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Original Article

Simple periodontal therapy combined with periodontal orthodontics improves the curative effect and reduces the inflammatory response in the treatment of PD

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Abstract: Objective To analyze the efficacy of simple periodontal therapy combined with periodontal orthodontics in the treatment of periodontal diseases (PD) and its effect on serum inflammatory factors. Methods The case data of 113 patients with PD admitted to the North China University of Science and Technology Affiliated Hospital between July 2019 and July 2021 were retrospectively analyzed. According to the treatment plans, patients were divided into the control group (56 cases undergoing simple periodontal treatment), and the observation group (57 cases undergoing orthodontic treatment combined with simple periodontal treatment). Treatment efficacy, gingival index (GI), plaque index (PI), clinical attachment loss (CAL), periodontal pocket depth (PPD), anterior tooth coverage distance and alveolar bone reconstruction distance before and after treatment were evaluated and compared between the two groups. The post-treatment tooth function and tooth mobility were also compared. Finally, serum inflammatory factors in both groups before and after treatment were detected and compared. Results The effective rate in the observation group was markedly higher than that in the control group ($P<0.05$). Before treatment, there was no marked difference regarding GI, PI and CAL, PPD, anterior tooth coverage distance and alveolar bone reconstruction between the two groups before treatment. While each of the indexes improved significantly in both groups after treatment, there was more significant improvement in the observation group ($P<0.05$). After treatment, tooth function and tooth mobility of the observation group were better as compared with the control group ($P<0.05$). In addition, serum inflammatory factors of both groups improved after treatment, with more obvious alleviation in the observation group ($P<0.05$). Conclusion Simple periodontal treatment combined with orthodontic treatment can effectively reduce inflammation in PD patients, improve their periodontal condition, promote periodontal tissue regeneration and repair, reduce tooth loosening, and improve masticatory function and aesthetics; moreover, it is beneficial for patients to maintain good oral hygiene for a long time, which is worthy of clinical application.

Keywords: Simple periodontal treatment, periodontal orthodontics, periodontal diseases, curative effect, inflammatory factors

Introduction

Periodontitis is a common chronic oral disease seen in clinical practice, which is caused by a wide range of microorganisms and their products on the gums, periodontal ligaments, cementum, and alveolar bone. Environmental, dietary, psychological and genetic factors can all lead to periodontitis [1]. The pathogenesis of periodontal disease (PD) is complex, and the disease mainly presents with gingival recession, occlusal trauma, and tooth displacement, which are the main causes of tooth loss [2]. PD not only seriously affects the oral function of patients, but also greatly compromises their mentality and health, as well as the aesthetic appearance of patients' teeth [3, 4].

Periodontitis has various clinical manifestations and a long course, which if not detected and treated promptly, can seriously affect the daily life of patients [5]. Previous research has demonstrated the interrelation between periodontal infection and systemic diseases of patients [6]. Moreover, PD is shown to promote inflammatory responses and secretion of inflammatory factors. Therefore, PD is also an independent factor that leads to diseases like

infectious endocarditis, diabetes, cerebral thrombosis, and chronic gastritis [7]. Simple periodontal therapy is often used in clinical practice, which contributes to ideal short-term efficacy but not a complete cure [8]. However, with the growing number of PD patients and the increasingly severe situation of PD treatment, more clinical attention must be paid to the concept of comprehensive treatment of the disease [9]. On the basis of simple periodontal treatment, combined periodontal and orthodontic treatment can correct dentition disorders caused by PD in patients, thereby restoring their periodontal function [10]. Although previous studies have compared the efficacy of periodontal therapy alone and combined periodontal orthodontics, there are relatively few studies focusing on its effect on serum inflammatory factors in PD patients.

In this study, we comprehensively evaluated the efficacy of simple periodontal therapy combined with periodontal orthodontics in PD treatment and its effect on serum inflammatory factors, so as to help find a periodontal treatment plan that can eliminate periodontal lesions, maintain tooth function, and meet the requirements of aesthetics and patient comfort as much as possible.

