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Original Article

Clinical evaluation of dental implant rehabilitation in patients with chronic periodontitis

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Abstract: Objective: To evaluate the clinical efficacy of dental implant rehabilitation in patients with chronic periodontitis. Methods: A total of 98 patients who had received dental implants rehabilitation were selected as subjects, including 48 patients with chronic periodontitis in the test group and 50 patients without chronic periodontitis in the control group. A clinical retrospective analysis was performed on the effects of dental implant rehabilitation in the two groups. Results: After dental implant rehabilitation, the test group showed a success rate of 90.38% for implantation and a patient satisfaction rate of 88.46% at 6 months; a success rate of 86.54% and a patient satisfaction rate of 84.62% at 12 months, and there were no statistically significant differences between the test and the control groups (all P>0.05). However, the test group showed significantly lower rates of dental implant success and lower patient satisfaction than the control group 36 and 60 months after loading. The satisfaction rate and success rate in the test group were significantly lower than those in the control group (both P<0.05). The alveolar bone resorption values in the test group were significantly higher than those in the control group at 12, 36 and 60 months, respectively (all P<0.05). For the periodontal indexes, there were significant between-group differences in peri-implant sulcular fluid (PISF), periodontal probing depth (PPD) and modification sulcus bleeding index (mSBI) at 6 months (all P<0.05); but no significant difference in attachment loss (AL) (P>0.05). However, the above four periodontal indexes showed significant differences at 12, 36 and 60 months between the two groups (all P<0.05). Results from comparison of soft tissue aesthetic rehabilitation showed that the pink esthetic score (PES) of the control group (13.35±3.21) was significantly higher than that of the test group (10.23±2.94) at 12 months (P<0.05). Conclusion: Compared with patients without chronic periodontitis, those with chronic periodontitis had an increased failure rate in long-term loading of dental implants. This caused other problems regarding periodontal health, affected the aesthetic outcomes of soft tissue after implantation, and led to lower subjective satisfaction in patients. Hence, the periodontal health of patients should be taken into consideration in dental implant rehabilitation to achieve higher success rates of dental implants and reduce the incidence of complications after implantation.

Keywords: Dental implant rehabilitation, chronic periodontitis, periodontal index, soft tissue aesthetic effect

Introduction

Periodontitis is a complicated disease worldwide. The condition is characterized by destructive inflammatory response of periodontal tissues to complex biofilms of compound bacteria and opportunistic pathogens [1]. It is estimated that it has affected 45.9% of adults in the United States, so it is considered a public health concern [2]. A health program shows that 35-44% of adults develop the symptoms of periodontitis in Brazil, and 15% of the global population suffers from periodontal conditions. There are pathogenic biofilms on the surface of teeth of patients with periodontitis, which causes inflammation, leading to periodontal collapse and further deterioration. Severe periodontitis can even result in tooth loss [3]. Therefore, there will be a greater demand for dental rehabilitation in patients with periodontitis.

With the progress in biomaterials and clinical technology as well as the patients' higher demands for comfortable and beautiful dentures, dental implant rehabilitation has become an ideal option for patients with dentition defects or edentulous jaw, and the clinical suc-

cess rate of the technique has attracted much attention [4]. Dental implants are primarily used to restore dentition defects and other dental diseases. Dental implants (similar to a tooth root in morphology), which are generally produced with artificial materials (such as metal, ceramics, etc.), are inserted into the tissues (commonly maxilla and mandible) by means of surgical procedures. They obtain firm retention force from bone tissues, connecting to dental implants supporting the upper part by means of special devices and approaches. In addition to improving the patients' dental functions, occlusal force and masticatory efficiency, this technique can also maximize the aesthetic rehabilitation of their mouths. Thus, it has been extensively used in clinical practice [5].

