Int J Clin Exp Med 2019;12(7):8694-8701
www.ijcem.com /ISSN:1940-5901/IJCEM0091932

Original Article

The clinical efficacy of orthodontic treatment and implant restoration in the treatment of malocclusion with dentition defects and their impact on patients' quality of life

Jiamei Peng[1], Jianfen Fan[2]

[1]*Department of Stomatology, The Affiliated Jiangyin Hospital of Medical College of Southeast University, Jiangyin 214400, Jiangsu, China;* [2]*Jiangyin Oral Disease Preventive Treatment, Jiangyin, Jiangsu, China*

Received January 28, 2019; Accepted April 11, 2019; Epub July 15, 2019; Published July 30, 2019

Abstract: Objective: To explore the clinical efficacy of orthodontic treatment and implant restoration in the treatment of malocclusion with dentition defects and their impact on patients' quality of life. Method: 150 patients with malocclusion and dentition defects were randomly divided into an observation group and a control group, with 75 cases in each group. Patients in the control group were treated with implant restoration alone. Patients in the observation group were treated with orthodontic implants combined with implant restoration. The total effective rate of treatment, plaque index, attachment loss index, language function, chewing function, and teeth fixation, treatment satisfaction, and quality of life were compared between the two groups. Result: The total effective rate of the observation group was significantly higher than the rate of the control group ($P<0.05$); The plaque index and attachment loss index of the two groups were significantly lower than they were before treatment, but those of the observation group were more significant than those of the control group ($P<0.05$); the language function, chewing function and scores of teeth fixation of the observation group were significantly higher than those of the control group ($P<0.05$). The total satisfaction of treatment in the observation group and the quality of life after 3 months of treatment were significantly higher than they were in the control group ($P<0.05$). Conclusion: Orthodontic combined implant restoration treatment can effectively improve the dental function of patients with malocclusion and dentition defects as well as patients' satisfaction and quality of life.

Keywords: Orthodontic treatment, implant restoration, malocclusion with dental defects, curative effect analysis, living quality

Introduction

In recent years, with the improvement of living standards and health care awareness, people are paying more and more attention to oral health [1]. Dentition defects are a common oral disease in clinical practice, which mainly refers to an incomplete state of dentition in part of the patient's teeth [2]. According to relevant research reports, most patients with dentition defects also have different degrees of teeth deformity and malocclusion [3]. However, malocclusion with dentition defects is not only bad for the patients' teeth aesthetics, but also has a serious impact on chewing and the other dental functions of patients. Impaired chewing function of teeth can affect the gastrointestinal digestive function and the intake of nutrients and will have a serious impact on the quality of life and physical and mental health of the patients [4].

At present, implant restoration is a commonly used method in the clinical treatment of malocclusion. Although it has a certain therapeutic effect, it is still not ideal for the patients in terms of teeth aesthetics and functional recovery of the teeth, which cannot meet the patient's treatment needs [5, 6]. Therefore, it is urgent to find a treatment method that can not only achieve the therapeutic effect but also restore the appearance and function of teeth in the clinic. With the rapid development of medical technology and restoration materials, more

and more methods have been applied to malocclusion with dentition defects [7]. Studies have shown that if orthodontic treatment is performed on patients with dentition loss before implant restoration, the overall treatment effect will be more significant, and the patients' needs for dental function and aesthetics can be met [8]. Some studies [9] indicated that orthodontic treatment before implantation and restoration can provide better conditions for subsequent implant restoration, and ultimately achieve the unification of restoring tooth function and oral aesthetics.

In order to further verify the application effect of implant restoration combined with orthodontics in malocclusion with dentition defects, the effect of treatment with implant restoration alone and that of treatment with implant restoration and orthodontics was compared, in order to provide a more theoretical basis for the treatment of malocclusion with dentition defects.