Materials and methods

Clinical information

The case data of 113 patients with PD admitted to the North China University of Science and Technology Affiliated Hospital between July 2019 and July 2021 were retrospectively analyzed. The study population comprised 65 male and 48 female patients with an average age of (53.34±2.13) years old. According to the treatment plan conducted, patients were divided into a control group (56 cases undergoing simple periodontal treatment), and an observation group (57 cases undergoing orthodontic treatment combined with simple periodontal treatment). Inclusion criteria: (1) Patients who meet the diagnostic criteria for PD [11]; (2) Patients with alveolar bone resorption and alveolar crest resorption horizontally toward the apex as indicated by X-rays; (3) Patients with decreased masticatory function; (4) Patients with indications for orthodontic treatment. Exclusion criteria: (1) Patients unwilling to receive orthodontic treatment; (2) Patients with poor oral hygiene habits; (3) Patients with hyperthyroidism, diabetes, tuberculosis, and coagulation disorders; (4) Pregnancy and lactating patients; (5) Patients with severe malnutrition; (6) Patients with incomplete clinical data; or (7) Patients who refused to participate in the present study. This study was approved by the Ethics Committee of the North China University of Science and Technology Affiliated Hospital and was conducted according to the Declaration of Helsinki, with all patients signing written informed consent and giving their agreement for participation.

Treatment methods

(1) All patients were treated with simple periodontal treatment first, including: ① Plaque control: oral hygiene knowledge brochures were distributed to patients. In addition, patients were given instruction on correct Pasteur brushing, mouth cleaning after meals, correct use of dental floss and interdental brush, and mouthwash application with 0.12%-0.2% chlorhexidine solution; ② Supragingival scaling: dental calculus removal and tooth surface polishing were performed; ③ Subgingival scaling: scaling of the calculus and plaque on the root surface of the periodontal pocket was performed. After the removal of calculus and plaque, the decayed and softened cementum layer was scraped out until the root surface was smooth and hard. After the operation, the calculus residues in the periodontal pockets were removed to make the gingival and tooth surface fit with each other; ④ Tooth blending and grinding: teeth with occlusal trauma were ground to eliminate early contact points; ⑤ Fixation of loose teeth: for loose teeth, wire ligation or photosensitive resin splint was used for fixing, and the occlusion was then checked and adjusted. Basic periodontal treatments mentioned above were aimed at controlling gingival inflammation and tissue repair.

(2) Observation group patients received combined orthodontic treatment on the basis of simple periodontal therapy, specifically as follows: correction was performed with edgewise appliance (Dongguan Aijiayi Tooth Co., Ltd.). The initial arch wire was made of a finer nickel-titanium round wire with a diameter of 0.35-0.40 cm, which was gradually increased to 0.40-0.45 cm. After ligation of anterior teeth, a rubber chain was hung between the canines,

the anterior teeth were adducted, and the gap between the anterior teeth was closed (without the necessity of banding molar area). The strength of orthodontic force was adjusted according to the specific condition of the patient with a general orthodontic cycle of 6 to 12 months. Patients were followed up once a month. Orthodontic force was adjusted, bonded and strengthened according to specific situation. X-ray oral panoramic photography was performed regularly for observation of alveolar bone reconstruction and expected effect of orthodontics. During the orthodontic period, patients were instructed to strictly maintain oral hygiene, brush their teeth correctly, use interdental brushes, reduce the intake of sweets, and drink less carbonated beverages. After orthodontic treatment, the edgewise appliance was removed, and patients were instructed to wear the tooth retainer to reduce the recurrence of anterior tooth displacement. After the treatment, the indicators of two groups of patients were evaluated.

Observation indexes

(1) Therapeutic efficacy of two groups of patients was evaluated as follows: cured (tooth loosening, gingival bleeding, swelling and other symptoms disappeared completely, and the gingival index [GI], probing depth [PD], and plaque index [PI] were all within the normal range); effective (tooth loosening, gingival bleeding, swelling and other symptoms were improved, and the GI, PD, and PI were improved but not returned to normal); ineffective (conditions did not improve significantly). Total effective rate = (cured + effective) cases/total number of cases × 100%.

(2) Gingival index (GI) [12] (score range: 0-3, with higher scores indicating more severe gingival bleeding and 0 for healthy gums), plaque index (PI) [13] (score range: 0-3; higher scores indicate more severe plaque, and 0 stands for sterile plaque) and the clinical attachment loss (CAL) [14] (by measuring the distance from the bottom of the pocket to the cementoenamel junction) of two groups before and after treatment was evaluated and compared.

(3) Periodontal pocket depth (PPD), anterior tooth coverage distance and alveolar bone reconstruction distance of two groups of patients before and after treatment were evaluated and compared.