The success of dental implants is determined by a wide range of factors [6]. The stability of dental implants can be divided into primary stability and secondary stability. The primary stability of dental implants at placement, also known as initial stability, is mostly determined by the mechanical interlocking capacity at placement which is a prerequisite for success of dental implants. The secondary stability after implantation depends on the biological intensity of the osseointegration between the implant surface and alveolar bone [7]. The initial stability of dental implants is associated with the bone mass and substance in the implant region, the screw thread on the implant surface and the methods of operation. The long-term stability of dental implants is related to the surface treatment of implants, soft tissue seal barrier, timing of implant loading and the postoperative nutrition and maintenance.

Therefore, in this study, the clinical efficacy of dental implant rehabilitation was investigated quantitatively and further analyzed in patients with chronic periodontitis on the basis of relevant indexes. The objective of the study was to detect the difference in the long-term stability of dental implants after implantation between patients with chronic periodontitis and those without chronic periodontitis. This study might be useful for clinical practice.

Materials and methods

Patient information

Ninety-eight patients (a total of 106 teeth) who received dental implants from January 2016 to January 2019 in the Affiliated Hospital of Jiangsu University were selected as study subjects. Among the enrolled patients, 48 with confirmed chronic periodontitis (52 teeth) were in the test group, and 50 patients without chronic periodontitis (54 teeth) in the control group. A comparative analysis was performed on age, sex, previous medical history, bad habits and other aspects between the two groups by using Chi-square test or t test, and the *p* values were calculated. The clinical efficacy of dental implant rehabilitation was analyzed for patients with chronic periodontitis. All patients were voluntary to sign and provide informed consent after they had been informed of the study and relevant information. This study was approved by the Ethics Committee of the Affiliated Hospital of Jiangsu University.

Inclusion and exclusion criteria

Inclusion criteria: Patients were diagnosed as having chronic periodontitis in compliance with the new classification of periodontal diseases and conditions developed by the American Academy of Periodontology (AAP) in 1999 [8]; met the indications to the surgeries of dental implant rehabilitation; had received conventional treatment for periodontitis prior to the surgery, and were receiving regular maintenance for the periodontal conditions; had stable dental prosthesis in the initial stage of dental implant rehabilitation; and received fixed dentures after implant rehabilitation.

Exclusion Criteria: Patients had systemic diseases; bad habits such as smoking or drinking; oral dysfunction; or periodontal conditions which were not well-controlled after treatment of periodontitis.

Treatment process

Preoperative preparation: For the two groups of patients with or without chronic periodontitis, placement of dental implants was performed with 89% Au-Pt based alloy ceramic crowns in combination with DK-O-MVS surgical power devices (Xishan) and Straumann dental implant system (Switzerland). In the process of dental implant rehabilitation, bone meal and barrier membranes (Geistlich, Switzerland) were applied. The Community Periodontal Index developed by WHO (the items assessed including coronal, adjacent, root, and cervical caries), gingival bleeding and periodontal pockets were

assessed in both groups based on dental films to confirm whether they suffered from periodontitis [9]. For patients with periodontitis, the corresponding treatment should be given prior to surgery. As for the surgery, at first, the positions of dental implants should be determined, then, a correct implant regimen was designed, followed by the conduct of clinical treatment.

Surgical procedures: First, after dental disinfection, the patient was administered with local anesthesia, then, an incision was made at the top of alveolar ridge crest in the area with a missing tooth. Another incision was made inside the gingival sulcus in the adjacent position. Pealing and flapping gingival and mucoperiosteal flaps along the surface of adjacent teeth were performed, followed by gradual expanding the implant bed, and pealing the mucoperiosteum for flapping. Second, a minimally invasive surgery was performed to extract a tooth, remove the residual periodontal ligament, granulation tissues and other residues in the extraction socket. A guide drill was used to deepen the alveolar socket by 1-2 mm to ensure a good stability in the initial stage after implant placement. Appropriate implants were selected and inserted according to the actual condition of the patient. Finally, the implants and the foramen were further confirmed, and the whole process of implant placement was completed [10]. After surgery, all patients received antibiotic treatment to prevent infection. Compound borax solution was used to clean the mouth. Three days after surgery, the patient was reexamined, and the sutures were removed 10 days later. All patients with or without chronic periodontitis underwent denture crown preparation within half a month after the second surgery.

