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*Original Article*

# Dental implant restoration for dentition defects improves clinical efficacy, masticatory function and patient comfort

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**Abstract:** Objective: The aim of this study is to demonstrate if dental implant restoration can improve the clinical efficacy, masticatory function and comfort in patients with dentition defects. Methods: The clinical data of 90 patients with single tooth loss treated in Yuyao People's Hospital of Zhejiang Province from May 2018 to May 2020 were analyzed retrospectively. The patients were enrolled and divided into two groups. The control group (CG; n=45) was intervened by traditional fixed partial denture (FPD) restoration, and the observation group (OG; n=45) was treated with dental implant restoration. The clinical efficacy was evaluated, and amelioration of tooth-related indexes and clinical indicators 2 years after treatment were observed. The improvement of masticatory function and comfort scores were compared. The adverse reactions during treatment were recorded, and patients' satisfaction with the treatment was calculated. Logistic regression was performed to assess the independent risk factors for inefficacy of the treatments. Results: After treatment, the OG presented with lower gingival index, plaque index and sulcus bleeding index.

**Keywords:** Dental implant restoration, dentition defect, clinical efficacy, masticatory function, comfort

## Introduction

Dentition defect refers to the incomplete dentition of permanent teeth caused by partial tooth loss, which can lead to decreased masticatory function as well as a variety of complications such as dysphonia, periodontal tissue changes and unbalanced tension of unilateral masticatory muscles, seriously affecting the patients' quality of life (QoL) [1, 2]. Clinical results have shown that the degree of influence varies with the location and number of teeth with missing dentition, so the restoration of dentition defects is of crucial importance [3]. The method of restoration after tooth extraction is often used clinically. However, the loss of alveolar bone mass after tooth extraction not only increases the difficulty and risk of implant, but also aggravates the economic burden of patients [4]. With the development of clinical dental implantology in recent years, dental implants have opened up a new path for the clinical treatment of dentition defects, with advantages of natural tooth function and aesthetic tooth structure [5]. Therefore, this study focused on finding ways to improve the quality outcome of dental restorations and to facilitate dental rehabilitation.

The main principle of restorative treatment is to use the adjacent teeth to share the chewing function of the missing teeth [6]. Indeed, the traditional restoration scheme can restore the anatomical morphology and physiological function of the missing tooth and its surrounding defect tissue to a certain extent [7]. Yet, the need to grind away the normal dental tissues of the adjacent teeth not only affects the comfort of patients, but also results in an accumulation of food debris between the denture and the natural teeth, which poses a serious threat to the health of the oromandibular system [8]. With the advances in science and technology, implant restoration now has a wider range of indications and a superior therapeutic value [9]. Oral implant restoration, a restorative modality in which the implant is supported by a substruc-

ture implanted in the bone tissue, while the upper part restores the missing tooth with a denture, consists of three parts: the implant, the abutment and the upper dental restoration [10]. The implants are made of artificial materials (metals, ceramics, etc.) similar to the shape of tooth roots, which are surgically implanted into the tissue to obtain firm retention of bone tissues, and link and support the upper dental prosthesis through special devices [11]. Literature has shown that dental implant restoration avoids damage to other bone tissues, reduces the incidence of other diseases and improves the treatment effect because it directly connects the implant with the bone tissue [12].

This study aims to provide a reference basis for treating patients with dental defects by comparing traditional fixed restorations with implant restorations by observing tooth-related indices, masticatory function, comfort and satisfaction of patients.