(4) Oral function assessment scale developed by Stratton [15] was utilized for assessment of dental function of patients in the two groups after treatment from the aspects of chewing function, fixation, aesthetics, and comfort, with a score of 1-5. Higher scores indicated better functional status.

(5) Tooth mobility of the two groups of patients after treatment was graded (grade I, grade II and grade III) and compared.

(6) The serum inflammatory factors before and after treatment were detected and compared between both groups, specifically as follows: venous blood was drawn from patients, and serum inflammatory factors, including tumor necrosis factor-α (TNF-α), interleukin (IL)-8, and IL-6, were detected with ELISA. (The above kits were purchased from Abcam, with the catalog numbers ab178013, ab214030 and ab181421, respectively).

Statistical methods

SPSS 19.0 was used for statistical analysis of the data and GraphPad 7 was used for image rendering. The number of cases and percentage (%) was used to indicate enumeration data, and the comparison was performed using the χ^2 test. For measurement data, inter-group comparison and comparison before and after treatment was performed by Student's t test and paired t test, respectively. $P<0.05$ was regarded as the significance level.

Results

Comparison of general data

Subjects were comparable due to insignificant differences observed regarding age, BMI and gender between the two groups ($P>0.05$), as shown in **Table 1**.

Comparison of therapeutic efficacy between two groups of patients

The number of patients with efficacy of cured, effective and ineffective in the observation group was 30, 25, and 2, respectively, with an effective rate of 96.49%; the corresponding data of the control group was 19, 22, and 15, respectively, and the effective rate was 73.21%. The treatment effective rate in the observation group was markedly higher than that in the control group ($P<0.05$, **Table 2**).

Table 1. Comparison of general data [n (%)]

Factors	Observation Group n=57	Control Group n=56	χ^2	P
Gender			0.709	0.400
Male	35 (61.40)	30 (53.57)		
Female	22 (38.60)	26 (46.43)		
Age (years)			0.007	0.931
≥63	31 (54.39)	30 (53.57)		
<63	26 (45.61)	26 (46.43)		
BMI (kg/m^2)			0.078	0.780
≥23	30 (52.63)	28 (50.00)		
<23	27 (47.37)	28 (50.00)		
History of Smoking			0.213	0.645
YES	36 (63.16)	33 (58.93)		
NO	21 (36.84)	23 (41.07)		
History of Drinking			0.073	0.787
YES	34 (59.65)	32 (57.14)		
NO	23 (40.35)	24 (42.86)		
Level of Education			0.071	0.790
Primary School or Under	38 (66.67)	36 (64.29)		
Primary School or Above	19 (33.33)	20 (35.71)		
Gum Type			0.074	0.786
Fan Shaped	33 (57.89)	31 (55.36)		
Thick and Flat	24 (42.11)	25 (44.64)		

Table 2. Comparison of the therapeutic efficacy between the two groups of patients [n (%)]

Items	Observation Group n=57	Control Group n=56	χ^2	P
Cured	30 (52.63)	19 (33.93)	-	-
Effective	25 (43.86)	22 (39.29)	-	-
Invalid	2 (3.51)	15 (26.79)	-	-
Efficiency Rate of treatment	55 (96.49)	41 (73.21)	11.971	<0.001

Comparison of gingival index, plaque index and attachment loss index between two groups before and after treatment

Before treatment, no marked difference was observed in GI, PI and CAL between the two groups (all P>0.05). After treatment, above indexes of both groups reduced significantly and were lower in the observation group compared with the control group (P<0.05, **Figure 1**).

Comparison of periodontal pocket depth, anterior tooth coverage distance and alveolar bone reconstruction distance between the two groups of patients before and after treatment

Before treatment, no marked difference was observed in PPD, anterior tooth coverage distance and alveolar bone reconstruction distance between the two groups (P>0.05). After treatment, the above indexes of both groups of patients went markedly lower than those before treatment, and the observation group held comparatively lower scores than those in the control group (P<0.05, **Figure 2**).

Comparison of dental function between the two groups of patients after treatment

After treatment, patients in the observation group were observed with markedly higher scores of chewing function, fixation, aesthetics and comfort of the teeth than those in the control group (P<0.05, **Table 3**).

