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The primary aim of *World Journal of Clinical Cases* (*WJCC*, *World J Clin Cases*) is to provide scholars and readers from various fields of clinical medicine with a platform to publish high-quality clinical research articles and communicate their research findings online.

WJCC mainly publishes articles reporting research results and findings obtained in the field of clinical medicine and covering a wide range of topics, including case control studies, retrospective cohort studies, retrospective studies, clinical trials studies, observational studies, prospective studies, randomized controlled trials, randomized clinical trials, systematic reviews, meta-analysis, and case reports.

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Randomized Controlled Trial

Clinical efficacy, bone density, and follow-up in implant and orthodontic treatment for inclined adjacent teeth

Yi Yang, Shun-Cheng Zhou, Yi-Hui Ma, Xiang Wang, Qing-Shan Dong

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Abstract

BACKGROUND

Tooth defects can cause elongation of occlusal teeth, leading to insufficient repair space. The combination of dental implant restoration and orthodontic treatment of oblique adjacent teeth has a significant therapeutic effect.

AIM

To explore clinical efficacy, bone density, and follow-up of implant and orthodontic treatment for patients with inclined adjacent teeth.

METHODS

In total, 98 patients with oblique adjacent teeth were randomly assigned to implant restoration combined with orthodontic treatment (group A, $n = 49$) or to receive implant restoration alone (group B, $n = 49$). Changes in alveolar ridge bone density and apical bone density were observed before and after treatment in the two groups. Changes in chewing function and language function were compared between the two groups of patients. Follow-up lasted for 12 mo after repair to observe any adverse reactions in the oral cavity.

RESULTS

The clinical effective rates of group A and group B were 97.96% and 85.71%, respectively, with group A having a higher clinical effective rate than group B. After treatment, the bone density of the alveolar ridge and apical bone in both groups decreased compared to before treatment, while the chewing and language functions improved. The changes in various indicators in group A were more significant. After treatment, the satisfaction rate of group A (97.96%) was higher than that of group B (79.59%). The incidence of adverse reactions in group A (2.04%) was lower than that in group B (24.49%).

CONCLUSION

The amalgamation of implant restoration and orthodontic treatment for adjacent tilted teeth demonstrates notable clinical efficacy, diminishes alveolar bone resorption, and fosters patient functional rehabilitation while exhibiting negligible adverse reactions.

Key Words: Dental implant restoration; Orthodontic correction; Tilt adjacent teeth; Clinical curative effect; Alveolar bone mineral density

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Core Tip: If dental defects are not repaired in a timely manner, adjacent teeth may tilt and shift. This causes elongation of the occlusal teeth, results in a lack of sufficient repair space, and leads to certain difficulties in the restoration of dentures. The combination of dental implant restoration and orthodontic treatment for tilted adjacent teeth has significant therapeutic effects, can reduce alveolar bone density, promote patient functional recovery, and is safe.

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INTRODUCTION

Dental defects resulting from caries, trauma, and congenital dysplasia are commonly encountered in clinical practice. These conditions not only significantly impact patients' masticatory function, speech articulation, and aesthetic appearance but also exert implications on the stomatognathic system and overall health[1]. Untimely repair of dental defects may lead to adjacent teeth misalignment and occlusal tooth elongation resulting in insufficient space for restoration, thereby posing challenges to denture rehabilitation[2].

With societal advancements and lifestyle changes coupled with an increased emphasis on self-image, there has been a rising trend in patients opting for dental restoration. Implant-supported dentures have emerged as a well-established and reliable modality for tooth replacement in contemporary dental care, offering advantages such as minimal invasiveness, reduced foreign body sensation, stability, and functional integrity. Nevertheless, not all patients meet the eligibility criteria for implantation[3]. In cases where implantation is hastily pursued without adequate tooth space, it can lead to improper occlusion and potential implant failure. Moreover, inadequate alveolar bone quality presents a significant challenge to successful implant therapy.

Bone augmentation and orthodontic intervention serve as pivotal approaches to address bone deficiencies[4]. The synergy between implant-supported dentures and orthodontic treatment is evident, with the latter facilitating sufficient space and optimal alveolar bone conditions for successful implant placement[5]. This study aimed to investigate the clinical efficacy and alveolar bone mineral density (BMD) outcomes of patients with inclined adjacent teeth who underwent combined implant restoration and orthodontic correction at our institution between May 2018 and January 2020. Subsequent patient follow-up and reevaluation were comprehensively analyzed to assess treatment effectiveness.

