

Original Article

Periodontal tissue regeneration combined with orthodontic treatment can improve clinical efficacy and periodontal function of patients with periodontitis

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Abstract: Objective: To determine the efficacy of periodontal tissue regeneration (PTR) combined with orthodontic treatment in patients with periodontitis. Methods: A total of 118 patients with periodontitis admitted to our hospital between March 2017 and May 2019 were enrolled. Among them, 56 patients were treated with PTR as a regular group, while the rest 62 were treated with PTR combined with orthodontic treatment as a joint group. The two groups were compared in efficacy, total treatment time, recovery time for periodontal function, periodontal function-associated indexes before and after treatment, pain, serum inflammatory factors, adverse reactions, and treatment satisfaction. Results: The joint group showed significantly higher effective treatment rate ($P<0.05$), and experienced significantly shorter total treatment time and recovery time for periodontal function than the regular group (both $P<0.05$). Before treatment, there was no meaningful difference between the two groups in plaque index (PLI), periodontal pocket probing depth (PD), sulcus bleeding index (SBI), attachment loss (AL), visual analog scale (VAS) score, and serum IL-6, IL-1 β and TNF- α levels, while after treatment, these indexes of both groups improved (all $P<0.05$), and the improvement in the joint group was more notable ($P<0.05$). Additionally, there were no significant difference between the two groups in the incidence of adverse reactions ($P>0.05$), and the joint group expressed significantly higher treatment satisfaction ($P<0.05$). Conclusion: With a high safety, PTR combined with orthodontic treatment can effectively alleviate the clinical symptoms of patients and promote the recovery of their periodontal function, and is more acceptable, so it is worthy of clinical promotion.

Keywords: Periodontal tissue, orthodontic treatment, periodontal function, periodontitis

Introduction

Periodontitis is a chronic oral infection condition mainly caused by bacterial invasion. It usually damages alveolar bone, periodontal membrane, and other tissues [1], so a delay in treatment can give rise to tooth deformity, and even secondary trauma, resulting in serious damage to periodontal tissues of patients and seriously comprising their life quality [2, 3]. Therefore, it is of great significance to choose a scientific treatment as soon as possible for patients with periodontitis. Currently, periodontitis is mainly treated by periodontal pocket treatment and clearance of periodontal abscess and local stimulation factors. There are many treatments for it, but their therapeutic effect is greatly different [4].

At the current stage, periodontal tissue regeneration (PTR) is a common treatment against periodontitis that has been clinically verified to be effective [5]. However, one study has pointed out that although PTR is effective for periodontitis, it takes effect relatively slowly and cannot guarantee the beauty of gums [6]. For making up for the deficiency of PTR and further improving the therapeutic effect on periodontitis, PTR combined with orthodontic treatment has been proposed to treat periodontitis in recent years [7]. Under such a combination treatment based on PTR, a condition suitable for orthodontic treatment is established, and then orthodontic treatment is adopted to recover the occlusal relationship of teeth to normal. The combination can deliver good results

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in theory, and it has been certified by some authoritative organizations [8, 9].

For the purpose of further determining the efficacy of PTR combined with orthodontic treatment on periodontitis, we comprehensively analyzed the effects of combination therapy on clinical efficacy, periodontal function and serum inflammatory factors of patients, with the aim of providing more data for clinical treatment of periodontitis.

Materials and methods

Clinical data

A total of 118 patients with periodontitis (61 males and 57 females, 33.56 ± 3.29 years old on average) admitted to Beijing Stomatological Hospital between March 2017 and May 2019 were enrolled. Among them, 56 patients were treated with PTR as a regular group, while the rest 62 were treated with PTR combined with orthodontic treatment as a joint group. All enrolled patients met the diagnostic criteria of periodontitis [10]. Exclusion criteria: Patients who had undergone periodontal therapy in the last 3 months; patients with other comorbid oral diseases or severe organ dysfunction; patients with severe auto-immune diseases, patients who had taken antibiotics recently; and those in pregnancy or menstrual period. All participants consented to participate in the experiment and signed written informed consent forms. The experiment was approved by the ethics committee of our hospital and was in line with the *Declaration of Helsinki*.