Comparison of tooth mobility between the two groups of patients after treatment

After treatment, the number of patients with tooth mobility of grade I-II and III in the observa-

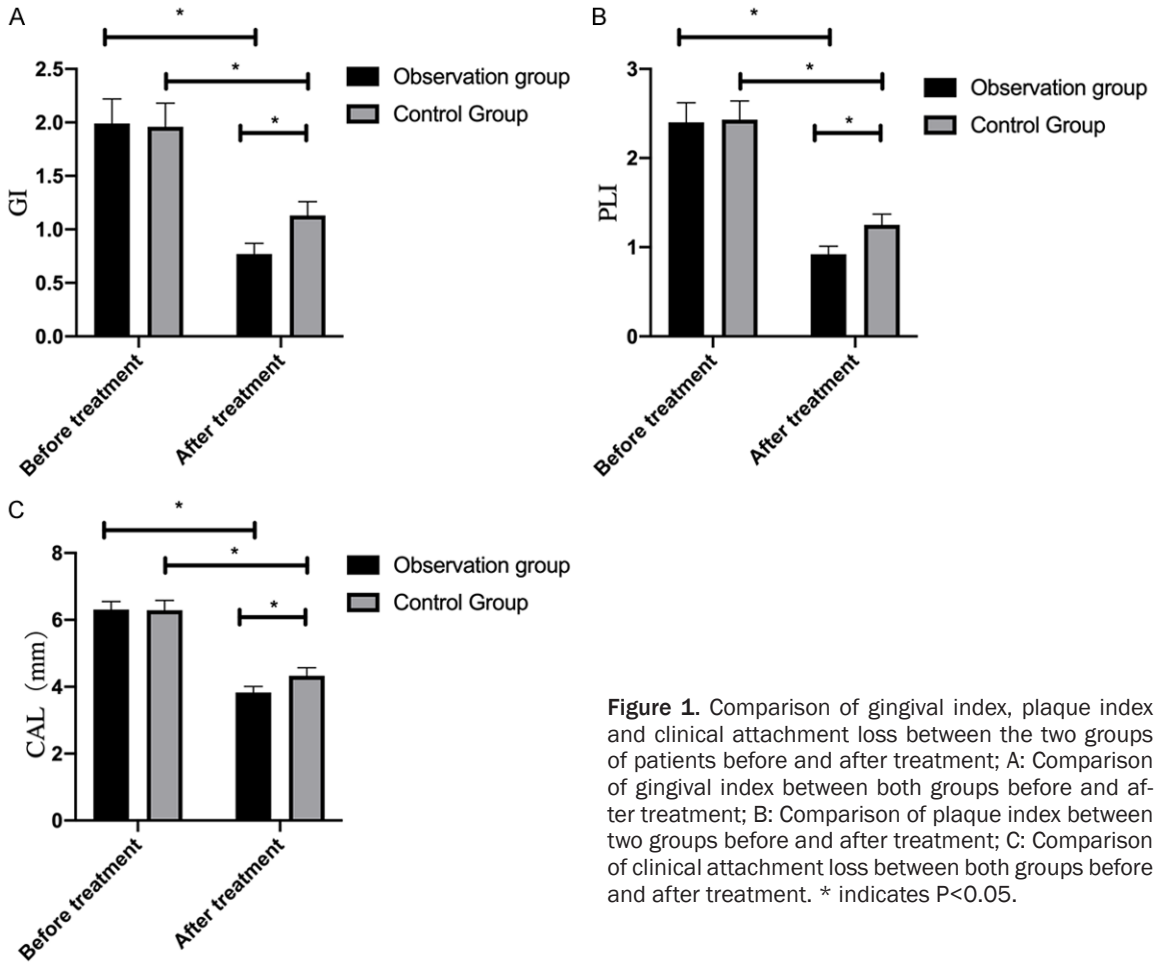

Figure 1. Comparison of gingival index, plaque index and clinical attachment loss between the two groups of patients before and after treatment; A: Comparison of gingival index between both groups before and after treatment; B: Comparison of plaque index between two groups before and after treatment; C: Comparison of clinical attachment loss between both groups before and after treatment. * indicates P<0.05.

tion group was 54 and 3, respectively, while that in the control group was 40 and 16, respectively. The tooth mobility degree of the observation group was significantly lower compared with the control group (P<0.05, **Table 4**).