Materials and methods

General information

A total of 150 patients with malocclusion and dentition defects admitted to our hospital were selected, including 87 males and 63 females. The patients were randomly divided into the observation group and the control group, with 75 cases in each group. The average age was (27.31±8.65) years. According to the Angle classification, the patients were classified as 45 cases of class I, 57 cases of class II, and 48 cases of class III. There were 61 cases of anterior dental defects, 42 cases of posterior dental defects, and 26 cases of anterior and posterior dental defects. Patients in the control group were treated with implant restoration alone. Patients in the observation group were treated with orthodontic implants combined with implant restoration. Inclusion criteria: patients who were clinically diagnosed with malocclusion and dentition defects were included. Patients who were older than 18 were included. Patients who did not receive restoration treatment within 3 months were included. Exclusion criteria: patients who had received restoration treatment within 3 months were excluded; patients with severe liver and kidney dysfunction were excluded; patients with coagulation dysfunction were excluded; patients with immune diseases were excluded; patients with communication and cognitive impairment were excluded; patients who did not cooperate with the experiment were excluded. All patients and their families agreed to participate in the experiment and signed the informed consent. This experiment was approved by the hospital ethics committee.

Therapeutic method

Before the treatment, the two groups of patients were photographed by dental X-ray. The dental arch shape, oral surface shape, dental axis inclination, dental defect location and midline and other oral conditions of the patients were comprehensively evaluated. The results were analyzed in detail, and appropriate models and treatment options were developed based on the actual situation of the patient. The control group was treated with restoration alone, and the specific steps were as follows: firstly, the number and location of the missing teeth of the patients were accurately determined. Under the premise of accurate positioning, the implant was implanted. After 10 days of surgery and the completion of bone union of the implant, porcelain crowns were used for fixation and restoration. The patient's malformed teeth were corrected and the healing abutment in the patient's mouth was replaced. Then the prepared model was properly adjusted for the porcelain crown and the patient tried it on. When the effect of the patient's try-on effect is better, the fixation was carried out. Then a retainer was used after the fixation, and the restoration was completed.

The observation group was treated with implant restoration combined with oral orthodontic treatment, and the specific steps were as follows: according to the specific situation of patients with dental malformation, the orthodontic technique of straight wire arch or the orthodontic technique of edgewise arch fixation were selected. First of all, the jaw plate with the direction of bone mass movement and the example of surgical positioning was made. Then the patient's dentition was corrected, and the teeth were tilted near the gap to stand upright. Then the remaining gaps were closed and the scattered gaps were redistributed. The teeth were stretched and lowered, and the occlusal relationship to the implant was properly adjusted. Problematic teeth were effectively adjusted and fixed. The anterior teeth coverage relationship was adjusted to establish a

satisfactory abutment condition. The subsequent implantation restoration process was the same as in the control group. All patients were given semi-liquid or liquid foods after the procedure and were advised that care should be taken to keep the mouth clean.

Outcome measures

(1) Firstly, the clinical efficacy of the two groups was evaluated and compared. The efficacy was divided into markedly effective, effective and ineffective. The criteria for markedly effective are: After treatment, the patient has a high degree of tooth matching and the teeth are arranged neatly. The implant is not loose and has good firmness. The patient does not need a tooth holder and both chewing and language skills return to normal. The criteria for effectiveness are: the patient's teeth are generally matched, and no retainer is needed after treatment. The patient's chewing function and language function are improved. The criteria for ineffective are: patients still need to wear a retainer after treatment. The position of the tooth is unstable. There are obvious abnormalities in chewing function and language function, and the patient has obvious discomfort.

(2) The plaque index of the two groups of patients before and after treatment was evaluated using Silness and Loe's plaque index [10]. (3) The adhesion loss index before and after treatment was evaluated in both groups. (4) The language function and chewing function of the two groups of patients were evaluated and compared after treatment. (5) The fixation of teeth in the two groups before and after treatment was evaluated and compared. (6) The treatment satisfaction of the two groups of patients was evaluated and compared. (7) The quality of life of the two groups of patients at 1 month after treatment was evaluated and compared with SF-36 [11].

Statistical method

Statistical software SPSS 18.0 (Beijing Network Times Technology Co., Ltd.) was used in this study to analyze and process the usage data. Percentages and examples are used to represent the counting data. A chi-square test was used for comparison between groups; measurement data were expressed as $x \pm s$, and independent t-tests were used for comparison between groups. A paired *t*-test was used for comparison before and after treatment in the group; $P<0.05$ indicated that the difference was statistically significant.

