

Original Article

Modified oral implant restoration improves dental aesthetics, function, and patient satisfaction in maxillary anterior tooth loss

Fang Liu^{1*}, Yu-Hong Wang^{2*}, Yan-Jie Xiong^{1*}, Yi-Liang Ni³

¹Dental Department, The Seventh Medical Center of PLA General Hospital, Beijing 100700, China; ²Emergency Department, The Seventh Medical Center of PLA General Hospital, Beijing 100700, China; ³Oral and Maxillofacial Surgery Department, Beijing Ni's Dental Hospital Co., Beijing 100025, China. *Equal contributors and co-first authors.

Received October 30, 2024; Accepted January 12, 2025; Epub February 15, 2025; Published February 28, 2025

Abstract: Objective: To evaluate the efficacy of modified oral implant restoration in patients with maxillary anterior tooth loss. Methods: A retrospective analysis was conducted on 98 patients (119 affected teeth) with maxillary anterior tooth loss from August 2021 to November 2023. Among these, 50 cases (63 affected teeth) received modified oral implant restoration (research group), while 48 cases (56 affected teeth) underwent routine dental restoration (control group). Treatment efficacy, safety, peri-implant bone resorption, periodontal pocket depth, dental aesthetics (Pink Esthetic Score, PES; White Esthetic Score, WES), masticatory function, oral function recovery, and patient satisfaction were compared between the two groups. Results: The research group demonstrated a significantly higher rate of excellent and good outcomes, with superior PES and WES scores and greater patient satisfaction compared to the control group. Additionally, the research group exhibited a significantly lower incidence of adverse events, reduced peri-implant bone resorption, and shallower periodontal pocket depths compared to the control group. Furthermore, masticatory function and oral function recovery were also notably better in the research group. Conclusions: Modified oral implant restoration for maxillary anterior tooth loss can effectively enhance restoration outcomes, improve dental aesthetics, and promote better masticatory function and patient satisfaction. It also helps prevent peri-implant bone resorption and gingival atrophy, lowers the risk of adverse events, and supports oral function recovery, making it a valuable clinical option.

Keywords: Modified oral implant restoration, maxillary anterior tooth loss, therapeutic effect, periodontal deep, PES, WES

Introduction

Maxillary anterior tooth loss is an oral health problem that impairs patients' ability to chew, thereby affecting their daily life and reducing their quality of life [1, 2]. Common causes include dental caries, periodontitis, smoking, and accidental injuries related to food consumption [3, 4]. Although the prevalence of tooth loss has been decreasing over time, especially in developed countries, statistics indicate that the risk of tooth loss among middle-aged and elderly individuals remains at 17.5% [5, 6]. The maxillary anterior teeth play a pivotal role in the aesthetics of the patient's smile, significantly influencing self-confidence.

Hence, achieving an aesthetically pleasing outcome after treatment for maxillary anterior tooth loss is crucial [7]. Exploring effective treatments for maxillary anterior tooth loss is vital to providing patients with a more complete and aesthetically appealing dentition.

Oral implant restoration is a common treatment for maxillary anterior tooth loss. The procedure involves exposing the alveolar ridge via an incision, placing the implant into the prepared socket, and suturing the mucoperiosteal flap to achieve the desired therapeutic effect [8, 9]. This method offers advantages such as high patient comfort, improved aesthetics, and enhanced chewing function, making it a popu-

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Figure 1. Pre- and post-operative results of the research group. A. Pre-operative dental condition of a patient in the research group. B. Post-operative results of a patient in the research group.

lar clinical choice [10]. However, routine dental restoration may not always provide satisfactory clinical results and can be associated with significant peri-implant bone resorption [11, 12]. Clinical experience suggests that modified oral implant restoration may offer superior outcomes for maxillary anterior tooth loss [13, 14]. This modified technique involves achieving the appropriate depth and diameter using a high-speed air turbine dental handpiece and preparing the implant socket with β -tricalcium phosphate (β -TCP) bone graft material [15]. Given the limited research on the clinical effect of modified oral implant restoration for maxillary anterior tooth loss, this study aims to address this gap and provide a more optimal choice for the treatment of maxillary anterior tooth loss.