MATERIALS AND METHODS

A total of 98 patients with oblique adjacent teeth treated in General Hospital of Central Theater Command from May 2021 to January 2023 were randomly divided into the study group (group A) ($n = 49$) and control group (group B) ($n = 49$). Among them, there were 29 males and 20 females in the study group, aged 21-54 years, with an average age of 38.66 ± 14.46 years. In the control group, there were 30 males and 19 females, aged from 23-years-old to 53-years-old, with an average age of 39.49 ± 14.64 years. There were no significant differences in age and other basic data between the two groups ($P > 0.05$). Method patients in group B underwent solely implant restoration treatment.

Inclusion criteria

(1) Age between 20 years and 60 years; (2) Absence of neurological impairments allowing for treatment cooperation; (3) Presence of long-term tooth loss with adjacent dental inclination necessitating orthodontic intervention rather than denture implantation; (4) Approval from the hospital ethics committee adhering to medical ethics standards; and (5) Documented informed consent from patient and their family.

Exclusion criteria

(1) Pregnancy or lactation; (2) Coagulation dysfunction; (3) Hepatorenal or cardiac insufficiency; (4) Bone metabolic disorders; and (5) Inability to maintain oral hygiene independently.

Method

Preoperative X-ray images were obtained to assess the oral condition, particularly the relationship between the implant site and adjacent structures, aiding in the selection of appropriate implant systems and components. Prior to the procedure, patients received routine administration of cephalosporin, metronidazole, and other medications for prophylaxis, along with oral and maxillofacial region disinfection. Local anesthesia was administered before making an incision in the gingiva to expose the alveolar bone. High-speed mobile phones and ball drills were utilized to create holes in the alveolar bone, gradually expanding them to accommodate the implants. Implants were then carefully inserted into the prepared sockets, with meticulous attention paid to the protection of adjacent teeth. Subsequently, dentures were fitted to optimize the maxillary arch alignment. Patients were instructed on oral hygiene practices, and stitches were typically removed 1 wk post-implantation.

Patients in group A received a comprehensive treatment approach involving both implant restoration and orthodontic intervention. Initially, X-ray imaging was employed to assess the extent and distribution of missing teeth. Following this, oral cleaning procedures were performed to prepare the mouth for subsequent treatment. Orthodontic techniques were then utilized to rectify malocclusions, focusing on aligning both upper and lower dentitions. Additionally, adjustments were made to the positions of abutment teeth, canines, and other adjacent teeth to optimize dental occlusion and alignment. Following the completion of orthodontic treatment, patients underwent implant restoration procedures to replace missing teeth.

Observation index clinical efficacy assessment encompassed the evaluation of therapeutic outcomes in both study groups and were categorized as effective, partially effective, and ineffective. Noteworthy effectiveness was characterized by stable implant fixation, aesthetically pleasing and satisfactory restorations, and restored normal masticatory function. Partial effectiveness denoted stable implant fixation with occasional loosening, improved restoration aesthetics, and satisfactory enhancement of masticatory function. Ineffectiveness was defined by implant damage or loosening, lack of improvement in masticatory function, and the presence of inflammation.

Alveolar BMD alterations, specifically at the crest and apical regions, were quantified *via* X-ray imaging to assess changes before and after treatment in both study cohorts. The masticatory and language functions of participants were evaluated utilizing the Eichner classification system, with a maximum score of 10 indicating optimal patient recovery. Higher scores correlated with improved functional outcomes. Patient satisfaction was gauged using a self-designed satisfaction assessment tool, with ratings including "very satisfied," "satisfied," and "dissatisfied." Scores ranged from 0 to 100, with ratings above 85 indicative of very high satisfaction, 55-85 indicating satisfaction, and scores below 55 representing dissatisfaction. Follow-up examinations were conducted after 12 mo post-treatment to monitor the occurrence of oral adverse reactions. Patients were advised to prioritize oral hygiene and maintain regular dental cleanings to optimize oral health outcomes.

Statistical analysis

In this study, a comparison of clinical efficacy, satisfaction, and the incidence of adverse reactions between group A and group B was conducted using the χ^2 test, with results expressed as n (%). The alveolar BMD, masticatory function, and language function of both groups were evaluated using independent sample t -tests, with results presented as mean \pm standard deviation. Statistical analyses were performed using SPSS 18.0 (IBM Corp., Armonk, NY, United States), with significance determined at $P < 0.05$.