Results

Comparison of general data between the two groups of patients

There were no significant differences in gender, age, or BMI between the two groups ($P>0.05$), which were comparable (**Table 1**).

Comparison of treatment effects between the two groups

The total effective rate of the observation group was 94.67%. The total effective rate of the control group was 72.00%. The total effective rate of treatment in the observation group was significantly higher than it was in the control group, and the difference was statistically significant ($P<0.05$) (**Table 2**).

Plaque index before and after treatment in both groups

The plaque index of the observation group before and after treatment was (2.49±0.67) and (1.02±0.34), respectively. The plaque indexes of the patients in the control group before and after treatment were (2.47±0.68) and (1.81±0.55), respectively. There was no significant difference in the plaque index between the two groups before treatment ($P>0.05$). The plaque index of the two groups was significantly lower than it was before treatment, but the plaque index of the observation group was more obvious than the index of the control group. The difference was statistically significant ($P<0.05$) (**Figure 1**).

Attachment loss index before and after treatment in both groups

The loss of attachment indexes before and after treatment in the observation group were (5.24±1.26) and (2.01±0.14), respectively. The loss of attachment indexes before and after treatment in the control group were (5.19±1.24) and (2.99±0.24), respectively. There was no significant difference in the loss of attachment index between the two groups before treat-

Table 1. General data of the two groups of patients

Factor	Observation group n=75	Control group n=75	X^2/t	P
Gender			0.027	0.869
Male	43 (57.33)	44 (58.67)		
Female	32 (42.67)	31 (41.33)		
Age			0.027	0.870
≥27	41 (54.67)	40 (53.33)		
<27	34 (45.33)	35 (46.67)		
BMI (kg/m^2)			0.027	0.870
≤22	37 (49.33)	36 (48.00)		
>22	38 (50.67)	39 (52.00)		
Course of disease (year)	1.24±0.29	1.23±0.30	0.208	0.836
Angle category			0.264	0.877
I	23 (30.67)	22 (29.33)		
II	27 (36.00)	30 (40.00)		
III	25 (33.33)	23 (30.67)		
Defect site			0.110	0.947
Anterior teeth defect	35 (46.67)	33 (44.00)		
Posterior teeth defect	24 (32.00)	25 (33.33)		
Defects of anterior and posterior teeth	16 (21.33)	17 (22.67)		
Defect types			0.134	0.935
Congenital dentition defect	32 (42.67)	33 (44.00)		
Traumatic defect	21 (28.00)	22 (29.33)		
Caries removal	22 (29.33)	20 (26.67)		

Table 2. Clinical efficacy evaluation of the two groups [n, (%)]

Curative effect	Observation group n=75	Control group n=75	X^2	P
Markedly effective	59 (78.67)	41 (54.67)	9.720	0.002
Effective	12 (16.00)	13 (17.33)	0.048	0.827
Invalid	4 (5.33)	21 (28.00)	13.87	<0.001
Total effective rate	71 (94.67)	54 (72.00)	13.87	<0.001

ment (P>0.05). The loss of attachment index of the two groups was significantly lower than that before treatment, but the attachment loss index of the observation group was more obvious than that of the control group. The difference was statistically significant (P<0.05) (**Figure 2**).

Evaluation and comparison of language function and chewing function after treatment in both groups

The language and chewing functions of the patients in the observation group were significantly higher than those of the control group. The difference was statistically significant (P<0.05) (**Table 3**).

The fixation of teeth in the two groups before and after treatment

The scores of teeth fixation in the observation group before and after treatment were (1.39±0.54) and (9.27±0.87), respectively. The scores of teeth fixation before and after treatment in the control group were (1.40±0.57) and (6.15±0.48), respectively. There was no significant difference in the scores of teeth fixation before treatment between the two groups (P>0.05). The scores of teeth fixation after treatment in both groups were significantly higher than those before treatment, but the scores of teeth fixation in the observation group were more obvious than those in the control group. The difference was statistically significant (P<0.05) (**Figure 3**).