Data and methods

Case selection

A total of 98 patients (119 affected teeth) with maxillary anterior tooth loss treated between August 2021 and November 2023 were retrospectively collected for this study based on the following criteria. Among them, 50 cases treated with modified oral implant restoration were assigned into the research group, while 48 cases treated with routine dental restoration were classified into the control group. This study was approved by the Ethics Committee of the Seventh Medical Center of PLA General Hospital.

Inclusion criteria: 1. Adult patients diagnosed with maxillary anterior tooth loss who met the aesthetic restoration indication. 2. Patients who exhibited favorable oral hygiene status and expressed willingness to undergo dental implant restoration. 3. Patients who had intact

medical records. 4. Patients who were free from periodontal pathologies and other associated diseases. 5. Patients that did not have deleterious parafunctional habits such as bruxism or occlusal clenching during sleep. 6. Patients who received treatment at our hospital for the first time.

Exclusion criteria: 1. Patients with malignant tumors, organic diseases, blood and/or immune system diseases, or infectious diseases. 2. Patients with contraindications to anesthesia. 3. Individuals with concurrent systemic diseases. 4. Women who were pregnant or lactating.

Intervening method

Before surgery, patients were instructed to rinse their mouths, and both groups were given local anesthesia and routine disinfection of the mucosa in the implant area. After surgery, both groups were instructed to gargle regularly to ensure oral hygiene and prevent incision infections.

Control group: Patients underwent routine dental restoration. First, the mucoperiosteum at the dental implant site was incised and separated to fully expose the alveolar ridge. Then, the implant socket was prepared and rinsed with normal saline. Finally, the implant was placed into the socket, followed by resetting and suturing of the mucoperiosteal flap. Post-operative care included antibiotics for 7-10 days.

Research group: Patients were treated with modified oral implant restoration. An incision was made at the dental implant site to separate the mucoperiosteum. The implant socket was then prepared using a high-speed air turbine dental handpiece, and a β -tricalcium phosphate (β -TCP) bone graft was inserted. Finally, the implant was placed into the implant socket, and the incision was sutured and fixed. Postoperative care included antibiotics and dexamethasone for 7-10 days. The pre- and postoperative outcomes are illustrated in **Figure 1**.

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Data collection and outcome measurements

(1) Therapeutic effect. Cured: no discomfort after treatment, with normal function and appearance of the restored teeth; Effective: slight discomfort after treatment, with basically normal function and an appearance similar to normal teeth; Ineffective: significant discomfort after treatment, inability to use the restored teeth normally, and great difference in the appearance of the restored teeth compared to normal teeth.

(2) Safety. The incidence and percentage of adverse events, such as periodontal pain, bleeding, and tooth loosening, were recorded for both groups.

(3) Peri-implant bone resorption. The peri-implant bone resorption depth was measured using professional software (Digimizer, Belgium). The periapical film taken immediately after crown restoration served as the baseline X-ray. Bone resorption depth on both the mesial and distal sides of the implant was measured, and the average value was used for evaluation.

(4) Periodontal pocket depth. A pure titanium periodontal probe was used to detect both cohorts of subjects.

(5) Aesthetic effect. The aesthetic effect of the restored teeth was assessed using the Pink Esthetic Score (PES) and White Esthetic Score (WES), with scores ranging from 0-14 and 0-10, respectively. Higher scores indicated better aesthetic outcomes.

(6) Masticatory function. Bite force and chewing efficiency were measured before and three months after treatment. The bite force (with a focus on the force generated when the teeth are brought into closure) was measured using a bite force tester; the chewing efficiency (with an emphasis on the process of food comminution and digestion) was determined by the weighing method. Higher values indicated better performance.

(7) Oral function recovery. Three months post-restoration, the patient's dental, chewing, and language functions were evaluated using a hospital-developed scale (total score: 150 points). Poor: 0-69 points; Good: 70-139 points; Excellent 140-150 points. The recovery rate =

$[(\text{number of excellent cases} + \text{good cases}) / \text{total number of cases}] \times 100\%$.

(8) Treatment satisfaction rate. After the operation, a questionnaire was used to assess patients' satisfaction with the treatment, with options such as very satisfied, basically satisfied and dissatisfied. The satisfaction rate was calculated accordingly.

