), total cholesterol (TC) and body mass index (BMI) did not improve significantly in the two groups, nor were there significant differences in these parameters before and after treatment ($p > 0.05$).*
Conclusion: *Semiconductor laser-assisted minocycline is effective in treating moderate and severe chronic periodontitis patients with type 2 diabetes, and can improve blood glucose. However, its effect on body weight needs further studies.*

Keywords: *Semiconductor laser, Minocycline, Chronic periodontitis, Type 2 diabetes, Obesity*

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INTRODUCTION

CP continuously destroys the periodontium under the effect of multiple factors and usually gives rise to loss of teeth at the last stage [1]. Previous studies demonstrated that CP is closely associated with (T2DM) [2,3]. In the clinics, it is considered that the two factors may interact.

Chronic periodontitis increases levels of inflammatory factors and impedes glucose metabolism through insulin resistance (IR), thereby aggravating T2DM [4]. Type 2 diabetes mellitus impacts on oral flora, contributes to their attachment, and weakens the body's ability to fight infection, thereby exacerbating CP. Chronic periodontitis has become a major complication of DM [5].

Previous studies revealed that obese T2DM patients are at higher risk of CP [6]. However, clinical studies on these patients are few. In recent years, semiconductor laser has been used for the clinical treatment of CP. However, its therapeutic effect is in dispute. In the present study, a total of 109 CP patients with T2DM and obesity, admitted in our hospital from November 2016 to November 2017, were recruited for investigating the clinical efficacy of semiconductor laser-assisted minocycline therapy.

EXPERIMENTAL

General characteristics of subjects

A total of 109 CP patients with T2DM and obesity, admitted in our hospital from November 2016 to November 2017 were the study participants. The inclusion criteria were: (1) eligibility for the diagnosis of chronic periodontitis [7]; eligibility for the diagnosis of type 2 diabetes mellitus (T2DM); (3) obesity with BMI > 28; (4) age > 18 years; (5) regular hypoglycemic treatment for diabetes for stable blood glucose control; and (6) signing of an informed consent. The exclusion criteria were: (1) remaining teeth < 20; (2) pregnant or lactating women; (3) periodontal therapy within three months before the study; and (4) intake of antibiotics within the previous one month. Based on the inclusion criteria, 109 CP patients with T2DM and obesity were enrolled in the study. All patients were divided into two groups, based on treatment methods, with 54 patients in the study group given semiconductor laser and minocycline, while 55 patients in the control group received minocycline alone. This research was approved by the Ethical Committee of Medical School of Xi'an Jiaotong University (approval no. 20171201) according to the Declaration of Helsinki promulgated in 1964 as amended in 1996 [8].

Treatment

All patients were educated on oral health, and all the affected teeth underwent periodontal non-surgical treatments including subgingival scaling and root planning (SRP). After periodontal non-surgical treatment, the control group was given periodontal pocket injection therapy with minocycline (Sunstar INC, H20150106), once a week, for 4 weeks. In addition to periodontal non-surgical treatment and minocycline, the study group received auxiliary semiconductor laser (Sirona, Germany, wavelength 980 nm, power 2 w), zig-zagged on periodontal pocket. Each observation point was exposed for 30 s, and the second laser radiation therapy was implemented at week 5 after the first one.

Measurement of clinical and biochemical parameters

Blood samples were collected from all patients before treatment, and at week 12 after treatment to determine glycosylated hemoglobin (HbA1c), triacylglycerol (TG), total cholesterol (TC) and fasting plasma glucose (FPG). Clinical attachment loss (CAL), probing depth (PD), bleeding on probing (BOP), gingival index (GI), plaque index (PLI), and sulcular bleeding index (SBI) were recorded before treatment, and at week 12 after treatment.

Statistical analysis

All data were analyzed by software SPSS 18.0. Measurement data such as GI and PD, were expressed as mean ± standard deviation ($\bar{\chi}$ ± s), while enumeration data were expressed as number/ percentage (n/%). Student's *t*-test and χ^2 test were used for the analysis of various data. Values of $p < 0.05$ were taken as indicative of significant difference between the effect of semiconductor laser-assisted minocycline treatment and the injection of minocycline alone.

RESULTS

Characteristics of subjects

The clinical data of two groups are shown in Table 1. There are no differences between the characteristics of two groups ($p > 0.05$).

BOP, GI and PD indices

At week 12 after treatment, there were significant improvements in BOP, GI and PD in both groups ($p < 0.05$), but the treatment group had much lower PD and BOP occurrence (4.06 ±0.25 and 20.37 %, respectively), when compared to the control group (4.23 ± 0.31, $p = 0.0148$; 41.82 %, $p = 0.0472$, respectively). However, there was no significant difference in GI between the two groups (t = 0.6920, $p = 0.4913$). These results are shown in Table 2.