Comparison of treatment satisfaction between the two groups of patients after treatment

The total effective rate of treatment of the observation group was 96.00%. The total satis-

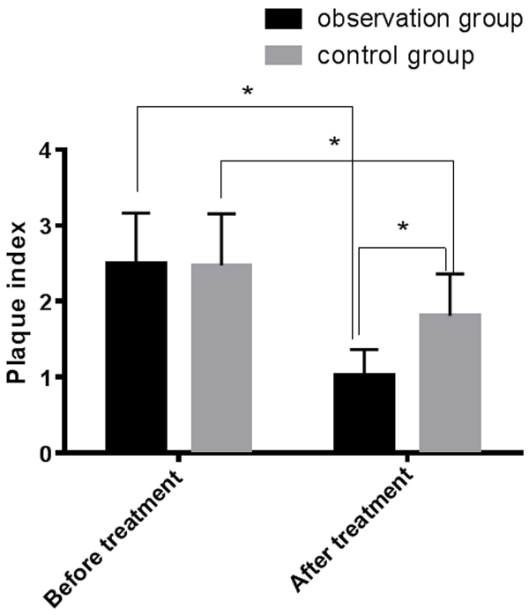

Figure 1. Comparison of the plaque index between the two groups before and after treatment. Comparison of the plaque index of the two groups before and after treatment. The plaque index of the two groups of patients after treatment was significantly lower than it was before treatment, but the plaque index of the observation group was significantly lower than that of the control group. The difference was statistically significant (P<0.05). Note: *indicated P<0.05.

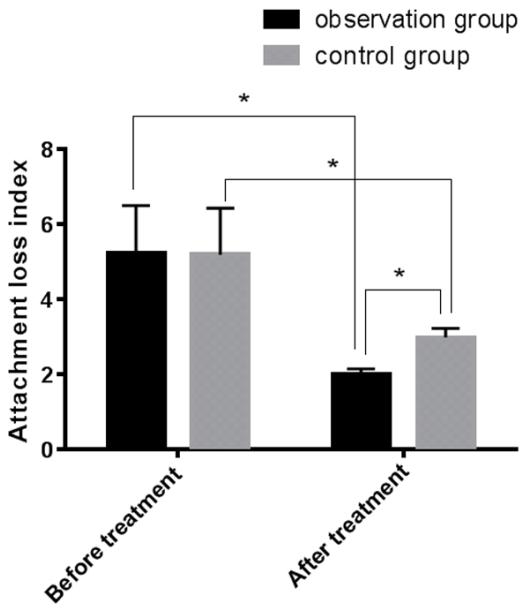

Figure 2. Comparison of the attachment loss index between the two groups before and after treatment. The attachment loss index of the patients in both groups after treatment was significantly lower than it was before treatment, but the attachment loss index of the patients in the observation group was significantly lower than it was in the control group. The difference was statistically significant (P<0.05). Note: *indicated P<0.05.

faction rate of treatment of the control group was 65.33%. The total satisfaction of treatment in the observation group was significantly higher than it was in the control group. The difference was statistically significant (P<0.05) (**Table 4**).

Comparison of quality of life between the two groups before treatment and after 3 months of treatment

The quality of life scores of the observation group before treatment and after 3 months of treatment were (58.69±1.77) and (96.16±2.84), respectively. The quality of life scores of the control group before treatment and after 3 months of treatment were (57.91±1.64) and (81.36±3.39), respectively. There were no significant differences in the quality of life score between the two groups before treatment. After 3 months of treatment, the quality of life scores of the two groups were significantly higher than they were before treatment (P<0.05). However, the scores of quality of life in the observation group after treatment were significantly higher than they were in the control group. The difference was statistically significant (P<0.05) (**Figure 4**).