Efficacy, safety, aesthetic effect, bite force, chewing efficiency, and oral function recovery were evaluated as primary outcome measures, while peri-implant bone resorption and periodontal pocket depth were secondary indicators.

Statistical methods

Graphpad Prism 6 (GraphPad Software, San Diego, USA) was used for data analysis and figure rendering. Counting data like gender, and treatment efficacy (cured, effective, ineffective) were expressed as counts and percentages [n (%)], and between-group comparisons were conducted using the Chi-square test. Continuous variables, such as age, bone resorption depth, and periodontal pocket depth, were presented as mean \pm SD. Comparisons between groups were performed using an independent sample t-test, while comparisons across multiple time points were conducted using a paired t-test. A significance level of $P < 0.05$ was considered statistically significant.

Results

Comparison of general information between the two groups of patients

In the research group, the male-to-female ratio was 28:22, with an average age of 37.03 ± 7.80 years and 63 affected teeth. In the control group, the male-to-female ratio was 28:20, and the average age was 35.21 ± 6.98 years, with 56 affected teeth. No statistically significant differences were observed in gender and age between the two groups ($P > 0.05$).

Comparison of efficacy between the two groups

Twenty-nine patients in the control group had effective treatment, resulting in an overall response rate was 60.41%. In the research group, 41 patients showed effective or cured

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Table 1. Comparison of treatment efficacy between the two groups [n (%)]

Groups	n	Cured	Effective	Ineffective	Total effective rate (%)
Control group	48	19 (39.58)	10 (20.83)	19 (39.59)	29 (60.41)
Research group	50	35 (70.00)	6 (12.00)	9 (18.00)	41 (82.00)
χ^2 value	-	-	-	-	5.590
P value	-	-	-	-	0.018

Table 2. Comparison of safety between the two groups

Groups	n	Periodontal pain	Periodontal bleeding	Tooth loosening	Total
Control group	48	4 (8.33)	4 (8.33)	1 (2.08)	9 (18.75)
Research group	50	1 (2.00)	1 (2.00)	0 (0.00)	2 (4.00)
χ^2 value	-	-	-	-	5.347
P value	-	-	-	-	0.021

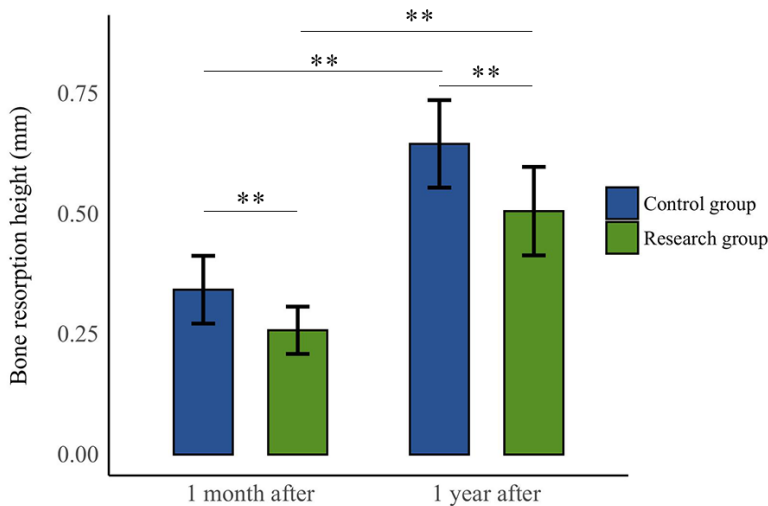


Figure 2. Comparison of peri-implant bone resorption between the two groups. **P<0.01.

treatment, giving a total effective rate of 82.00%. These data revealed a notably higher overall response rate in the research group compared to the control group (P<0.05, **Table 1**).

Comparison of safety between the two groups

The total incidence of adverse events, such as periodontal pain, bleeding, and tooth loosening in the control group was 18.75%, significantly higher than the 4.00% observed in the research group (P<0.05, **Table 2**).