Table 1: Characteristics of subjects

Group	Gender (M / F)	Age	Duration (year)	HCP (months)	Missing teeth	Smoking	SBP (mmHg)	DBP (mmHg)
Study (n=54)	29/25	58.95±6.18	7.94±2.44	10.34±5.03	3.20±0.33	12	125.54±13.16	83.37±9.57
Control (n=55)	31/24	60.32±7.38	7.80±2.61	11.28±4.97	3.15±0.41	11	122.76±12.88	82.56±8.91
t / χ^2 value	0.12	0.83	0.23	0.78	0.56	0.12	0.89	0.36
p value	0.73	0.41	0.82	0.44	0.58	0.73	0.38	0.72

HCP = History of chronic periodontitis; SBP = Systolic blood pressure; DBP = Diastolic blood pressure

Table 2: BOP, GI and PD of patients (mean ± SD)

Group	PD (mm)		GI (mm)		BOP (+)	
	Before treatment	***After treatment***	***Before treatment***	***After treatment***	***Before treatment***	***After treatment***
Study (n=54)	5.78±0.85	4.06±0.25*	1.33±0.37	0.68±0.25*	54 (100.00)	11 (20.37)*
Control (n=55)	5.69±0.94	4.23±0.31*	1.35±0.36	0.72±0.23*	55 (100.00)	23 (41.82)*
t / χ^2 value	0.4168	2.5031	0.2276	0.6920	-	3.9380
P-value	0.6782	0.0148	0.8207	0.4913	-	0.0472

*$P < 0.05$, compared with value before treatment

PLI, CAL and SBI indices

At week 12 post-treatment, both groups had significant improvements in PLI, CAL and SBI ($p < 0.05$), but the study group had much lower PLI, CAL, and SBI (0.50 ± 0.28, 3.42 ± 0.27, 1.43 ± 0.26, respectively) than the control group (0.84 ± 0.49, $p = 0.0008$; 4.35 ± 0.30, $p < 0.0001$; 1.67 ± 0.19, $p < 0.0001$, respectively). These results are shown in Table 3.

Blood glucose parameters for the patients

After 12 weeks of treatment, FPG and HbA1c in the study group (8.50 ± 1.31mmol/L and 7.33 ± 0.90mmol/L, respectively) and the control group (8.93 ± 1.20mmol/L and 8.42 ± 1.21mmol/L, respectively) improved significantly ($p < 0.05$), but there was no significant difference in FPG between both groups (t = 1.4225, $p = 0.1595$). However, HbA1c was significantly lower in the study group than in the control group (t = 4.2360, $p = 0.0001$; Table 4).

Changes in TG, TC and BMI following treatment

After 12 weeks of treatment, there were no significant improvements in TG, TC and BMI of the study group when the previous and post-treatment values were compared

Table 3: PLI, CAL and SBI indices for the patients (mean ± SD)

Group	PLI		Cal (mm)		SBI	
	Before treatment	***After treatment***	***Before treatment***	***After treatment***	***Before treatment***	***After treatment***
Study (n=54)	1.30±0.53	0.50±0.28*	5.47±0.33	3.42±0.27*	3.40±0.51	1.43±0.26*
Control (n=55)	1.32±0.49	0.84±0.49*	5.50±0.42	4.35±0.30*	3.35±0.69	1.67±0.19*
t value	0.1628	3.5249	0.3293	13.5222	0.3415	4.3870
P-value	0.8711	0.0008	0.7430	＜0.0001	0.7338	＜0.0001

**P* < 0.05, compared with value before treatment

Table 4: Blood glucose and HbAIc levels of the patients (mean ± SD)

Group	FPG (mmol/L)		HbA1c (%)	
	Before treatment	***After treatment***	***Before treatment***	***After treatment***
Study (n=54)	9.88±1.75	8.50±1.31*	9.78±1.85	7.33±0.90*
Control (n=55)	9.83±1.60	8.93±1.20*	9.60±2.02	8.42±1.21*
t value	0.1239	1.4225	0.3857	4.2360
p value	0.9017	0.1595	0.7009	0.0001

**P* < 0.05, compared with pre-treatment value

Table 5: Changes in TG, TC and BMI of patients after treatment (mean ± SD)

Group	TG (mmol/L)		TC (mmol/L)		BMI (kg/m^2)	
	Before treatment	***After treatment***	***Before treatment***	***After treatment***	***Before treatment***	***Before treatment***
Study (n=54)	2.23±1.12	1.89±1.03	5.73±1.22	5.77±1.58	28.88±3.10	28.35±3.68
Control (n=55)	2.45±1.56	2.10±0.75	6.04±1.45	5.92±1.60	29.05±4.26	28.86±3.60
t value	0.6712	0.9702	0.9596	0.3917	0.1891	0.5817
P-value	0.5044	0.3354	0.3407	0.6965	0.8506	0.5627

(2.23 ± 1.12/1.89 ± 1.03 mmol/L, 5.73 ± 1.22/5.77±1.58 mmol/L, 28.88 ± 3.10/28.35 ± 3.60 mmol/L, respectively), and the control group (2.45 ± 1.56/2.10 ± 0.75 mmol/L, 6.04 ± 1.45/5.92 ± 1.60 mmol/L, 29.05 ± 4.26/28.86 ± 3.60 mmol/L, respectively) ($p > 0.05$). Moreover, the differences in TG, TC and BMI between the two groups after 12 weeks of treatment were not significant ($p > 0.05$; Table 5).

