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Original Article

Oral implant restoration and the levels of TNF-α and IL-8 affect the efficacy of dentition defects

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Abstract: Objective: This study aimed to explore the efficacy of oral implant restoration in dentition defects and the factors that influence the efficacy. Methods: 98 patients with dentition defects in our hospital were enrolled in this study. They were randomized into group A and group B. Group A received oral implant restoration treatment and Group B received denture restoration treatment. The efficacy and functions of language and chewing in the two groups before and after treatment were observed. The levels of TNF-α and IL-6 in gingival crevicular fluid were measured by enzyme-linked immunosorbent assay (ELISA). Results: After treatment, the scores of chewing and language functions of group A and group B increased significantly ($P<0.001$), and were higher in group A than in group B ($P<0.001$). Meanwhile, Group A showed lower TNF-α and IL-6 levels of gingival crevicular fluid than those of group B ($P<0.001$). The univariate analysis of logistic regression suggested that the course of disease, number of defects, treatment, TNF-α and IL-6 levels might affect the efficacy ($P<0.05$). Further multivariate analysis of logistic regression suggested that the course of disease, number of defects, treatment, TNF-α and IL-6 levels were the factors that influenced the efficacy ($P<0.05$). Conclusion: Oral implant restoration showed good outcomes in dentition defects. Chewing and language functions were improved and the inflammatory factors in the gingival crevicular fluid were down-regulated. The course of disease, the number of defects, the treatment of oral implant restoration and the levels of TNF-α and IL-8 are the factors that influence the efficacy of dentition defects.

Keywords: Dentition defects, oral implant, denture, clinical efficacy

Introduction

Defective dentition is a common dental disease in humans, often caused by caries and trauma [1]. Without effective treatment, defective dentition will affect the chewing and language functions. Furthermore, the teeth malformation will occur, causing serious impacts on the aesthetics of the face and posing a great threat to the patients' mental and physical health [2]. Therefore, timely treatment is of great significance.

Removable partial denture restoration is a common method for dentition defects, characterized by simple operation procedures, less odontoprisis and fast postoperative recovery [3]. However, the foreign body sensation of removable dentures is obvious, which affects the patients' chewing ability and stability. It may damage the abutment teeth, and cause complications such as mucosal ulcer and periodontitis [4].

Medical technology development has gradually promoted oral implant restoration in the treatment of dentition defects. Oral implants have similar structural features to normal teeth. They can reduce or avoid the use of the base plate, promote the recovery of the dentition [5]. In the process of oral implant restoration, stress responses often occur and it may stimulate the release of inflammatory factors [6]. Tumor Necrosis Factor-alpha (TNF-α) is mainly synthesized and secreted by monocytes and macrophages. It can induce inflammatory reactions in the body and promote the activity of bone cells, causing damages to connective tissues and affecting the recovery of periodontal tissues [7]. Interleukin-6 (IL-6) is a type of inflammatory cytokine. It can induce the release of inflammatory factors, and thus cause systemic inflam-

matory reactions. The level of IL-6 is closely related to inflammatory responses and degree of tissue damages [8].

There have been many reports about the treatment of defective dentitions by oral implants [9-11], but few of them studied the changes of TNF-α and IL-6 levels in gingival crevicular fluid and the related factors affecting the efficacy. In this study, the efficacy of oral implant restoration in dentition defects was observed to explore the changes of TNF-α and IL-6 levels and related factors.

Materials and methods

General information

98 patients with dentition defects in our hospital were selected as subjects and randomly divided into group A and group B. There were 24 males and 25 females in group A. The patients and family members were informed and had signed full informed consent forms.

Inclusion & exclusion criteria

Inclusion criteria: Dentition defects were diagnosed by X-ray film; the patients aged >22; the patients had a history of periodontitis or dental caries and a poor function of chewing; the number of defects ranged from 1 to 3.

Exclusion criteria: The patients had a history of orthodontic treatment; the patients had a poor oral hygiene status; the patients also suffered neurological diseases, hematopoietic dysfunction, severe heart, liver and kidney dysfunction, malignant tumors and immune diseases; the patients had jawresidual roots, cysts and ambushed teeth; the patients were pregnant or in lactation.