Postoperative observation: The affected teeth of all the patients in both groups were managed by the same physician. After operation, all patients were followed up to measure the peri-implant and bone resorption levels (including X-ray examination). The specific observations were mostly obtained in the following aspects.

(1) Data regarding the success rates of dental implants and rates of patient satisfaction were collected at 6, 12, 36 and 60 months, respectively. Evaluation criteria: The criteria for success of dental implants were: after completion of implantation, the patient' gingiva was in good health condition, absence of abnormal swelling; no postoperative infection, numbness or pain; no occurrence of obvious bone mass absorption, and the masticatory function of teeth was basically recovered. Patient satisfaction was assessed by subjective judgment of the patients [11].

(2) Statistics of alveolar resorption were observed at 12, 36 and 60 months, respectively; and the data of the two groups were collected for comparison. The alveolar bone height and resorption were compared between the two groups. Dental X-ray films were taken prior to and 12 months after dental implants rehabilitation to measure the distance from alveolar ridge crest to the cement-enamel junction (CEJ) of adjacent teeth. Absorption value was set as differences between actual measurements at two different time points [12].

(3) Determination of periodontal indexes after dental implants insertion: The four periodontal indexes, including peri-implant sulcular fluid (PISF), periodontal probing depth (PPD), modification sulcus bleeding index (mSBI) and attachment loss (AL), were evaluated.

PISF: Dental isolation was performed in the fluid intake area, ie. The fluid intake area for the affected teeth and the control teeth were cleaned with sterile cotton balls and dried gently. Sterilized, weighed and documented dental absorbent paper points were placed in the gingival sulcus on the facial/buccal side. 60 seconds later, dental absorbent paper points were taken out, weighed and recorded. The peri-implant sulcular fluid volume was the difference between the weights of the dental absorbent points before and after intaking GCF [13].

PPD: Full-mouth periodontal probing depth was performed using conventional periodontal probing for each patient. The probing depth (PD) values were recorded at 6 sites (mesial-buccal, midbuccal, distalbuccal, mesiallingual, midlingual, and distallingual sites) [14].

mSBI: Pressure-controlled plastic probes were used for probing along the gingival margin of the implant with a probing force of 0.2 N (approximately 20 g). 0 indicates no bleeding on probing; 1 indicates punctate bleeding; 2 linear bleeding in gingival sulcus; and 3 severe bleeding [15].

Table 1. Indexes and scoring criteria of PES

Indexes	Loss	Incomplete	Complete
Distal gingival papilla	0	1	2
Mesial gingival papilla	0	1	2
Soft tissue level	0	1	2
Soft tissue shape	0	1	2
Soft tissue color	0	1	2
Soft tissue texture	0	1	2
Loss of alveolar process	0	1	2

Note: PES, pink esthetic score.

Clinical AL: The measurement ranged from the neck of the implant to the bottom of the probing pocket, with the recording unit of mm. The above parameters were measured at 6 sites (esialbuccal, midbuccal, distalbuccal, mesiallingual, midlingual, and distallingual sites) of each implant, and the mean values were calculated [14].

(4) Soft tissue aesthetic rehabilitation: The pink esthetic score (PES) was applied to evaluate soft tissue aesthetic rehabilitation at the completion of dental implant rehabilitation and 12 months after rehabilitation, including the height of gingival papilla, soft tissue level, contour and color quality on both sides. As for the PES scale, the scoring of each item ranged from 0 to 2 scores, with the sum score of all items up to 14. A higher score indicated better aesthetic effect. See **Table 1** [11].