Comparison of serum inflammatory factors between the two groups before and after treatment

Before treatment, no marked difference was observed in serum TNF-α, IL-8 and IL-6 between the two groups before treatment (P>0.05). After treatment, the above indexes declined markedly in both groups, and the reduction in the observation group was more obvious compared with the control group (P<0.05, **Figure 3**).

Discussion

PD, one of the most common chronic oral infectious diseases, mainly manifests as red and swollen gums that bleeding upon probing. Given the persistence of the disease, the periodontal support tissue can be destroyed, resulting in decreased tooth adhesion, tooth loss and alveolar bone resorption, affecting the overall appearance of patient's mouths and greatly reducing their life quality [16]. It can even lead to the progressive destruction of periodontal tissue in severe cases, resulting in reduced tooth adhesion and tooth loss [17].

Simple periodontal therapy is the most commonly used method for PD treatment. A large number of long-term clinical trials have shown that, after receiving professional and simple periodontal therapy, most patients were treated effectively with controlled gingival inflammation, ceased gingival recession and certain ameliorated loss of attachment, preventing PD from further progression. However, the treatment may also be not so effective, due to more complex conditions and a longer course of disease in some cases [18]. Combined periodon-

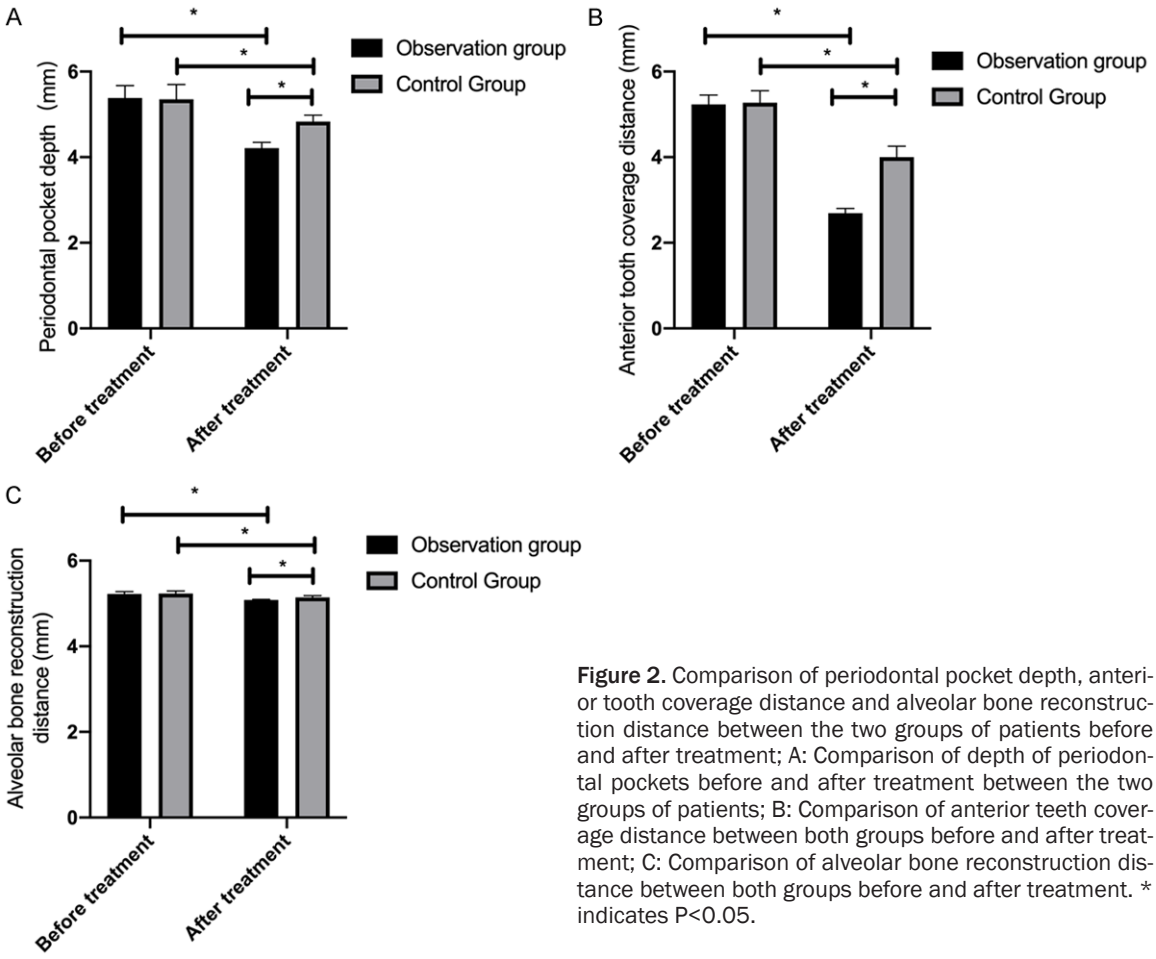

Figure 2. Comparison of periodontal pocket depth, anterior tooth coverage distance and alveolar bone reconstruction distance between the two groups of patients before and after treatment; A: Comparison of depth of periodontal pockets before and after treatment between the two groups of patients; B: Comparison of anterior teeth coverage distance between both groups before and after treatment; C: Comparison of alveolar bone reconstruction distance between both groups before and after treatment. * indicates P<0.05.