Therapeutic regimen

During treatment, each patient in the two groups was required to take metronidazole before surgery, and the patient was treated with amoxicillin to diminish inflammation. Additionally, the patient's affected teeth were washed with hydrogen peroxide locally, and his/her periodontal pocket was filled with metronidazole rod or minocycline hydrochloride sustained-release capsule. After remission of acute inflammation, patients in the regular group were treated via PTR, including subgingival curettage, supragingival cleaning, root planning, tooth regeneration based on medical imaging to alveoli, bone grafting or guided tissue regeneration combined with bone grafting.

For patient in the joint group, each patient was given orthodontic treatment based on the treatment to the regular group. Specifically, a 0.1 mm nickel-titanium wire was adopted to align the patient's teeth. After neat arrangement, the tooth gap was closed or maintained by movement for correction and repair. The orthodontic treatment spanned 3 months, during which the patient need to pay special attention to oral cleaning.

Outcome measures

(1) After the end of the treatment cycle, clinical efficacy in the two groups was evaluated as follows: Cured: recovery of periodontal tissues to normal and complete disappearance of clinical symptoms; Effective: notable amelioration of periodontal tissues and clinical symptoms; Ineffective: no change in periodontal tissues and clinical symptoms. The total effective rate = (the number of cured patients + the number of effectively treated patients)/the total number of patients $\times 100\%$. (2) Plaque index (PLI), periodontal pocket probing depth (PD), sulcus bleeding index (SBI), and attachment loss (AL) of the two groups were determined and compared before and after treatment. To obtain the PD, a graduated sterile probe was used to probe the buccal near-middle, central and far-middle parts, and the lingual near-middle, central and far-middle parts of each patient, and the results were averaged. SBI was classified into 5 grades. A higher grade indicated more serious bleeding. AL is the distance from enamel-cementum boundary to pocket bottom detected by a graduated sterile probe. (3) A visual analog scale (VAS) was adopted to evaluate and compare the periodontal pain between the two groups before and after therapy. (4) The ELISA assay was adopted to quantify serum IL-6, IL-1 β , and TNF- α in both groups before and after treatment. (5) The recovery time for periodontal function and total treatment time consumed by the two groups were recorded and compared. (6) Adverse reactions including mild soft tissue edema, discomfort and oral inflammation of the two groups during treatment were recorded and compared. (7) The satisfaction of the two groups with the therapeutic regimen and effect was evaluated, which was classified into high satisfaction, satisfaction, and dissatisfaction. Treatment satisfaction = (the number of patients with high satisfaction + the number

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Table 1. General data

Factor	Joint group (n = 62)	Regular group (n = 56)	t/X ²	P-value
Sex			0.517	0.472
Male	34 (54.84)	27 (48.21)		
Female	28 (45.16)	29 (51.79)		
Age (year)			0.001	0.985
≤33	32 (51.61)	29 (51.79)		
>33	30 (48.39)	27 (48.21)		
BMI (kg/m ²)			0.220	0.639
≤23	27 (43.55)	22 (39.29)		
>23	35 (56.45)	34 (60.71)		
Course of disease (month)	13.41±1.13	13.52±1.17	0.519	0.605
Loose of tooth			0.001	0.970
Yes	33 (53.23)	30 (53.57)		
No	29 (46.77)	26 (46.43)		
Severity			0.010	0.919
Mild	36 (58.06)	32 (57.14)		
Severe pain	26 (41.94)	24 (42.86)		
Education level			0.001	0.989
With junior high school diploma or below	20 (32.26)	18 (32.14)		
With senior high school diploma and above	42 (67.74)	38 (67.86)		
Brush teeth every day			0.058	0.809
Yes	51 (82.26)	47 (83.93)		
No	11 (17.74)	9 (16.07)		

Table 2. Evaluation of clinical efficacy of the two groups [n, (%)]

Efficacy	Joint group (n = 62)	Regular group (n = 56)	X ²	P-value
Cured	40 (64.52)	26 (46.43)	-	-
Effective	20 (32.26)	18 (32.14)	-	-
Ineffective	2 (3.23)	12 (21.43)	-	-
Total effective rate	60 (96.77)	44 (78.57)	9.323	0.002

of patients with satisfaction)/total number of patients ×100%.

Statistical analyses

This study adopted SPSS 20.0 for statistical analyses and graphpad7.0 for drawing of corresponding figures. The chi-square test was used to analyze enumeration data, expressed as percentage, and the student t test and paired t test were adopted for inter-group comparison and intra-group comparison before and after treatment of measurement data, presented by mean ± SD, respectively. Additionally, the LSD/t test was used for post hoc test. *P*<0.05 suggests a significant difference.