Statistical analysis

A statistical analysis was performed on the post-operative observed data. The success and patient satisfaction rates 6, 12, 36 and 60 months after surgery between two groups were analyzed with the use of the chi-square test, and the *P* values were calculated. The five indexes of PPD, mSBI, AL, PISF and PES of the two groups were statistically analyzed at the above time points, respectively, and the means and variance were calculated. In addition, the data of both groups were compared by a t-test, and the *P* values were calculated. P<0.05 indicates that the difference was statistically significant.

Results

Patient information

Ninety-eight patients were enrolled in this study. The total number of teeth was 106 (Detailed information is present **Table 2**). In the test group (patients with chronic periodontitis, n = 48, number of teeth = 52), 28 patients were male, and 20 were female; the age ranged from 18 to 52 years old, with a mean age of 42.1±7.5 years old. There were 31 males and 19 females in the control group (patients without chronic periodontitis, n = 50, number of teeth = 54); the age ranged from 8 to 50 years old, with a mean age of 44.7±9.6 years old. There was no statistically significant difference in age of the patients (P>0.05). The number of patients with bad habits was significantly greater in the test group than in the control group, and the difference was statistically significant between the two groups (P<0.05). In addition, there were significant differences in acquired injury and pathological causes between the two groups (P<0.05). This indicates that bad habits may be directly related to the occurrence of chronic periodontitis.

Comparison of success rates and patient satisfaction with dental implant rehabilitation

The success rates of the two groups were measured 6, 12, 36 and 60 months after dental implant rehabilitation, and the differences were compared using the chi-square test. The detailed results are presented in **Table 3**. The results show that the *P* values for the comparison between the test group and the control group were 0.801 and 0.940 at 6 and 12 months after implantation, respectively, indicating no significant difference. However, at 36 and 60 months after implantation, there were significant differences in the success rates of dental implants between the two groups (both P<0.05). The patients with chronic periodontitis had significantly lower rates of success and patient satisfaction than those without chronic periodontitis (**Table 3**).

Alveolar resorption after dental implants

The results of retesting the alveolar absorption of the two groups were summarized at 12, 36 and 60 months. It indicates that the mean values of the alveolar absorption at the three time points were significantly higher in patients with chronic periodontitis (1.27 mm, 1.46 mm, and 2.13 mm, respectively) than those in patients without chronic periodontitis (0.36 mm, 0.51 mm, and 0.60 mm, respectively). The details are shown in **Table 4**.

Table 2. Basic statistics of patients

Group	Test group	Control group	t/χ^2	P
Age (years)	42.1±7.5	44.7±9.6	1.490	0.140
History of past treatment	25	18	2.572	0.109
Bad habits				
Smoke	18	9	4.665	0.031
Excessive drinking	11	3	5.723	0.017
Stay up late often	24	13	6.002	0.014
Classification of etiology				
Congenital absence	6	12	2.160	0.142
Acquired injury	8	28	20.494	0.000
Pathological causes	34	10	25.579	0.000
Gender			0.137	0.711
Male	28	31		
Female	20	19		
Total number of people	48	50	0.082	0.775

Table 3. Comparison of clinical effects between two groups

Observation time	Test group (n = 52)	Control group (n = 54)	χ^2	P
6 months				
Success	47 (90.38%)	48 (88.89%)	0.064	0.801
Satisfaction	46 (88.46%)	48 (88.89%)	0.062	0.923
12 months				
Success	45 (86.54%)	47 (87.04%)	0.058	0.94
Satisfaction	44 (84.62%)	46 (85.19%)	0.057	0.962
36 months				
Success	31 (59.62%)	44 (81.48%)	6.121	0.013
Satisfaction	29 (55.77%)	44 (81.48%)	8.346	0.008
60 months				
Success	30 (57.70%)	43 (79.63%)	5.946	0.015
Satisfaction	29 (55.77%)	43 (79.63%)	6.922	0.009