Treatment

With conventional drape and disinfection in the patients' perioral skin and oral cavity, local anesthesia was performed with 2% lidocaine. The sick teeth were cleaned and removed when lidocaine worked. After the local mucosa of the teeth was completely healed, conventional model teeth were worn. The patients in group B received denture restoration treatment. Dentures were produced on the basis of conventional model teeth, and were adjusted according to the wearing feelings of the patients. The oral implant restoration treatment was implemented in the patients of group A. A curved incision was made at the top of the alveolar ridge to fully expose the alveolar bone which was drilled using a grade 1 split drill to achieve the desired depth. Then the 2 stage split drill was used to fully expand the top of the implant hole. After local cooling with physiological saline, the implant was implanted. After the implant was fixed, the wound was washed by physiological saline and sutured. When the combination between the implant and bone was confirmed by X-ray 3-5 months after operation, the abutment was placed, and the wounds on both sides of the gingival were sutured. The suture was removed 7 days after surgery, and the implant dentures were made according to the dental gypsum model. Then implant denture restoration was performed. The patients were treated with oral antibiotics for 3 days to prevent infection.

Observation index

The efficacy was evaluated 3 months after restoration. Significantly effective: The language and chewing functions returned to normal, the visual and dental function were consistent with normal teeth, and all dental defects were restored. Effective: Language and chewing functions were significantly improved, visual and dental function were slightly different from normal teeth, and most dental defects were restored. Invalid: The fixation effect was poor, there were obstacles in chewing and language functions, and the dental defects could not be restored. Effective rate = (significantly effective + effective) group/total cases × 100%.

A self-made questionnaire was used to evaluate the chewing and language functions of the patients before treatment and 3 months after treatment. The chewing function included the stability of dentures during chewing, the condition of chewing food, the presence or absence of abnormality, and 4 aspects of impacts on digestive function. There were 3 options in each aspect with a total score of 12 points.

The language function was evaluated by observing the patients' pronunciation style. There were 5 options with a total score of 15 points. A higher score indicated a better recovery of chewing and language functions.

Table 1. General information of group A and group B [n (%)]/($\bar{x}$ ± sd)

Category	Group A (n = 49)	Group B (n = 49)	t/χ^2 value	*P* value
Gender			0.164	0.686
Male	24 (48.98)	22 (44.90)		
Female	25 (51.02)	27 (55.10)		
Age			0.200	0.655
≥50	34 (69.39)	36 (73.47)		
<50	15 (30.61)	13 (26.53)		
Course of disease (year)	3.4±0.5	3.2±0.6	1.793	0.076
Cause			0.740	0.691
Trauma	10 (20.41)	13 (26.53)		
Periodontal disease	39 (79.59)	36 (73.47)		
Diabetes			0.122	0.726
Yes	4 (8.16)	5 (10.20)		
No	45 (91.84)	44 (89.80)		
Smoking history			0.883	0.347
Yes	39 (79.59)	35 (71.43)		
No	10 (20.41)	14 (28.57)		
Drinking history			0.800	0.371
Yes	37 (75.51)	33 (67.35)		
No	12 (24.49)	16 (32.65)		
Osteoporosis			0.710	0.399
Yes	2 (4.08)	4 (8.16)		
No	47 (95.92)	45 (91.84)		
Number of defects			0.383	0.536
≥2	31 (63.27)	28 (57.14)		
<2	18 (36.73)	21 (42.86)		
History of brushing bleeding			0.200	0.655
Yes	15 (30.61)	13 (26.53)		
No	34 (69.39)	36 (73.47)		
Mouth habit			1.180	0.277
Frequently gargle	36 (73.47)	31 (63.27)		
Basically not swearing	13 (26.53)	18 (36.73)		