Results

Comparison of general data

There was no significant difference between the two groups in gender, age, BMI, severity and educational level (all *P*>0.05), so they were comparable (**Table 1**).

Comparison of clinical efficacy

We evaluated and compared the effective treatment rate of the two groups. As a result, the joint group showed a total effective rate of 96.77%, with 40 cured patients, 20 effectively treated patients, and 2 ineffectively treated patients, while the regular group showed a total effective rate of 78.57%, with 26 cured patients, 18 effectively treated patients, and 12 ineffectively treated patients, and the joint group showed a significantly higher total effective rate (*P*<0.05) (**Table 2**).

Comparison of the recovery time for periodontal function and total treatment time

The joint group experienced greatly shorter recovery time for periodontal function and total

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Table 3. Comparison of the recovery time for periodontal function and total treatment time between the two groups (d)

Item	Joint group (n = 62)	Regular group (n = 56)	t	P-value
Recovery time for periodontal function	20.68±2.11	29.01±2.69	18.81	<0.001
Total treatment time	26.37±2.68	38.25±3.37	21.29	<0.001

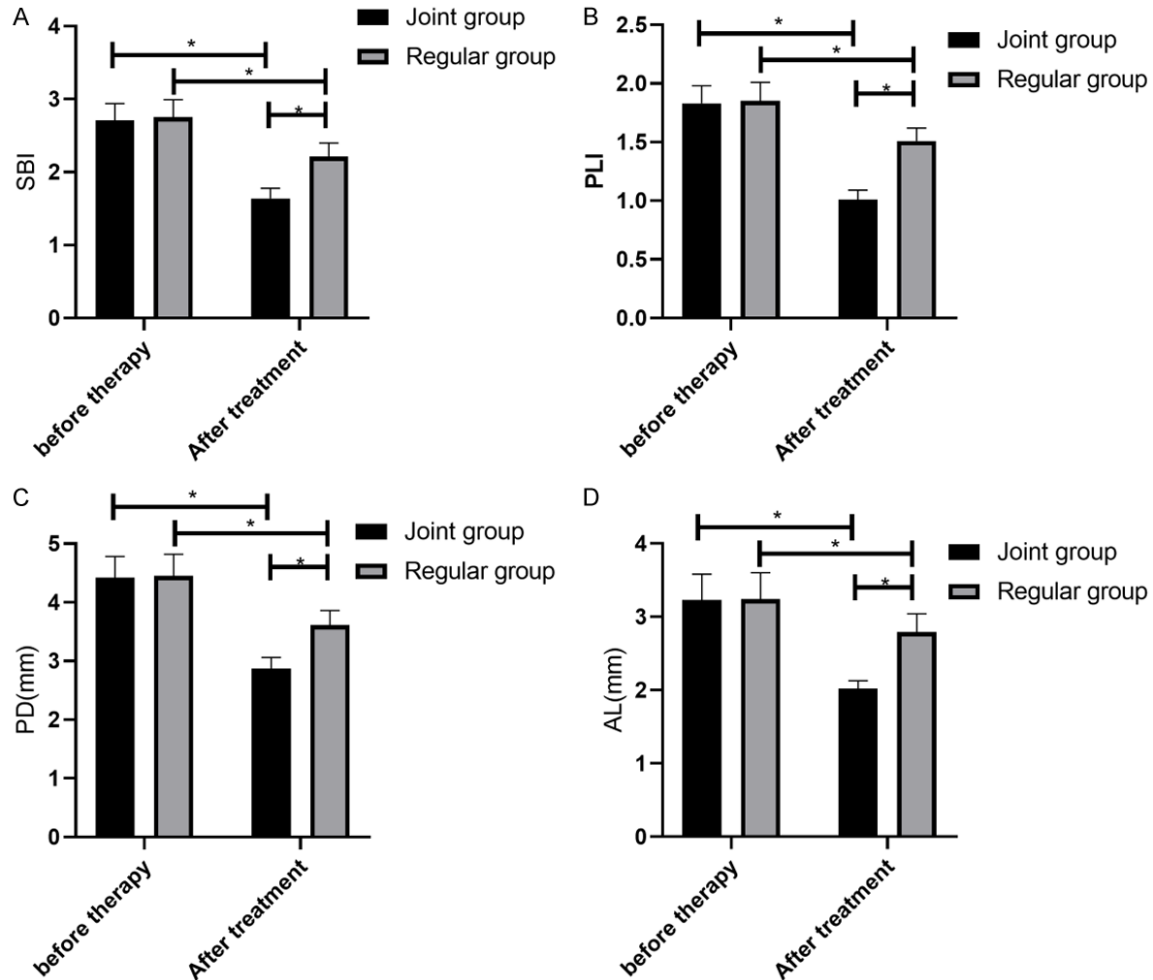


Figure 1. Comparison of periodontal function-associated indexes between the two groups before and after treatment. A. SBI. B. PLI. C. PD. D. AL. * indicates $P < 0.05$.