## Materials and methods

### *General data*

The clinical data of 90 patients with single tooth loss who were admitted to the Yuyao People's Hospital of Zhejiang Province between May 2018 and May 2020 were reviewed in this study. The patients were divided into two groups according to different treatment modalities: an observation group (OG) and a control group (CG), each with 45 patients. The CG was intervened with traditional fixed partial denture (FPD) and the OG was treated with dental implant restoration. The Ethics Committee of Yuyao People's Hospital of Zhejiang Province ratified this study (2022-03-001), and the subjects and their guardians were informed and signed a fully informed consent form. Inclusion criteria: (1) patients who were diagnosed with dentition defects [13]; (2) patients with absence of single tooth position; (3) patients who were aged from 18 to 80 years old; (4) patients with mesial and distal spaces of the missing tooth of 3.43-4.79 mm, and a degree of looseness of bilateral adjacent teeth of ≤ I; (5) patients with complete medical records. Exclusion criteria: (1) patients with mental illness or cognitive impairment; (2) patients with other oral diseases; (3) patients with poor treatment compliance; (4) patients who were lost to follow-up.

### *Methods*

1. Collection of cases: All patients with dental defects admitted to Yuyao People's Hospital of Zhejiang Province between May 2018 and May 2020 were enrolled to this study.

2. Case selection: Patients with single tooth loss were selected based on inclusion and exclusion criteria.

3. Grouping and data collection: The data of cases meeting the criteria were collected, and patients were divided into two groups of 45 cases each. The surgical observation indexes, questionnaires, incidence of adverse reactions and efficacy were recorded and registered in the forms.

### *Outcome measures*

1. Tooth-related indexes: The following tooth-related indexes were observed after treatment: gingival index (GI): on a 0-3 point scale, the score was in proportion to the severity of the gingival inflammation; plaque index (PLI): on a 0-3 point scale, and higher scores after treatment indicate more severe gingival bleeding; sulcus bleeding index (SBI): on a 0-4 point scale, and the higher the score after treatment, the more serious the gingival bleeding [14].

2. Comparison of clinical indicators: The aesthetic degree, retention function and language function, each scored 10 points, were observed in both groups after treatment. Higher scores indicate better repair effects [15].

3. Masticatory function score: A self-made questionnaire (0-100 points) developed by Yuyao People's Hospital of Zhejiang Province was used to observe patients' masticatory function before and after treatment. The higher the score after treatment, the better the recovery of chewing function.

4. Comfort score: A self-made questionnaire (0-100 points) developed by Yuyao People's Hospital of Zhejiang Province was employed for the assessment of patient comfort before and after treatment. The higher the score after treatment, the better the comfort and dental function recovery.

5. Clinical efficacy: Markedly effective: the patient's dentition was basically repaired with-

**Table 1.** General data of patients in both groups [n (%)] (mean ± SD)

| Classification | Observation group (n=45) | Control group (n=45) | $t/\chi^2$ | P |
|---|---|---|---|---|
| Sex | | | 0.741 | 0.389 |
| Male | 29 (64.44) | 25 (55.56) | | |
| Female | 16 (35.56) | 20 (44.44) | | |
| Average age (years old) | 53.82±5.17 | 53.13±5.06 | 0.640 | 0.524 |
| BMI ($kg/m^2$) | 27.37±2.67 | 26.58±2.45 | 1.462 | 0.147 |
| Mean course of disease (months) | 2.89±0.80 | 2.80±0.81 | 0.530 | 0.597 |
| Place of residence | | | 0.776 | 0.378 |
| Urban | 31 (68.89) | 27 (60.00) | | |
| Rural | 14 (31.11) | 18 (40.00) | | |
| Educational background | | | 0.178 | 0.673 |
| ≥ High school | 22 (48.89) | 24 (53.33) | | |
| < High school | 23 (51.11) | 21 (46.67) | | |
| History of smoking | | | 0.526 | 0.468 |
| Yes | 32 (71.11) | 35 (77.78) | | |
| No | 13 (28.89) | 10 (22.22) | | |
| History of drinking | | | 0.829 | 0.362 |
| Yes | 33 (73.33) | 29 (64.44) | | |
| No | 12 (26.67) | 16 (35.56) | | |
| Tooth-brushing time | | | 0.756 | 0.385 |
| ≥ 2 minutes | 15 (33.33) | 19 (42.22) | | |
| <2 minutes | 30 (66.67) | 26 (57.78) | | |
| Dentition defect site | | | 0.185 | 0.667 |
| Molar area | 26 (57.78) | 28 (62.22) | | |
| Posterior molar area | 19 (42.22) | 17 (37.78) | | |
| Causes of disease | | | 1.265 | 0.531 |
| Trauma | 15 (33.33) | 17 (37.78) | | |
| Dental lesions | 18 (40.00) | 13 (28.89) | | |
| Periodontal diseases | 12 (26.67) | 15 (33.33) | | |
| Chewing-side preference | | | 0.200 | 0.656 |
| Yes | 31 (68.89) | 29 (64.44) | | |
| No | 14 (31.11) | 16 (35.56) | | |