Detection method

2 mL of gingival crevicular fluid was collected before treatment and 3 months after treatment, and the supernatant was separated by centrifugation at 1000 × g for 10 min. ELISA was used to detect the levels of TNF-α and IL-6 in gingival crevicular fluid, consulting the instructions of human TNF-α and IL-6 ELISA kits (Xiamen Research Biotechnology Co., Ltd., China, Item No.: IQP-163P, KT-669). The standard, sample and blank wells (without sample and enzyme-labeled reagents) were set up. 50 μl of the standard was added to the well, and 10 μl of the sample was added to the well with 40 μl of the sample dilution (the final dilution of the sample is 5 times). The plate was covered with a membrane and incubated at 37°C for 30 min. After removing the liquid in each well, the plate was washed 5 times. 50 μl of enzyme labeled reagent was added to each well (except for blank wells), and incubated at 37°C for 30 min. Then 50 μl of developer A and developer B were added in order. They were mixed and colored at 37°C for 10 min in the dark. 50 μl of the stop solution was added to terminate the reaction. The absorbance (OD value) of each well was measured at a wavelength of 450 nm using a DNM-9606 enzyme labeling analyzer (Beijing Prang Medical Devices Co., Ltd., China), and the levels of TNF-α and IL-6 were calculated.

Statistical analysis

Statistical analysis was performed using SPSS 20.0 (IBM Corp, Armonk, NY, USA). The enumeration data was expressed as (n/%), and χ^2 test was used for the enumeration data between two groups. The measurement data was expressed as $\bar{x}$ ± sd and analyzed by independent-t test. Paired-t test was used before and after treatment in the group. Univariate and multivariate analyses of logistic regression models were used to explore the risk factors for the efficacy of patients with dentition defect. *P*<0.05 implied significant differences.

Results

General information

There was no significant difference in general clinical information in gender, age, course of disease, etiology, diabetes, smoking history, drinking history, osteoporosis, number of defects, history of brushing bleeding and sputum habits between group A and group B (P>0.05) (**Table 1**).

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

Group	n	Significantly effective	Effective	Invalid	Effective rate (%)
Group A	49	33 (67.35)	12 (24.49)	4 (8.16)	91.84
Group B	49	22 (44.90)	11 (22.45)	16 (32.65)	67.35
χ^2 value	-	-	-	-	9.046
P value	-	-	-	-	0.003

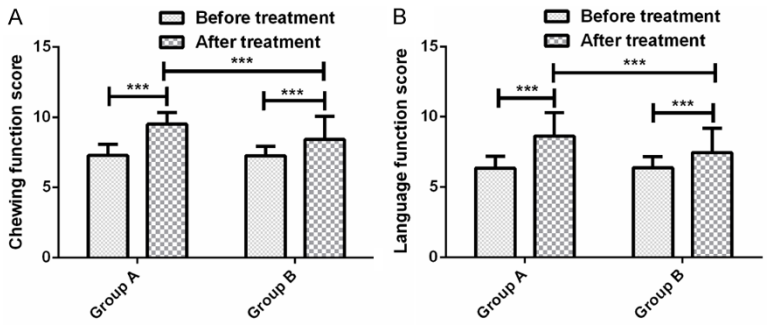

Figure 1. Comparison of the scores of chewing and language functions before and after treatment in group A and group B. Comparison of chewing function scores before and after treatment in group A and group B (A); comparison of language function scores before and after treatment in group A and group B (B). Note: ***P<0.001.

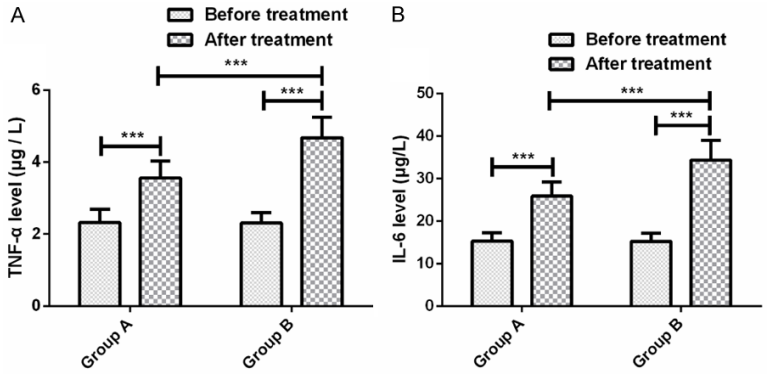

Figure 2. Comparison of TNF-α and IL-6 levels in gingival crevicular fluid before and after treatment in group A and group B. Comparison of TNF-α levels in gingival crevicular fluid before and after treatment in group A and group B (A); comparison of IL-6 levels in gingival crevicular fluid before and after treatment in group A and group B (B). Note: ***P<0.001.