Discussion

As an important part of the human body, teeth not only have a close relationship with the chewing and language functions of the human body, but also have an important influence on the aesthetics of the human body [12]. A dentition defect is a clinically common oral disease that is often accompanied by malocclusion when it occurs [13]. The occurrence of malocclusion with dentition defects causes a patient's anterior teeth to be introverted and the teeth are tilted, which causes an imbalance of the patient's teeth as a whole and seriously affects the patient's language and chewing function. It ultimately has a serious impact on a patient's quality of life [14, 15]. Therefore, when a patient has a dentition defect, timely and effective treatment should be adopted. If effective restoration treatment is not carried out for an extended period of time, there may be a situation in which restoration is difficult or even impossible to carry out [16, 17]. Therefore,

Table 3. Evaluation of language function and masticatory function after treatment in the two groups

Project	Observation group n=75	Control group n=75	t	P
Language function	9.78±1.53	5.32±1.15	20.18	<0.001
Masticatory function	8.89±0.64	5.21±0.72	33.08	<0.001

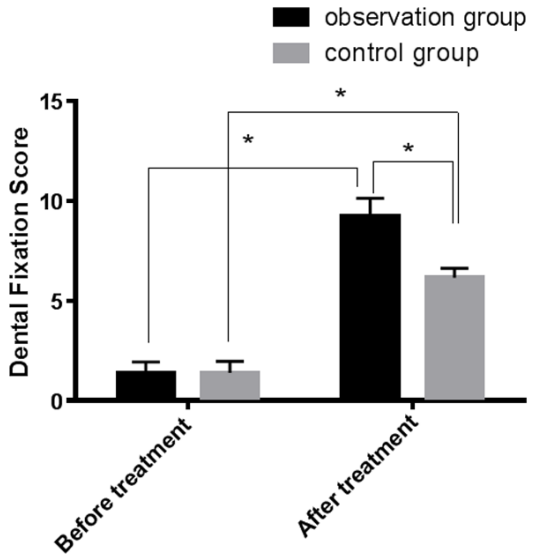

Figure 3. Dental fixation before and after treatment in the two groups. After treatment, the tooth fixation score in both groups was significantly higher than it was before treatment, but the tooth fixation score in the observation group was significantly higher than it was in the control group. The difference was statistically significant (P<0.05). Note: *indicated P<0.05.

the timely and effective treatment of patients with malocclusion and dentition defects is particularly important.

In our study, the therapeutic effects of simple implant restoration and orthodontic treatment combined with implant restoration for the treatment of malocclusion with dentition defects were explored. Our results showed that the effective rate of treatment in the observation group was significantly higher than that in the control group, which indicated that the combined effect of orthodontic implant restoration for the treatment of malocclusion with dentition defects was significantly better than that of simple implant restoration treatment. Previous studies [18] have shown that a single treatment for malocclusion with dentition defects cannot achieve significant therapeutic effects. Some studies [19] explained that this is because if a single implant restoration treatment is directly adopted, the implant defect is greatly hindered due to the patient's dentition defect plus the abnormal position of the teeth and the existence of the interstitial space. The obstacles make the restoration effect greatly compromised. This also explained our experimental results. To further validate our results, we also compared the plaque and adhesion loss indexes before and after treatment in both groups. The results suggest that the combination of orthodontics and implant restoration is better than the implant restoration alone for the improvement of the aesthetics and stability of the teeth. Many studies [20, 21] indicated that orthodontic treatment before implantation and restoration can not only correct the teeth in the patient's mouth to establish conditions for the subsequent implantation and restoration, but also accelerate the recovery of the normal physiological functions of the jaw. This aligns the patient's teeth, improves the overall periodontal aesthetics, and ultimately achieves therapeutic goals, which also confirmed our conclusion. Finally, we compared the treatment satisfaction of the two groups of patients with the quality of life after 3 months of treatment. The higher satisfaction of the patients and the quality of life after treatment in the observation group suggests that by improving the treatment effect and the patient's oral function and periodontal aesthetics, combined orthodontics and implant restoration treatment can improve the patient's treatment satisfaction and quality of life. Some studies [5] have shown that the use of orthodontic implants for the treatment of dentition defects compared with a single repair treatment can significantly improve the patient's treatment satisfaction, which also confirmed some of our conclusions. However, there are still some deficiencies in this study. Some studies [22, 23] indicated that with the increase of age, the patient's adaptability and the degree of bone metabolism in the body will be weakened, which will reduce the ability of the patient's teeth to move. Therefore, in the case of older patients with malocclusion and dentition defects, only assisted orthodontic treatment can be used, which is related to the efficacy of implant restoration alone. However, elderly patients were not included in our study