body mass index (BMI).

out loosening and falling off, and the chewing function basically recovered normal. Effective: the patient's dentition was well repaired after treatment, with mild loosening, improved masticatory function and occasional pain. Ineffective: the denture with missing dentition became loose or even fell off, and the chewing function did not improve. Overall response rate = (markedly effective + effective) cases/total cases * 100%.

6. Adverse reactions (ARs): ARs such as gingivitis, loosening of abutment teeth and periapical periodontitis were observed in both groups.

7. Satisfaction: Patients were invited to score their satisfaction with a questionnaire made by Yuyao People's Hospital of Zhejiang Province (full score: 100 points). A score of 90 points or more represented satisfaction, 70-90 points for basic satisfaction, and less than 60 points for dissatisfaction.

*Statistical analysis*

SPSS20.0 (IBM Corp, Armonk, NY, USA) was used for statistical analysis and GraphPad Prism 7 for graphics plotting. The categorical data, expressed by [n (%)], were analyzed by Chi-square test or continuity correction Chi-square test in case the theoretical frequency in the Chi-square test was less than 5 between groups. The quantitative data were expressed by mean ± SD, and the difference between

**Table 2.** Comparison of tooth-related indexes between the two groups before and after treatment (mean ± SD)

| Group | n | GI (points) | PLI (points) | SBI (points) |
|---|---|---|---|---|
| Observation group | 45 | 0.95±0.21 | 0.87±0.19 | 1.46±0.38 |
| Control group | 45 | 1.75±0.34 | 1.65±0.31 | 2.58±0.57 |
| t | - | 13.430 | 14.390 | 10.970 |
| P | - | <0.001 | <0.001 | <0.001 |

Gingival index (GI), Plaque index (PLI), Sulcus bleeding index (SBI).

**Table 3.** Comparison of clinical indicators between the two groups after treatment (mean ± SD)

| Group | n | Aesthetic degree | Retention function | Language function |
|---|---|---|---|---|
| Observation group | 45 | 9.25±1.65 | 8.93±1.54 | 9.34±1.37 |
| Control group | 45 | 6.13±1.04 | 7.09±1.21 | 7.23±1.14 |
| t | - | 10.730 | 6.302 | 7.942 |
| P | - | <0.001 | <0.001 | <0.001 |

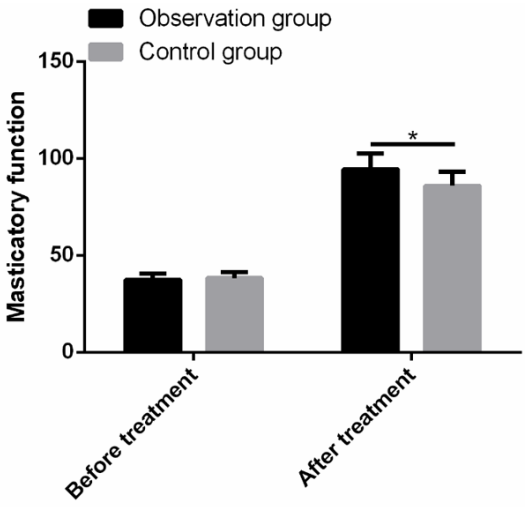


**Figure 1.** Comparison of masticatory function scores before and after treatment. There was no significant difference in the masticatory function score before treatment, but the masticatory function score in the observation group was higher than that in the control group after treatment. Note: * indicates P<0.05 between the two groups after treatment.

groups was determined by independent sample t-test and that before and after treatment by paired t-test. A significance level of P<0.05 was used in all analyses.