Table 3. Comparison of dental function between the two groups of patients after treatment

Tooth function	Observation Group n=57	Control Group n=56	t	P
Chewing function	3.22±0.11	2.63±0.13	26.063	<0.001
Fixation Degree	2.92±0.12	2.52±0.14	16.321	<0.001
Aesthetics	3.58±0.10	3.12±0.14	20.134	<0.001
Comfort Rating	2.84±0.13	2.51±0.11	14.553	<0.001

Table 4. Comparison of tooth mobility between the the two groups of patients after treatment [n (%)]

tooth mobility	Observation Group n=57	Control Group n=56	χ^2	P
I-II	54 (94.74)	40 (71.43)	10.972	0.001
III	3 (5.26)	16 (28.57)		

tal and orthodontic treatment, which is a combination therapy on the basis of simple periodontal treatment, can correct the abnormal dentition of patients caused by PD to restore its function [19], repair PD-induced tooth displacement, close the interdental space caused by PD, improve patient's chewing function and appearance, and restore normal bite and lip line relationship [20]. In the present study, it was also observed that this combination had better therapeutic effects on patients with improved periodontal-related indicators and tooth function, lower tooth mobility, reduction of clinical symptoms and better patient satisfaction. Previous studies [21] have drawn similar conclusions, which is consistent with our observations. Analyzing the reasons, it is mainly because orthodontics can restore the relationship of the teeth by performing orthodontic indentation and adduction on the scattered affected position to correct the occlusion of the anterior teeth, thereby increasing periodontal support tissue and reducing tooth