treatment time than the regular group ($P < 0.05$) (Table 3).

Comparison of periodontal function-associated indexes

Before treatment, there was no significant difference between the two groups in SBI, PLI, PD, and AL (all $P > 0.05$), while after treatment, the indexes of both groups decreased greatly (all $P < 0.05$), and the indexes of the joint group were greatly lower (all $P < 0.05$) (Figure 1).

VAS scores of the two groups

Before treatment, the two groups were not different in VAS score ($P > 0.05$), while after treatment, the VAS scores of both groups decreased greatly, and the decrease in the joint group was more notable ($P < 0.05$) (Figure 2).

Comparison of serum inflammatory factors

We quantified serum IL-6, IL-1 β and TNF- α of the two groups before and after treatment by

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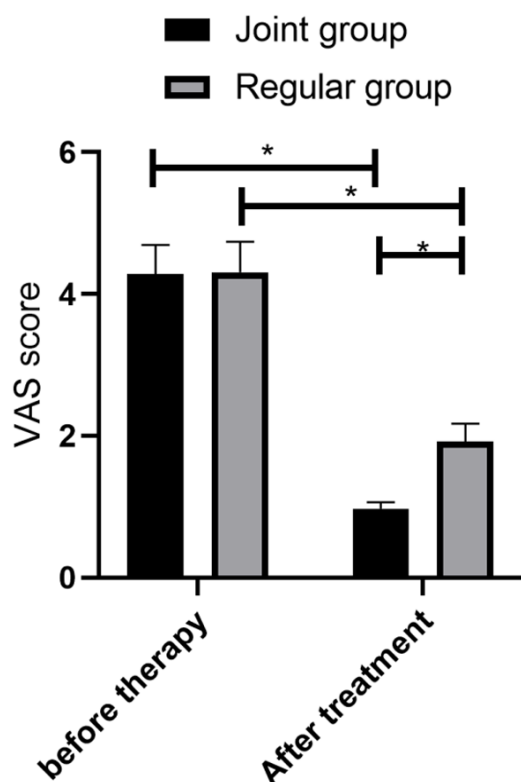


Figure 2. VAS scores of the two groups before and after treatment. * indicates $P < 0.05$.

ELISA. Before treatment, the two groups were not different in the levels of IL-6, IL-1 β and TNF- α (all $P > 0.05$), while after treatment, the levels of them in the two groups decreased significantly, and the decrease in the joint group was more notable ($P < 0.05$) (Figure 3).

Incidence of adverse reactions

The joint group showed an incidence of adverse reactions of 6.45%, with 2 cases of mild soft tissue edema, 1 case of discomfort and 1 case of oral inflammation, while the regular group showed an incidence of adverse reactions of 5.36%, with 1 case of mild soft tissue edema, 1 case of discomfort and 1 case of oral inflammation. As the results show, the incidence of adverse reactions in both groups was low and not significantly different ($P > 0.05$) (Table 4).

Comparison of treatment satisfaction

We evaluated the satisfaction of the two groups with the therapeutic regimen. It was turned out that the joint group showed a treat-

ment satisfaction of 98.39%, with 50 patients highly satisfied, 11 patients satisfied, and 1 patient dissatisfied, while the regular group showed a treatment satisfaction of 76.79%, with 31 patients highly satisfied, 12 patients satisfied, and 13 patients dissatisfied. Therefore, the joint group showed a significantly higher treatment satisfaction ($P < 0.05$) (Table 5).

Discussion

Periodontitis is an oral disease with a relatively high incidence among adults, which is mostly caused by microbial infection [11]. Periodontitis progresses slowly, but belated or ineffective treatment of it will give rise to further necrosis of periodontal soft tissues and recurrent inflammation, seriously compromising patients' life quality [12]. Thus, timely scientific treatment is of profound clinical value for patients with the disease.