## Results

*General data*

No significant difference was found in clinical baseline data including sex, average age, body mass index, average course of disease, residence, education background, smoking history, drinking history, tooth-brushing time, dentition defect location, cause of disease and chewing-side preference (P>0.05). See **Table 1**.

*Comparison of pre- and post-treatment tooth-related indexes*

After treatment, there were differences in tooth related indexes (GI, PLI and SBI) between the two groups (P<0.001), with notably lower indexes in the OG than those in the CG (P<0.001). See **Table 2**.

*Comparison of clinical indicators after treatment*

After treatment, the scores of clinical indicators aesthetic degree, retention function and language function were notably higher in the OG as compared to those in the CG (P<0.001). See **Table 3**.

*Comparison of pre- and post-treatment masticatory function scores*

The masticatory function score was similar in the OG and the CG before treatment (P>0.05), while the score reduced markedly in both groups after treatment (P<0.05), especially in the OG (P<0.05). See **Figure 1**.

*Comparison of curative efficacy between the two groups after treatment*

The efficacy of the two groups after treatment was compared. The overall response rate was 93.33% in the OG and 75.56% in the CG, with a distinct difference between the two groups (P<0.05). See **Table 4**.

*Comparison of adverse reactions during treatment between the two groups*

The total incidence of adverse reactions after treatment in the OG (4.44%) was dramatically lower than that in the CG (17.78%), with remarkable difference (P<0.05). See **Table 5**.

*Comparison of satisfaction between two groups after treatment*

After treatment, the satisfaction of the OG was 91.11%, which was notably higher than that in the CG (75.56%) (P<0.05). See **Table 6**.

**Table 4.** Comparison of efficacy between the two groups after treatment [n (%)]

| Efficacy | Observation group (n=45) | Control group (n=45) | $\chi^2$ | P |
|---|---|---|---|---|
| Markedly effective | 24 (53.33) | 12 (26.67) | - | - |
| Effective | 18 (40.00) | 22 (48.89) | - | - |
| Ineffective | 3 (6.67) | 11 (24.44) | - | - |
| Total response rate | 42 (93.33) | 34 (75.56) | 5.414 | 0.020 |

**Table 5.** Adverse reactions during treatment [n (%)]

| Groups | n | Gingivitis | Abutment teeth loosing | Periapical periodontitis | Total incidence of adverse events (%) |
|---|---|---|---|---|---|
| Observation group | 45 | 1 (2.22) | 0 (0.00) | 1 (2.22) | 2 (4.44) |
| Control group | 45 | 2 (4.44) | 3 (6.67) | 3 (6.67) | 8 (17.78) |
| $\chi^2$ | - | 0.345 | 3.103 | 1.047 | 4.050 |
| P | - | 0.557 | 0.078 | 0.306 | 0.044 |

**Table 6.** Comparison of satisfaction between the two groups after treatment [n (%)]

| Groups | n | Satisfied | Basically satisfied | Dissatisfied | Satisfaction (%) |
|---|---|---|---|---|---|
| Observation group | 45 | 30 (66.67) | 11 (24.44) | 4 (8.89) | 41 (91.11) |
| Control group | 45 | 15 (33.33) | 19 (42.22) | 11 (24.44) | 34 (75.56) |
| $\chi^2$ | - | - | - | - | 3.920 |
| P | - | - | - | - | 0.047 |

*Univariate analysis of factors related to ineffective outcomes of patients*

All patients were classified into an effective group and an ineffective group according to the response to the treatment. The clinical data of both groups revealed statistical differences in average age, mean course of disease, history of smoking, history of drinking, tooth-brushing time, chewing-side preference and treatment methods between patients with an effective outcome and those with an ineffective outcome ($P<0.05$). See **Table 7**.