RESULTS

The clinical effective rates of group A and B were 97.96% and 85.71%, respectively, and the clinical effective rate of the group A was higher than group B (Table 1). After treatment, the alveolar crest BMD and apical BMD in the two groups were reduced than before treatment, and those in group A were reduced more than group B (Table 2). After treatment, the masticatory function and language function of the two groups were increased than those before treatment. The masticatory function of group A was higher than group B (Table 3). After treatment, the satisfaction of patients in group A and group B was 97.96% and 79.59%, respectively, and the satisfaction in group A was higher than group B (Table 4). There was only 1 case of implant loosening in group A, and the incidence of adverse reaction was 2.04%. In group B, there were 41 cases of gingivitis, 41 cases of periodontal discomfort, 7 cases of implant loosening, and 3 cases of root resorption. The incidence of adverse reaction was 24.49%. The level in group A was decreased compared to group B (Table 5).

DISCUSSION

Dentition defects denote variations in the number of missing teeth across different regions of the dentition, thereby compromising the patient's masticatory function, speech articulation, and aesthetic appearance. Investigations reveal persistently high prevalence rates of dentition defects and periodontal diseases. Untimely restoration of missing teeth may precipitate adjacent teeth tilting and shifting towards the edentulous spaces, while opposing teeth may elongate due

Table 1 Proportion of clinical efficacy

Group	n	Significant effect	Effective	Invalid	Total effective
A	49	35 (71.43)	13 (26.53)	1 (2.04)	48 (97.96)
B	49	27 (55.10)	15 (30.61)	7 (14.29)	42 (85.71)
χ^2					4.900
P value					0.027

Data are n (%). Group A: Implant restoration combined with orthodontic treatment; Group B: Implant restoration alone.

Table 2 Comparison of alveolar bone mineral density

Group	n	Alveolar crest parietal bone mineral density in g/cm ²		t value	P value	Apical bone mineral density in g/cm ²		t value	P value
		Before treatment	After treatment			Before treatment	After treatment		
A	49	350.28 ± 25.37	327.36 ± 26.60	4.365	< 0.001	332.23 ± 11.58	308.09 ± 12.62	9.866	< 0.001
B	49	350.54 ± 23.63	339.17 ± 25.16	2.306	0.023	331.28 ± 14.73	300.04 ± 15.75	10.141	< 0.001
t value		0.053	2.258			0.355	2.792		
P value		0.958	0.026			0.723	0.006		

Data are mean ± standard deviation. Group A: Implant restoration combined with orthodontic treatment; Group B: Implant restoration alone.

Table 3 Comparison of masticatory function and language function

Group	n	Time	Masticatory function	Language function
A	49	Before treatment	4.68 ± 1.24	4.82 ± 0.98
		After treatment	9.39 ± 0.39 ^{a,b}	9.25 ± 0.22 ^{a,b}
B	49	Before treatment	4.75 ± 1.36	4.85 ± 1.03
		After treatment	7.13 ± 0.40 ^a	7.05 ± 0.47 ^a

Data are mean ± standard deviation.

^aP < 0.05 vs pre-treatment.

^bP < 0.05, indicated a significant difference between the study group and the control group. Group A: Implant restoration combined with orthodontic treatment; Group B: Implant restoration alone.

Table 4 The proportion of patient satisfaction

Group	n	Very satisfied	Satisfied	Not satisfied	Satisfaction
A	49	39 (79.59)	9 (18.37)	1 (2.04)	48 (97.96)
B	49	23 (46.94)	16 (32.65)	10 (20.41)	39 (79.59)
t value					8.295
P value					0.004

Data are n (%). Group A: Implant restoration combined with orthodontic treatment; Group B: Implant restoration alone.

Table 5 Proportion of oral adverse reactions

Group	n	Gingivitis	Periodontal discomfort	Implant loosening	Root resorption	Total
Total	49	0 (0.00)	0 (0.00)	1 (2.04)	0 (0.00)	1 (2.04)
B	49	1 (2.04)	1 (2.04)	7 (14.29)	3 (6.13)	12 (24.49)
χ^2						10.731
P value						0.001

Data are n (%). Group A: Implant restoration combined with orthodontic treatment; Group B: Implant restoration alone.

to lack of occlusal contact, resulting in occlusal discrepancies, food impaction, and potential periodontal tissue damage [6]. Furthermore, dental and skeletal atrophy may ensue, leading to facial asymmetry and consequent impairment of masticatory function and nutrient absorption[7]. Such conditions exert a significant impact on the patient's oral and maxillofacial complex as well as overall systemic health.