Our study determined the effect of PTR combined with orthodontic treatment on periodontitis. Over the past few years, as the dental medical technology advances continuously, PTR has become the mainstream therapeutic regimen for periodontitis. In the method, the diseased periodontal tissues caused by inflammatory reaction can be effectively repaired by guided-soft tissue regeneration and artificial bone grafting. Additionally, this method can guide precursor cells at the root of healthy teeth in migration, proliferation, and differentiation into new cementocytes, osteoblasts and fibroblasts and attachment to the periodontal part. Although it can deliver good treatment results, it is unable to ensure the aesthetics of patients' gums, so it is necessary to combine it with other treatment to address its shortcoming [13, 14]. Our study found that combination of PTR and orthodontic treatment was more effective than PTR alone, and the combination therapy can help patient obtain faster recovery for periodontal function and shorter treatment time. Orthodontic treatment, as a modern method, is to correct teeth and relieve malocclusion, which can make teeth form a more standardized balance occlusal structure and promote the recovery of patients with periodontitis [15]. One related study has revealed that PTR combined with orthodontic treatment can strengthen the efficacy on periodontitis and prevent secondary diseases partially [16]. In order to evaluate the efficacy in patients, we

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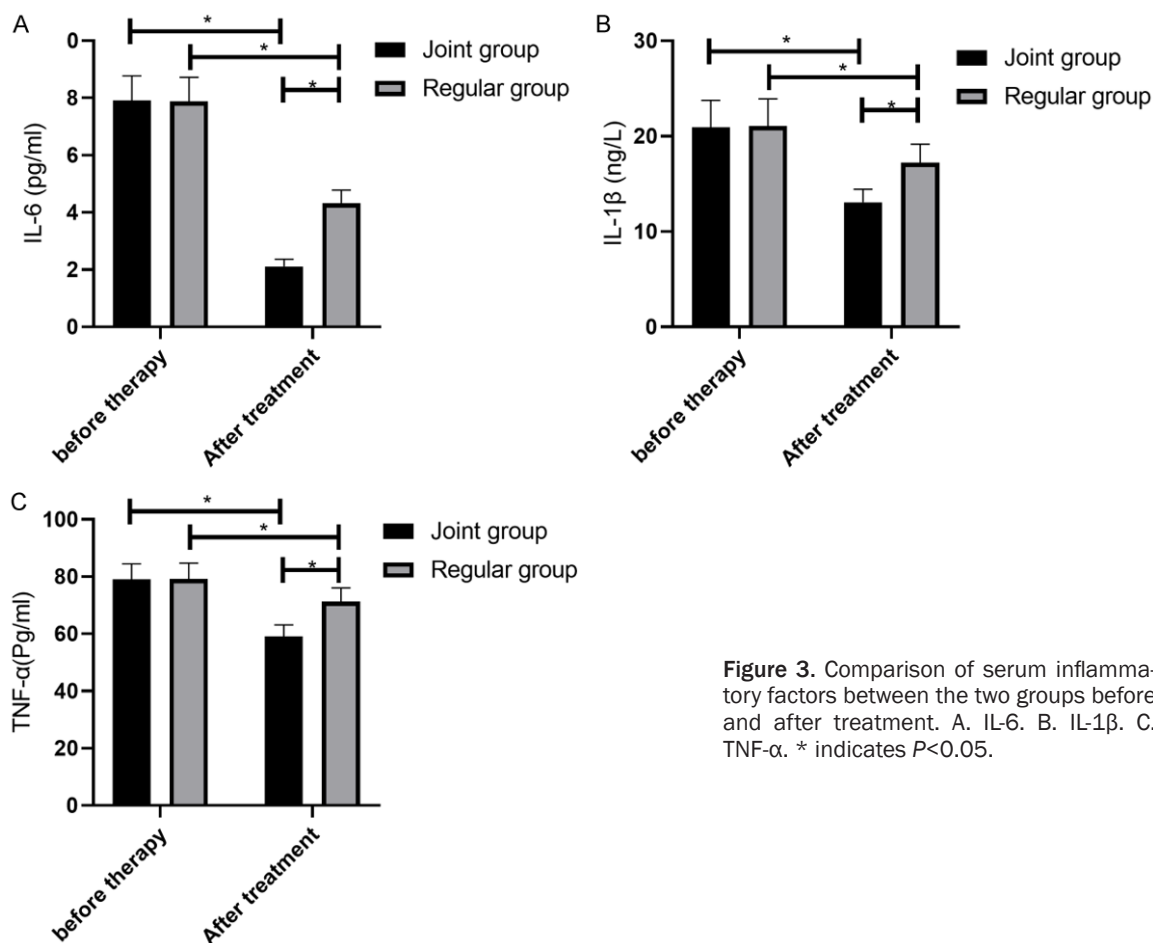