Table 4. Treatment satisfaction after treatment in the two groups [n (%)]

Satisfaction degree	Observation group n=75	Control group n=75	X^2	P
Very satisfied	65 (86.67)	39 (52.00)	21.20	<0.001
Satisfied	7 (9.33)	10 (13.33)	0.597	0.440
Dissatisfied	3 (4.00)	26 (34.67)	22.61	<0.001
Total satisfaction rate	72 (96.00)	49 (65.33)	22.61	<0.001

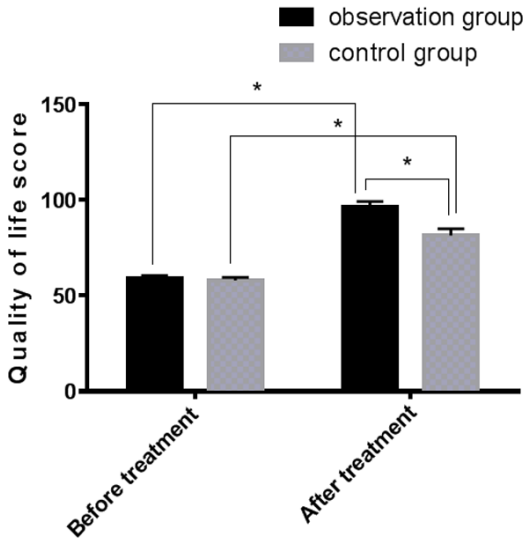

Figure 4. Comparison of the quality of life between the two groups before and after 3 months of treatment. After 3 months of treatment, the quality of life scores of patients in both groups were significantly higher than those before treatment (P<0.05), but the quality of life scores of the patients in the observation group after treatment were significantly higher than those in the control group. The difference was statistically significant (P<0.05). Note: *indicated P<0.05.

cohort. In a follow-up study, we will further explore the efficacy of treatments on patients of different ages. In addition, due to the short treatment time and insufficient operation, there is still room for further improvement of the treatment efficiency. In a follow-up study, it will be necessary to further improve the technical level to improve the treatment efficiency.

In summary, oral orthodontics combined with implant restoration treatment can effectively improve the dental function of patients with malocclusion and dentition defects and has obvious therapeutic effects. It can improve patients' satisfaction with treatment and quality of life, which is worth promoting in the clinic.

Acknowledgements

This work was supported by the Health Planning Commission Scientific Research Project of Jiangyin City [Grant number: Z201504].

Disclosure of conflict of interest

None.

Address correspondence to: Jianfen Fan, Jiangyin Oral Disease Preventive Treatment, No. 18 Jiankang Road, Jiangyin 214400, Jiangsu, China. Tel: +86-15950439215; E-mail: fanjiafen@163.com

References

[1] Rozier RG, White BA and Slade GD. Trends in oral diseases in the U.S. population. J Dent Educ 2017; 81: eS97-eS109.

[2] Zhifang C and Wei Z. [Clinical application on restoration of dentition defects using tooth-alveolar bone grafts]. Hua Xi Kou Qiang Yi Xue Za Zhi 2016; 34: 364-368.

[3] van Putten MC Jr. The use of biomechanical orthodontic treatment concepts for removable appliances in maxillofacial prosthodontics. Part I: review of prosthesis design principles. J Prosthodont 2010; 11: 4-10.

[4] Palomares NB, Celeste RK and Miguel JA. Impact of orthosurgical treatment phases on oral health-related quality of life. Am J Orthod Dentofacial Orthop 2016; 149: 171-181.

[5] Zhou GL, Liu D, Liang X, Wang J, Tang L and Zhang N. [A clinical observation of therapeutic alliance of orthodontics and implant prosthodontics for dentition defect with malocclusion]. Hua Xi Kou Qiang Yi Xue Za Zhi 2008; 26: 499-502.