As social and economic advancements continue alongside progress in medical science and technology and with an evolving clinical repair ethos, there is a growing patient inclination towards aesthetically pleasing, minimally invasive treatment modalities. In contrast to conventional fixed and removable partial dentures, implant restoration offers distinct advantages including minimal tissue disruption, reduced foreign body sensation, stability, and optimal functionality. Furthermore, implant restoration facilitates superior aesthetic outcomes, occlusal function, and physiological efficacy while preserving the integrity of adjacent teeth. Consequently, it has emerged as a well-established and dependable method for edentulous reconstruction in contemporary dental care[8,9].

Nevertheless, not all patients meet the criteria for implantation adaptation. The decision for repair often hinges on aesthetic or functional concerns arising from missing teeth, typically manifesting with symptoms such as narrowed interdental spaces due to adjacent tooth displacement or occlusal tooth intrusion as well as an increase in scattered spaces, among others. Failure to address these issues promptly may impede subsequent treatment steps. Some researchers posit that establishing a harmonious occlusal relationship is pivotal in preventing bone resorption and occlusal trauma in implant-supported restorations[10]. Consequently, even in cases where implantation and repair are deemed necessary, achieving optimal harmony between function and aesthetics remains challenging. Hence, orthodontic intervention targeting inclined adjacent teeth and depressed elongated molars becomes essential to create adequate space and establish a favorable occlusal relationship for restoration.

Orthodontic measures serve to close interdental gaps, realign adjacent teeth towards edentulous spaces, and augment implant placement areas. Concurrently, implant therapy facilitates denture restoration, thereby fulfilling corrective and aesthetic objectives. This integrated approach effectively enhances patients' oral function, promoting overall oral health and well-being[11,12].

This study found that orthodontic intervention combined with implant therapy was minimally invasive, which can reduce the damage caused by grinding tooth tissue and reduce the trauma of occlusal by depressing the extended teeth, restoring the distance between the jaws and the gingiva and improving the efficiency and life of the implant[13]. The results of this study found that implant restoration combined with orthodontic treatment of inclined adjacent teeth had an obvious clinical effect, improved patient dental aesthetic satisfaction, and reduced the probability of adverse reactions.

Patients with dental defects often present with varying degrees of alveolar bone destruction, resulting in diminished bone mass, reduced periodontal ligament area, and alveolar ridge atrophy. These anatomical challenges pose significant obstacles to orthodontic interventions. Research indicates that during orthodontic tooth movement, the rate of alveolar bone resorption accelerates, leading to increased tooth mobility[14]. The health status of alveolar bone can be reflected by many aspects, among which BMD is an important index. BMD refers to the unit bone volume and the average bone mineral content of the noodle machine, which is not only an important index to reflect the cooling but also a sensitive index to reflect the severity of the disease[15].

The results of this study showed that implant restoration combined with orthodontic treatment of inclined adjacent teeth could reduce the BMD of the alveolar crest and apical area, improve the masticatory function and language function, and promote the recovery of patients. Implant restoration combined with orthodontic treatment of inclined adjacent teeth can play a significant clinical effect, reduce alveolar BMD, and promote the functional recovery of patients. After restoration, it was found that there were no obvious adverse reactions in implant restoration combined with orthodontic treatment.

CONCLUSION

The findings of this study demonstrated that the combination of implant restoration and orthodontic correction in patients with adjacent maloccluded teeth yielded superior clinical efficacy, improved alveolar bone density, enhanced masticatory and language functions, and reduced incidence of adverse reactions compared to implant restoration therapy alone. This method merits widespread clinical application. However, due to the limited number of participants, statistical significance may be affected, potentially reducing the reliability and representativeness of the results. Future directions

may involve multicenter studies recruiting participants from various regions to ensure sample diversity and result generalizability.

FOOTNOTES

Author contributions: Yang Y performed the majority of experiments, wrote the manuscript, and served as scientific advisor; Zhou SC and Ma YH designed the study and revised the manuscript; Wang X contributed to analytical tools; Dong QS and Yang Y participated to the collection of the human material; Ma YH was the guarantor.

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