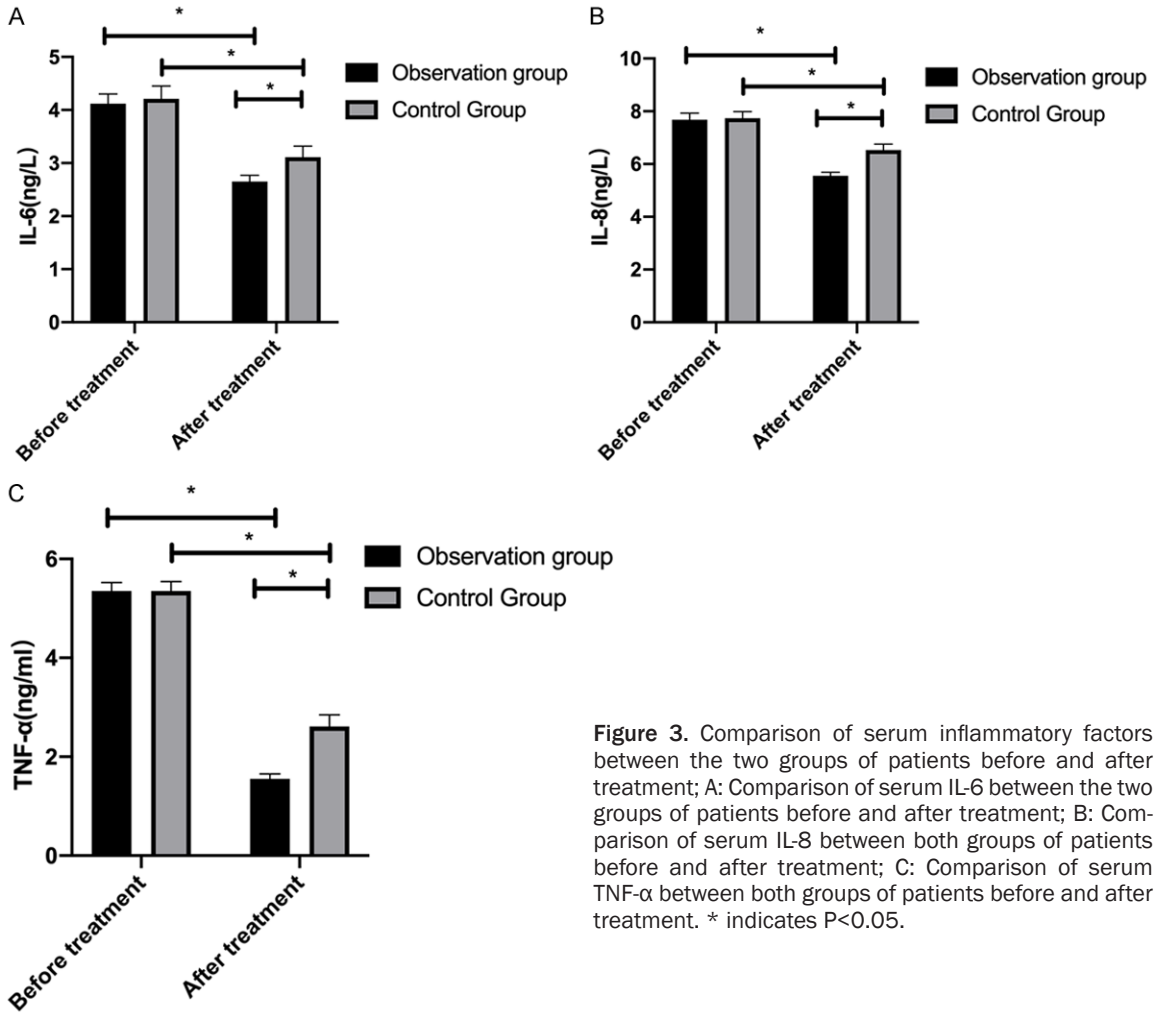

Figure 3. Comparison of serum inflammatory factors between the two groups of patients before and after treatment; A: Comparison of serum IL-6 between the two groups of patients before and after treatment; B: Comparison of serum IL-8 between both groups of patients before and after treatment; C: Comparison of serum TNF-α between both groups of patients before and after treatment. * indicates P<0.05.

mobility [22]. However, few studies have focused on the effect of combined orthodontic treatment on serum inflammatory factors in patients.

Periodontal infection has been shown to be related to systemic diseases, mainly because it can promote inflammatory responses and the formation of inflammatory factors, playing an essential role in pathological changes of periodontal tissue [23]. A previous study also found that levels of IL-8, IL-6, and TNF-α increased markedly in the serum and gingival crevicular fluid of patients with periodontitis [24]. In this study, changes in serum levels of IL-6, IL-8 and TNF-α were observed and these inflammatory factors were evidently up-regulated after treatment in both groups. IL-6 stimulation is not only involved in cell proliferation and differentiation of the immune response, but also in the inflammatory response and febrile response [25]. IL-8, a neutrophil chemokine, can regulate inflammatory response and achieve the purpose of sterilization and cell damage [26]. TNF-α has a wide range of effects and plays an important role in the acute inflammatory response [27]. The reason why orthodontic treatment can alleviate the body's inflammatory response may be due to its ability to remove traumatic occlusion, eliminate gingival inflammation, maintain periodontal lesions in a quiescent state, terminate the process of periodontal tissue destruction, improve periodontal status, and attenuate periodontal inflammation in patients, thereby reducing the levels of IL-6, IL-8 and TNF-α.

In conclusion, simple periodontal therapy combined with orthodontic treatment can not only effectively reduce the inflammatory response

of patients with PD, and improve their periodontal condition, but also promote periodontal tissue regeneration and repair, reduce tooth loosening, and improve patients' masticatory function and aesthetics; this treatment is beneficial for patients to maintain good oral hygiene for a long time, which is worthy of clinical application.

This study has certain limitations. First, due to the small sample size, further large-sample studies are still needed to confirm our conclusions. Second, the follow-up should be extended to investigate the effect of this therapy on the long-term oral health of patients. In the future, we will conduct a larger-sample study with extended follow-up time, so as to provide more concrete evidence for the treatment plan of patients with PD.

Disclosure of conflict of interest

None.

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