*Multifactorial analysis of ineffective outcomes of patients*

We included the indicators that revealed in the univariate analysis for assignment (**Table 8**). Multifactorial logistic regression analysis performed by LR manifested that mode of treatment (OR: 0.019, 95% CI: 0.001-0.360), average age (OR: 0.019, 95% CI: 0.001-0.360), mean course of disease (OR: 0.691, 95% CI: 0.482-0.988), history of drinking (OR: 0.047, 95% CI: 0.002-0.949), and chewing-side preference (OR: 0.035, 95% CI: 0.002-0.775) were independent risk factors for ineffective outcomes. See **Table 9**.

## Discussion

Dentition defect, a common disease in the Stomatology Department, predisposes patients to a variety of clinical symptoms, which not only compromise their comfort and QoL, but also affect their pronunciation, chewing and eating functions [16]. In severe cases, the defect can adversely impact the interpersonal communication of patients, giving rise to negative emotions such as inferiority [17]. With the development of economy and the demand for better QoL, people attach increasing importance to oral health [18]. Therefore, it is particularly important to find a more effective ways to treat dentition defects and promote the dental rehabilitation of patients.

Previously, fixed prosthesis was the main approach for repairing dentition defects in clinic, with certain effects. However, the economic applicability of this approach is not good, and prostheses are prone to fall off and loosen during wearing, affecting the treatment experience of patients [19]. In this study, we compared the treatment protocols of both groups and found that the masticatory function of patients with oral implant restorations for tooth loss was markedly improved and they gave positive feed-

**Table 7.** Factors for univariate analysis

| Classification | Total effective group (n=76) | Ineffective group (n=14) | $t/\chi^2$ | P |
|---|---|---|---|---|
| Sex | | | 0.691 | 0.406 |
| Male | 47 (61.84) | 7 (50.00) | | |
| Female | 29 (38.16) | 7 (50.00) | | |
| Average age (years) | 52.68±5.00 | 57.79±3.17 | 3.680 | <0.001 |
| BMI ($kg/m^2$) | 27.01±2.56 | 26.79±2.80 | 0.291 | 0.772 |
| Mean course of disease (months) | 2.76±0.75 | 3.29±0.99 | 2.307 | 0.023 |
| Residence | | | 0.386 | 0.535 |
| Urban | 50 (65.79) | 8 (57.14) | | |
| Rural | 26 (34.21) | 6 (42.86) | | |
| Educational background | | | 0.241 | 0.623 |
| ≥ High school | 38 (50.00) | 8 (57.14) | | |
| < High school | 38 (50.00) | 6 (42.86) | | |
| History of smoking | | | 5.691 | 0.017 |
| Yes | 53 (69.74) | 14 (100.00) | | |
| No | 23 (30.26) | 0 (0.00) | | |
| History of drinking | | | | |
| Yes | 49 (64.47) | 13 (92.86) | 4.444 | 0.035 |
| No | 27 (35.53) | 1 (7.14) | | |
| Tooth-brushing time | | | 3.892 | 0.049 |
| ≥ 2 minutes | 32 (42.11) | 2 (14.29) | | |
| <2 minutes | 44 (57.89) | 12 (85.71) | | |
| Dentition defect site | | | 0.059 | 0.812 |
| Molar area | 46 (60.53) | 8 (57.14) | | |
| Posterior molar area | 30 (39.47) | 6 (42.86) | | |
| Causes of disease | | | 1.295 | 0.524 |
| Trauma | 23 (30.26) | 6 (42.86) | | |
| Dental lesions | 27 (35.53) | 3 (21.43) | | |
| Periodontal diseases | 26 (34.21) | 5 (35.71) | | |
| Chewing-side preference | | | 5.117 | 0.024 |
| Yes | 47 (61.84) | 13 (92.86) | | |
| No | 29 (38.16) | 1 (7.14) | | |
| Mode of treatment | | | 5.414 | 0.020 |
| Implant restoration | 42 (55.26) | 3 (21.43) | | |
| Fixed partial denture | 34 (44.74) | 11 (78.57) | | |