DISCUSSION

It is necessary to eliminate pathogenic factors, control plaque attachment and inflammation in the treatment of CP. A range of therapeutic measures used in clinics have been documented [9-12]. These include periodontal non-surgical treatment, medication, surgery, laser therapy and orthodontic therapy [13]. Periodontal non-surgical treatment is the most basic approach to treating CP. It comprises plaque control, scaling, and root planing. Medication may be topical and/or systemic. The common topical medications include periodontal pocket lavage fluid, and gargling with antibiotics. These medications directly reduce plaque by killing pathogenic bacteria that attach to periodontal tissues. Systemic medications contain broad spectrum antibiotics, such as tetracycline and metronidazole, and Chinese *materia medica*. Minocycline has broader antimicrobial spectrum and it is more widely used in treating CP due to fact that it produces good effect. Surgical strategies include gingival resection and guided periodontal tissue regeneration used for patients with PD > 5 mm and positive BOP after 2~3 months of non-surgical treatment [14]. Laser therapy is a major adjuvant therapy used to clear pathogenic bacteria and diseased tissue in the deeper recesses of the periodontal pocket, thereby improving the therapeutic effect of CP [15]. It has been reported that orthodontic treatment controls periodontal inflammation and augments control of blood glucose [16]. Studies on semiconductor laser-assisted minocycline therapy are very few. Therefore, the present study investigated the effect of using semiconductor laser-assisted minocycline therapy for the treatment of CP patients with T2DM.

Clinically, indices like PLI, CAL and SBI are usually used to assess CP and its treatment [17]. In this study, at week 12 after treatment, both groups had marked improvements in BOP, GI and PD, but the occurrences of PD and BOP in the study group were much less than those of the control group. These results are in agreement with a previous report on decreases in BOP after three months of treatment [18]. In addition, it has been reported that PLI in patients undergoing semiconductor laser combined with periodontal non-surgical therapy decreased significantly after three months of therapy [19]. In the present study, both groups also had improvements in PLI, CAL and SBI after treatment, but the PLI, CAL and SBI of the study group were much lower than those of the control group. This indicates that semiconductor laser-assisted minocycline therapy is very beneficial in treating CP. The possible mechanism involved in this beneficial effect is that semiconductor laser can remove the diseased tissues in periodontal pocket more thoroughly, especially those deeply embedded, thereby preventing the proliferation of attached bacteria under anaerobic environment [20].

In patients with T2DM, vasculopathy may aggravate periodontal pocket hypoxia. The removal of diseased tissues by semiconductor is very important for these patients. Studies have shown that T2DM is positively related to the severity of CP, suggesting that effective treatment of CP can be beneficial to the blood glucose control of T2DM patients [21]. Patients with T2MD are affected by CP, and their increased levels of inflammatory factors enhance insulin resistance [22]. It has been suggested that with treatment, C-creative protein (CRP) in CP patients with T2DM greatly decreases and that the control of the inflammatory responses associated with CP is helpful to the control of blood glucose in these patients [23]. In this study, the pattern of changes in FPG and HbA1c in the study group and the control group shows that semiconductor laser-assisted minocycline

therapy in treating CP was able to control blood glucose, weaken the effect of hyperglycemia on the periodontal tissues, and enhance the therapeutic effect of CP. These findings are in agreement with results obtained in a previous study, in which it was found that treatment of periodontal diseases of DM patients is helpful for the control of blood glucose [24].

It has been suggested that obesity is a risk factor for DM patients, and that abnormal lipid levels can also have adverse effects on CP [25]. In this study, after 12 weeks of treatment, there were no significant improvements in TG, TC and BMI of both groups. Thus, controlling periodontal inflammation did not appear to have any effect on BMI. It is likely that the follow-up period of twelve weeks was too short for any meaningful changes in the patients' BMI. Moreover, there was no comparison between therapeutic effects in patients with various BMIs.

CONCLUSION

The results of this study indicate that semiconductor laser-assisted therapy is capable of greatly enhancing the efficacy of minocycline in treating moderate-to-severe chronic periodontitis in patients with T2DM, via better control of their blood glucose levels. Thus, semiconductor laser-assisted therapy deserves further exploration in the management of chronic periodontitis.

DECLARATIONS

Conflict of Interest

No conflict of interest associated with this work.

Contribution of Authors

We declare that this work was done by the authors named in this article and all liabilities pertaining to claims relating to the content of this article will be borne by the authors, all authors read and approved the manuscript for publication. Tao Hong conceived and designed the study, Ren Le, Zhang Zhe, Li Daxu, Deng Chunni collected and analysed the data, Ren Le C wrote the manuscript.

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