[6] Chung KR, Kim SH, Choo H, Kook YA and Cope JB. Distalization of the mandibular dentition with mini-implants to correct a Class III malocclusion with a midline deviation. Am J Orthod Dentofacial Orthop 2010; 137: 135-146.

[7] Chi ZB. [Observation of the clinical effect on the treatment of traumatic intrusion of upper anterior teeth using orthodontic method]. Shanghai Kou Qiang Yi Xue 2003; 12: 253-255.

[8] Jiang J, Lin J and Ji C. Two-stage treatment of skeletal Class III malocclusion during the early permanent dentition. Am J Orthod Dentofacial Orthop 2005; 128: 520-527.

[9] Shen P, Xu WF, Ma ZG, Zhang SY, Zhang Y. Case studies on local orthodontic traction by

minis-implants before implant rehabilitation. Int J Clin Exp Med 2015; 8: 8178.
[10] Rocha MO, Oliveira DD, Costa FO, Pires LR, Diniz AR and Soares RV. Plaque index and gingival index during rapid maxillary expansion of patients with unilateral cleft lip and palate. Dental Press J Orthod 2017; 22: 43-48.
[11] Lins L and Carvalho FM. SF-36 total score as a single measure of health-related quality of life: scoping review. SAGE Open Med 2016; 4: 2050312116671725.
[12] Ren MM, Liu LP and Liu ZH. [Eight-year clinical results of SLA surface implant for dentition defect]. Shanghai Kou Qiang Yi Xue 2017; 26: 447-452.
[13] Li Y. [Occlusal evaluation and design of dental implant therapy in defect dentition]. Zhonghua Kou Qiang Yi Xue Za Zhi 2016; 51: 219-223.
[14] Andrews KM, Roberson G, Subramani K and Chaudhry K. The effect of dental chair light exposure duration on shear bond strength of orthodontic brackets: an in vitro study. J Clin Exp Dent 2018; 10: e1075-e1081.
[15] Ciavarella D, Tepedino M, Gallo C, Montaruli G, Zhurakivska K, Coppola L, Troiano G, Chimenti C, Laurenziello M and Lo Russo L. Post-orthodontic position of lower incisors and gingival recession: A retrospective study. J Clin Exp Dent 2017; 9: e1425-e1430.
[16] Wu XY and Zhong Q. [Evaluation of fiber reinforcement composites in restoring lower dentition defect and fixing loose teeth for chronic periodontitis]. Shanghai Kou Qiang Yi Xue 2014; 23: 204-208.
[17] He HY, Zhu M and Wu YN. [Distribution of subgingival flora after restoration of dentition defect with conical telescopic removable denture in patients with periodontitis]. Shanghai Kou Qiang Yi Xue 2006; 15: 282-284.
[18] Bidra AS and Uribe F. Preprosthetic orthodontic intervention for management of a partially edentulous patient with generalized wear and malocclusion. J Esthet Restor Dent 2012; 24: 88-100.
[19] Gava EC, Miguel JA, de Araujo AM and de Oliveira BH. Psychometric properties of the Brazilian version of the orthognathic quality of life questionnaire. J Oral Maxillofac Surg 2013; 71: 1762, e1761-1768.
[20] Maruo H, Maruo IT, Saga AY, Camargo ES, Guariza Filho O and Tanaka OM. Orthodontic-prosthetic treatment of an adult with a severe Class III malocclusion. Am J Orthod Dentofacial Orthop 2010; 138: 820-828.
[21] Soh CL and Narayanan V. Quality of life assessment in patients with dentofacial deformity undergoing orthognathic surgery--a systematic review. Int J Oral Maxillofac Surg 2013; 42: 974-980.
[22] Chen H, Han B and Xu T. Effect of different combinations of bracket, archwire and ligature on resistance to sliding and axial rotational control during the first stage of orthodontic treatment: an in-vitro study. Korean J Orthod 2019; 49: 21-31.
[23] Zheng L, Yang J, Hu X and Luo J. Three dimensional finite element analysis of a novel osteointegrated dental implant designed to reduce stress peak of cortical bone. Acta Bioeng Biomech 2014; 16: 21-28.