The clinical efficacy of group A and group B

In group A, the treatment was significantly effective in 33 patients (67.35%), effective in 12 patients (24.49%), invalid in 4 patients (8.16%), and the effective rate was 91.84%. In group B, the treatment was significantly effective in 22 patients (44.90%), effective in 11 patients (22.45%), invalid in 16 patients (32.65%), and the effective rate was 67.35%. Group A showed higher effective rate than group B (P<0.05) (**Table 2**).

The scores of chewing and language functions before and after treatment in group A and group B

There was no significant difference in the scores of chewing and language functions of group A and group B before treatment (P>0.05). After treatment, the scores increased significantly (P<0.001), and the scores of group A were higher than those of group B (P<0.001) (**Figure 1**).

The changes of TNF-α and IL-6 levels in gingival crevicular fluid before and after treatment in group A and group B

No significant difference in the TNF-α and IL-6 levels were shown between two groups before treatment (P>0.05). After treatment, the corresponding levels in group A were lower than those of group B (P<0.001) (**Figure 2**).

Logistic regression analysis of factors influencing the efficacy of the patients with dentition defects

According to the efficacy, 98 patients were divided into the improved group (significantly effective + effective, n = 78) and the invalid group (invalid, n = 20). The clinical parameters of patients were assigned to variables.

The univariate analysis of logistic regression suggested that gender, age, etiology, diabetes, smoking history, drinking history, osteoporosis, history of brushing bleeding and sputum habits had no effect on the treatment of patients with dentition defects (P>0.05), while the course of disease, number of defects, treatment, TNF-α

Table 3. Logistic values

Factor	Variable	Assignment
Gender	X1	Male = 1, Female = 2
Age	X2	≥50 years old = 1, <50 years old = 2
Disease course	X3	Continuous variable
Cause	X4	Trauma = 1, Periodontal disease = 2
Diabetes	X5	Yes = 1, No = 2
History of smoking	X6	Yes = 1, No = 2
Drinking history	X7	Yes = 1, No = 2
Osteoporosis	X8	Yes = 1, No = 2
Number of missing teeth	X9	≥2 = 1, <2 = 2
Brushing bleeding history	X10	Yes = 1, No = 2
Mouth habit	X11	Frequently gargle = 1, Basically not swearing = 2
Treatment	X12	Denture repair = 1, Oral implant restoration = 2
TNF-α	X13	Continuous variable
IL-6	X14	Continuous variable

Table 4. Univariate and multivariate analysis of treatment effects in patients with dentition loss

Variable	Univariate analysis		multi-factor analysis	
	HR (95% CI)	P	HR (95% CI)	P
Gender	1.035 (0.604-1.783)	0.223		
Age	1.501 (0.822-2.615)	0.193		
Disease course	3.158 (1.483-7.256)	0.007	3.058 (1.159-9.226)	0.021
Cause	0.869 (0.448-1.036)	0.853		
Diabetes	0.852 (0.552-1.753)	0.746		
History of smoking	1.108 (0.528-6.364)	0.628		
Drinking history	0.963 (0.425-3.852)	0.436		
Osteoporosis	1.632 (0.776-3.358)	0.326		
Number of missing teeth	2.015 (1.156-3.205)	0.011	2.152 (1.119-3.473)	0.017
Brushing bleeding history	0.985 (0.407-2.125)	0.435		
Mouth habit	1.523 (0.775-2.436)	0.149		
Treatment	13.152 (4.428-38.896)	<0.001	7.963 (1.725-39.152)	0.009
TNF-α	2.036 (1.119-5.563)	0.006	1.908 (1.083-3.486)	0.043
IL-6	3.496 (1.893-9.585)	<0.001	2.036 (1.078-4.637)	0.035

and IL-6 levels might affect the efficacy (P<0.05). Further multivariate analysis of logistic regression suggested that the course of disease, number of defects, treatment, TNF-α and IL-6 levels were the factors that influenced the efficacy (P<0.05) (**Tables 3** and **4**).