Comparison of peri-implant bone resorption between the two groups

A comparative analysis of peri-implant bone resorption at 1 month and 1 year after treat-

ment is shown in **Figure 2**. The results showed that the bone resorption depth at 1 year after treatment was significantly greater than at 1 month in both groups (P<0.01). Furthermore, the resorption depth in the research group was significantly lower when compared to the control group (P<0.01).

Comparison of periodontal pocket depth between the two groups

Periodontal pocket depth in the control group decreased markedly after 1 year compared to the depth at 1 month (P<0.01). However, no significant change was observed in the research group (P>0.05). At both 1 month and 1 year after treatment, the periodontal pocket depth was significantly lower in the research group versus the control group (P<0.01, **Figure 3**).

Comparison of aesthetic effects between the two groups

The aesthetic effects were assessed by measuring the PES and WES (**Figure 4**). The results showed elevated PES and WES scores in both groups after 1 year of treatment compared with 1 month after treatment (P<0.05). Additionally, the research group exhibited significantly higher PES and WES scores than the control group at both 1 month and 1 year post-treatment (P<0.05).

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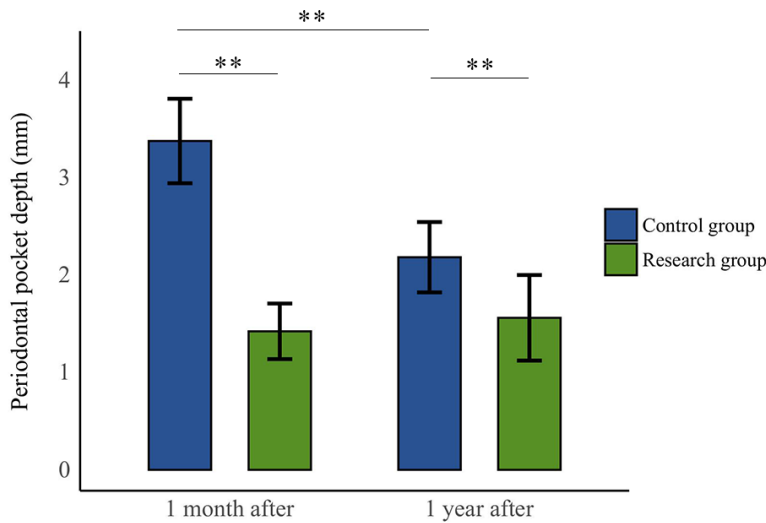


Figure 3. Comparison of periodontal pocket depth between the two groups. ** $P < 0.01$.

Comparison of masticatory function between the two groups

Before treatment, there were no significant differences in bite force or chewing efficiency between the two groups ($P > 0.05$). After treatment, both groups showed significant improvements in bite force and chewing efficiency ($P < 0.05$), with the research group showing particularly greater enhancements ($P < 0.05$, **Table 3**).

Comparison of oral function recovery between the two groups

The recovery of dental, chewing, and language functions was significantly better in the research group compared to the control group ($P < 0.05$, **Table 4**).

Comparison of treatment satisfaction rate between the two groups

Post-treatment satisfaction ratings were collected, and the results, shown in **Table 5**, revealed a significantly higher satisfaction rate in the research group compared to the control group (94.00% vs. 79.17%, $P < 0.05$).

Discussion

Maxillary anterior teeth, including upper central incisors, upper lateral incisors and upper canines, are particularly susceptible to damage and defects [16]. In patients with maxillary

anterior tooth loss, the associated periodontal tissue damage and alveolar bone resorption often result in increased oral sensitivity, leading to symptoms such as ulcers and gum pain. These issues can significantly impair the patient's ability to eat and chew normally [17, 18]. Besides, the loss of these teeth can cause malformation of the teeth and jaws, which not only compromises facial beauty, but also complicates the process of implant restoration [19]. Therefore, optimizing and improving treatment for maxillary anterior tooth loss is crucial for enhancing both facial appearance and functional outcomes.