Table 4. Comparison of alveolar absorption (mm)

Observation time (months)	12	36	60
Test group	1.27±0.06	1.46±0.07	2.13±0.70
Control group	0.36±0.05	0.51±0.08	0.60±0.15
t	84.946	66.148	15.641
P	0.000	0.000	0.000

Comparison of relevant periodontal indexes after dental implant rehabilitation

After dental implant rehabilitation, observations of the periodontal indexes of patients showed that the PPD was 3.43 mm in the test group, and 1.50 mm in the control group (**Table 5**), and the mSBI 0.65 and 0.16 (**Table 6**), respectively. The PISF, PPD and mSBI values of the test group were all significantly higher than those of the control group (all P<0.05); but there was no significant difference in AL values (P>0.05). The PISF volume was significantly higher in the test group than that in the control group at each time point (P<0.05) (**Figure 1A**). There was no significant difference in AL between the two groups at 6 months (P>0.05). At 12, 36 and 60 months, however, the AL of the test group was significantly higher (P<0.05; **Figure 1B**).

Comparison of soft tissue aesthetic effects after dental implant rehabilitation

The two groups were compared in the scores by the PES at completion of dental implant rehabilitation and 12 months after rehabilitation, respectively. The final results reveal that there were no significant differences in the scores between the two groups at completion of rehabilitation (P> 0.05). The score of the control group was 13.35±3.21, while that of the test group was only 10.23±2.94, and the difference was significant (P<0.05; **Table 7**).

Discussion

It is reported that 50% of all the patients with teeth loss in China are caused by periodontal diseases which have become a critical risk factor for dentition defects or tooth loss. An important manifestation of chronic periodontitis is the persistent alveolar absorption of patients, which leads to more serious dental problems [16].

For the dental implant and prosthetics technology, dentition defect or tooth loss has been

Table 5. Comparison of PPD values between the two groups (mm)

Group	PPD (6 months)
Test group	3.43±0.44
Control group	1.50±0.80
t	15.307
P	0.000

Note: PPD, periodontal probing depth.

Table 6. Comparison of mSIBI values between the two groups

Group	mSIBI (6 months)
Test group	0.65±0.02
Control group	0.16±0.04
t	78.810
P	0.000

Note: mSBI, modification sulcus bleeding index.

studied for many years in China and abroad. There are many kinds of prosthetic techniques, and the criteria for evaluating prosthetics are also in many ways [17]. The alveolar absorption, PISF, PPD, mSBI, AL and aesthetics after dental rehabilitation were used as indexes for clinical evaluation [18, 19].

In this paper, the clinical evaluation of chronic periodontitis after dental implant rehabilitation is primarily reflected in the following aspects.

First, results from comparison of patients' data demonstrate that bad habits were directly related to the presence of chronic periodontitis in patients undergoing dental implant prosthesis. It is reported that prevention and reduction of systemic diseases, nutrition improvement and body immunity strengthening can increase the disease resistance of periodontal tissues. Good oral hygiene, and abstinence from habits harmful to periodontal tissues, including smoking, drinking, and unilateral chewing, can drop the incidence of periodontitis [20].

Second, patients with chronic periodontitis may form osseointegration of dental implants in the early stage after implantation. Their alveolar absorption values over time are more significantly different from those of patients without chronic periodontitis. Many studies have reported that the long-term efficacy of dental implant rehabilitation in patients with chronic periodontitis was significantly inferior to that of patients without chronic periodontitis. The alveolar absorption was significantly higher after long-term loading, which is consistent with the result of this study [21]. Some scholars believe that immediate dental implant is a good method for treatment of tooth loss due to chronic periodontitis. However, other researchers believe that patients with chronic periodontitis should be treated with controlled therapy prior to dental implant rehabilitation based on the symptoms of patients [22]. In a lot of literature, the investigators have reached a consensus that the technology of dental implants and prosthetics can be characterized by alveolar absorption after dental implant rehabilitation [23].