back on the comfort of the treatment. Kulkarni et al. have found that dental implants are the main treatment for tooth loss, which can effectively improve the GI, PLI and SBI of patients [20]. This study also compared the impact of these two treatment methods on patients' tooth-related indexes. Our results showed notably lower GI, PLI and SBI in the OG than those in the CG after treatment, suggesting that dental implant restoration has less influence on the flora in patients' oral cavity, causes less irritation to the inflammation of gums and other soft tissues around the teeth, and improves the periodontal health of patients. Generally, adjacent teeth are used as abutments in conventional restoration, but due to periodontal tissue and retention effect, masticatory function cannot be completely restored [21]. The study of Ramaglia showed that dental implant restoration effectively improved dental aesthetics and chewing function of patients [22]. In this research, it was found that the scores of aesthetics, retention function, language function and chewing function were evidently higher in the OG compared with those in the CG after treatment. This indicates that compared with

**Table 8.** Assignment table

| Factor | Assignment |
|---|---|
| Average age | Data are continuous variables analyzed using raw data |
| Mean course of disease | Data are continuous variables analyzed using raw data |
| History of smoking | Yes =1, No =0 |
| History of drinking | Yes =1, No =0 |
| Tooth-brushing time | ≥ 2 minutes =1, <2 minutes =0 |
| Chewing-side preference | Yes =1, No =0 |
| Mode of treatment | Implant restoration =1, FPD =0 |

**Table 9.** Factors in multifactorial analysis

| Factor | B | S.E | Wals | Sig. | Exp (B) | 95% C.I. of EXP (B) | |
|---|---|---|---|---|---|---|---|
| | | | | | | lower limit | upper limit |
| Mode of treatment | -3.963 | 1.501 | 6.975 | 0.008 | 0.019 | 0.001 | 0.360 |
| Average age | -0.370 | 0.183 | 4.098 | 0.043 | 0.691 | 0.482 | 0.988 |
| Mean course of disease | -1.452 | 0.676 | 4.619 | 0.032 | 0.234 | 0.062 | 0.880 |
| History of drinking | -3.060 | 1.535 | 3.976 | 0.046 | 0.047 | 0.002 | 0.949 |
| Chewing-side preference | -3.348 | 1.578 | 4.502 | 0.034 | 0.035 | 0.002 | 0.775 |

FPD restoration, dental implant restoration can better improve the aesthetics of teeth, facilitate the recovery of chewing and swallowing functions, and enable patients to eat normally. A study by Chang et al. [23] likewise compared the results of implant restorations with conventional restoration in dental defects and again found that patients with implant restorations had better verbal, masticatory and aesthetic scores. At the same time, the inflammation caused by the implant restoration was less than that by conventional methods and therefore resulted in a lower incidence of complications, which is similar to our results. The reason for this may be that implant restorations can reduce the destructive effect on periodontal tissues, reduce marginal bone resorption of implants, and effectively improve clinical success and retention. Also, dental implants are less damaging to the teeth as they do not use roots and clasps, offer better comfort, less foreign body sensation for patients, and have no impact on pronunciation or swallowing. This research also denoted that mode of treatment, average age, mean course of disease, history of drinking, and chewing-side preference were independent risk factors for ineffective outcomes.

Although this study confirmed that dental implant restoration was highly effective in the treatment of dentition defects, there is still room for improvement. First, as a retrospective study, some bias is unavoidable. Second, included patients tended to be older, so it is hoped that younger individuals will be included in subsequent studies.

To sum up, the intervention of dental implant restoration in patients with dentition defect can improve the treatment effect, masticatory function, teeth related indexes and patient comfort.

## Disclosure of conflict of interest

None.

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