Discussion

Dentition defects is a common dental disease, and mainly caused by periodontitis or teeth decay. Although it does not pose a threat to the life, dentition defects will affect the patient's normal pronunciation, chewing ability and other functions. Meanwhile, it will affect the appearance of the face, resulting in a poor mental state and a serious decline in quality of life [12, 13]. Conventional denture restoration has certain clinical effects, but a large number of dentures need to be prepared, and patients with severe symptoms need to receive endodontic treatment, which often causes a series of complications [14]. Oral implant restoration is a new way to treat dentition defects, which has a better fixation effect and causes less complications [15]. Many studies have reported the application of oral implant restoration in the patients with dentition defects. For exam-

ple, Battistuzzi et al. [16] found that the support of implants could restore defects by removing the partial dentures and residual teeth. The application of implants improved functions, comfort and stability by comparing with conventional removable partial dentures. Liu et al [17] reported that the micro-implant anchorage therapy could improve the efficacy of patients with orthodontic treatment. It also could improve the success rate of treatment and reduce the incidence of postoperative infection. In this study, the effective rate of group A was significantly higher than that of group B. After treatment, the scores of chewing and language functions of group A were higher than those of group B. It was suggested that oral implant restoration had a better clinical efficacy in the treatment of dentition defects and could improve the language and chewing functions of patients, which was similar to the conclusion of the previous studies. The reason might be that the root material and chimerism used in oral implant restoration are more in line with the mechanical characteristics [18], which can reduce the use of base. The artificial roots can be tightly fitted to the bone after being placed in the alveolar bone [19]. They can effectively prevent the influence of food residue and bacteria on the bone environment and increase the combination of implants and nearby tissues [20]. Therefore, oral implant restoration has a better efficacy by providing a good fixation effect.

Oral implant restoration can stimulate cellular immune responses. It may cause local microecological changes of periodontal tissues, resulting in bleeding of the gums, stabbing pains of periodontium, etc. [21]. Gingival crevicular fluid originates from epithelial tissues or microbial destruction products, plasma and interstitial fluid. The changes of gingival tissues can be reflected by detecting the components of gingival crevicular fluid [22]. TNF-α and IL-6 are pro-inflammatory cytokines that reflect inflammatory responses of the body [23]. After treatment, TNF-α and IL-6 levels in group A were lower than those of group B. Different degrees of inflammatory responses could be caused by the treatment of dentition defects, but less inflammatory responses and smaller stimulation were induced to the patients during oral implant restoration compared with conventional treatment. In the study of Wang et al [24], TNF-α, IL-8, AST, ALP and MDA levels were increased significantly in patients with dentition defects after cobalt-chromium alloy and gold alloy porcelain crown restoration. Although the used materials were different from ours, it was confirmed that stress responses were induced during the repair process of dentition defects, resulting in an increase in the levels of inflammatory factors in the gingival crevicular fluid. We speculated that oral implant restoration might have less stimulation to periodontal tissues and better chimerism in bone formation, and reduce the incidence of irritants. Thereby it alleviated the inflammatory reaction and provided a good protection for the patients' dentition.

Multivariate analysis of cox regression showed that the course of disease, the number of defects, oral implants restoration and levels of TNF-α and IL-8 were the factors affecting the efficacy of dentition defects. In the study of Ruan et al [25], oral implant restoration of dental defects had better short-term and long-term effects and lower incidence of complications than conventional restoration. It was suggested that age, length of implant (mm), and number of defects could affect the incidence of complications. In this study, the risk factors for the efficacy of patients with dentition defects were observed instead. The efficacy and complications after treatment often reflect the recovery of patients. Therefore, observation of these indicators may have an important role in the subsequent recovery of patients.

This study confirmed that oral implant restoration had a certain efficacy in patients with dentition defects, and preliminarily analyzed the relevant factors affecting the efficacy. However, there were some defects in the study. First, in-depth observations on the post-treatment complications and related risk factors for complications were not conducted. Second, the satisfaction and quality of life of patients with dentition defects after treatment were unknown. These will be supplemented in future researches to further proof the conclusions of this study.

In summary, the application of oral implant restoration for dentition defects has a good clinical effect. It can improve the chewing and language functions of patients, and down-regulate the inflammatory factor levels of the gingival

crevicular fluid after treatment. The course of disease, the number of defects, oral implants restoration treatment and levels of TNF-α and IL-8 were factors influencing the treatment of dentition defects.

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Disclosure of conflict of interest

None.

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