Third, comparison between patients with chronic periodontitis and those without chronic periodontitis in periodontal indexes after dental implant rehabilitation shows the PISF, PPD and mSBI values of patients with chronic periodontitis were significantly higher than those of patients without chronic periodontitis at 6 months; but there was no significant difference in AL value. With the prolonged loading time, there were significant differences in the four periodontal indexes, and the results are similar to those of the study from Jin et al. [24]. Since periodontitis is a chronic disease arising from mixed anaerobic bacteria infection, and chronic infectious diseases affecting periodontal tissues may be caused by many factors. However, after dental implant rehabilitation, peri-mucositis and peri-implantitis are prone to occur, resulting in the increase in PISF, PPD, mSIBI and AL values [25-27]. In addition, according to the comparison of soft tissue aesthetic effects after dental implant rehabilitation, the effect of tissue rehabilitation in patients with chronic periodontitis after dental implant placement is not ideal, which impacts the success rates of dental implants and the subjective satisfaction of patients. Hence, for patients with chronic periodontitis, persistent periodontal treatment and oral health can increase success of dental implants [28].

However, this paper was only designed to compare the periodontal indexes between patients with chronic periodontitis and those without chronic periodontitis. No follow-ups were performed for the periodontal indexes before and after dental implant placement in patients with chronic periodontitis. Thus, if we want to show more complete changes in the periodontal indexes of patients with chronic periodontitis after dental implant placement, collection of

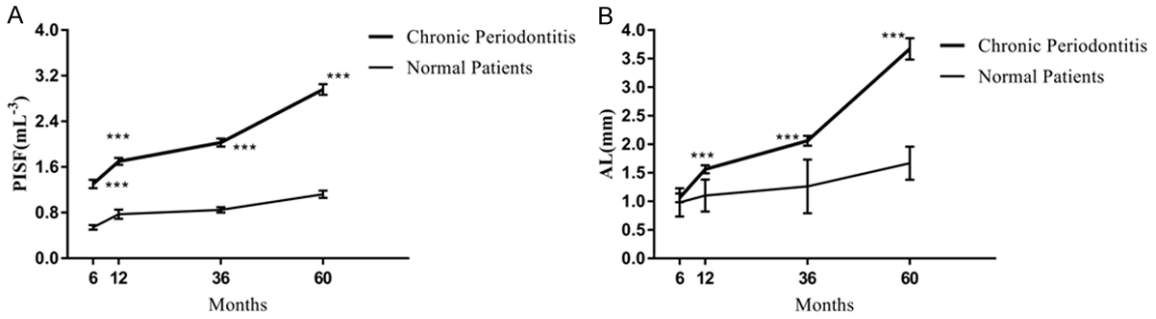

Figure 1. Comparison of PISF and AL value between the two groups. A. PISF, peri-implant sulcular fluid; B. AL, attachment loss. Compared with control group, ***P<0.001.

Table 7. Comparison of PES scores between the two groups after dental implant rehabilitation

Group	PES	
	Repair completed	12 months after repair
Test group	9.85±2.51	10.23±2.94
Control group	9.65±2.39	13.35±3.21
t	0.420	5.212
P	0.675	0.000

Note: PES, pink esthetic score.

patients' data on the physiological indexes of the periodontium before and after implantation is still needed for further validation.

In summary, compared with the control group, the test group had a higher failure rate of long-term loading after dental implant placement, which caused other health problems concerning the periodontium. It may affect the soft tissue aesthetic rehabilitation after implantation and result in lower patient satisfaction. Therefore, the periodontal indexes of patients with periodontitis should be considered in the conduct of dental implant rehabilitation, and relevant treatment should be conducted to ensure the success of long-term loading. In addition, the periodontal indexes after dental implants should be monitored to assure the success rate of implantation and patient satisfaction.

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Disclosure of conflict of interest

None.

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