Figure 3. Comparison of serum inflammatory factors between the two groups before and after treatment. A. IL-6. B. IL-1β. C. TNF-α. * indicates $P < 0.05$.

Table 4. Comparison of the incidence of adverse reactions between the two groups [n, (%)]

Evaluation of adverse reactions	Joint group (n = 62)	Regular group (n = 56)	χ^2	P-value
Mild soft tissue edema	2 (3.23)	1 (1.79)	-	-
Discomfort	1 (1.61)	1 (1.79)	-	-
Oral inflammation	1 (1.61)	1 (1.79)	-	-
The incidence of adverse reactions	4 (6.45)	3 (5.36)	0.063	0.802

Table 5. Comparison of treatment satisfaction between the two groups [n, (%)]

Evaluation of adverse reactions	Joint group (n = 62)	Regular group (n = 56)	χ^2	P-value
High satisfaction	50 (9.62)	31 (3.57)	-	-
Satisfaction	11 (3.85)	12 (1.79)	-	-
Dissatisfaction	1 (5.77)	13 (1.79)	-	-
Treatment satisfaction	61 (98.39)	43 (76.79)	13.13	<0.001

tested periodontal function-associated indexes and pain of them, finding that after treatment, SBI, PLD, PD, and AL indexes and VAS score of both groups decreased significantly,

while the decrease in the joint group was more significant. The results suggest that our combination therapy can not only effectively repair periodontal loss tissues, but also achieve effective tooth fixation and correction, promote the recovery of patients' occlusal function and relieve pain. One earlier study has pointed out that PTR can provide a favorable situation for orthodontic treatment, and combination of the two can not only better consolidate the restoration effect, but also better improve the orthodontic effect [17],

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which are consistent with our observations. The reason may lie in the following: PTR can treat periodontitis well, but in practice, periodontitis is mainly caused by traumatic occlusion. After treatment, the patients' clinical symptoms are relieved, but their traumatic occlusion will still cause periodontal damage, which is prone to resulting in recurrence. Therefore, it is necessary to actively eliminate the pathogenic factors while treating the symptoms. Orthodontic treatment can correct the oral deformity of patients well and avoid patients from continuing "traumatic occlusion", so the combination therapy has better curative effect [18, 19].

For patients with periodontitis, inflammatory factors play a crucial role in the damage and repair of periodontal tissues [20]. For example, one study has concluded that IL-6 can regulate the process of protein production in acute inflammatory phase, aggravate inflammatory reaction, and thus reduce the repair ability of periodontal tissues, further aggravating alveolar bone injury [21]. IL-1 β increases when the body is in an inflammatory state, which can participate in the immune regulation of the body, activate osteoclasts and regulate bone resorption [22]. In addition, TNF- α , as a lymphotoxin subtype, can promote the synthesis of substances of acute phase reaction such as IL-6 [23]. Our study determined the three inflammatory factors in the serum of patients before and after treatment. It was found that after treatment the three factors in both groups decreased significantly, while the decrease in the joint group was more notable. The results suggest that combination of PTR and orthodontic treatment can better improve the inflammatory state of the body. Finally, we compared the adverse reactions and treatment satisfaction between the two groups. The results showed that the incidence of adverse reactions in the two groups was low and not greatly different, and the joint group showed significantly higher treatment satisfaction. The results imply that our combination therapy can improve the satisfaction of patients, with a high safety, and is more acceptable to patients.

To sum up, with a high safety, PTR combined with orthodontic treatment can effectively alleviate the clinical symptoms of patients and promote the recovery of their periodontal function, and is more acceptable, so it is worthy

of clinical promotion. However, this study also has some limitations. First of all, the number of cases enrolled is small, so the conclusions of the study need to be further verified. Second, we have not included more treatment methods for comparison. Therefore, it is necessary to carry out a multi-center study in the future based on a larger sample size.

Disclosure of conflict of interest

None.

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