Traditional restoration methods for maxillary anterior tooth loss, such as dentures and fixed bridge prostheses, can improve chewing function but often fail to meet patients' pursuit of long-term and stable aesthetic effect [20]. As a result, implant restoration was introduced to address these needs and has developed into a common approach for treating maxillary anterior tooth loss [21]. However, routine dental restoration is time-consuming and may cause significant friction around the remaining teeth in patients with severe maxillary anterior tooth loss, potentially compromising healthy teeth and leading to unsatisfactory clinical outcomes [22]. In contrast, modified oral implant restoration, which has become increasingly popular in recent years, offers a simpler procedure and shorter implantation time. This method not only enhances the aesthetic appearance of the teeth but also reduces skin damage in the oral cavity, providing a protective effect on the implant area and periodontal tissues, ultimately aiding in faster recovery of oral health [23]. In this study, the research group showed a notably higher total response rate than the control group (82.00% vs. 60.41%), suggesting better clinical effect of modified oral implant restoration for patients with maxillary anterior tooth loss. In terms of safety, the modified approach was associated with a notably lower incidence of total adverse events, demonstrating a favor-

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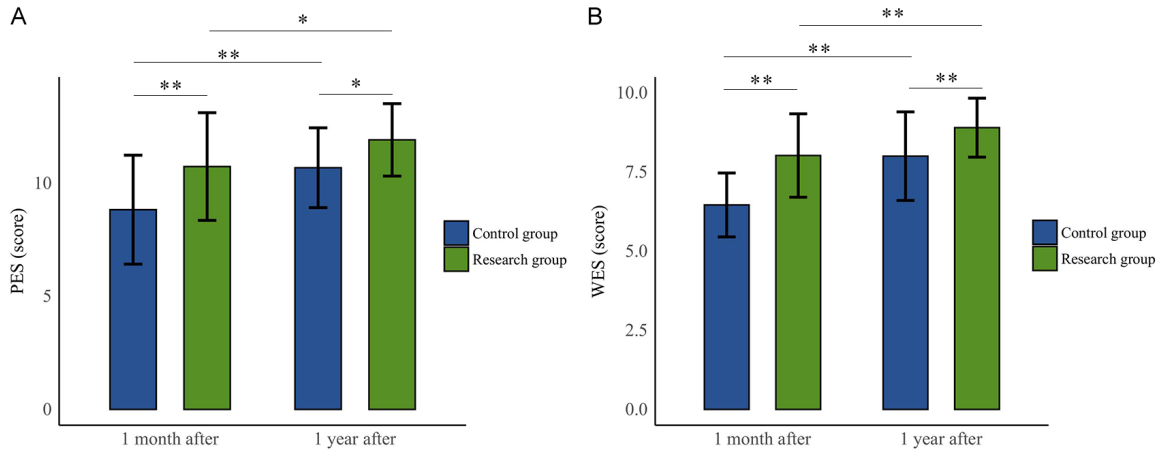


Figure 4. Comparison of aesthetic effects between the two groups. A. PES scores. B. WES scores. Note: *P<0.05, **P<0.01. PES, Pink Esthetic Score; WES, White Esthetic Score.

Table 3. Comparison of masticatory function between the two groups

Indicators	Control group (n=48)	Research group (n=50)	t	P
Bite force (1 bs)				
Before treatment	85.46±4.98	85.62±6.56	0.136	0.892
After treatment	122.62±5.29	131.26±8.66	5.930	<0.001
Chewing efficiency (%)				
Before treatment	53.98±4.77	55.54±3.49	1.853	0.067
After treatment	80.88±5.64	87.52±5.34	5.987	<0.001

Table 4. Comparison of oral function recovery between the two groups

Groups	n	Dental function	Chewing function	Language function
Control group	48	36 (75.00)	38 (79.17)	35 (72.92)
Research group	50	46 (92.00)	47 (94.00)	45 (90.00)
χ ² value	-	5.181	4.683	4.767
P value	-	0.023	0.031	0.029

Table 5. Comparison of treatment satisfaction rate between the two groups [n (%)]

Groups	n	Very satisfied	Basically satisfied	Dissatisfied	Satisfaction rate (%)
Control group	48	15 (31.25)	23 (47.92)	10 (20.83)	38 (79.17)
Research group	50	27 (54.00)	20 (40.00)	3 (6.00)	47 (94.00)
χ ² value	-	-	-	-	4.683
P value	-	-	-	-	0.031

able safety profile. Previous evidence has indicated that β-TCP graft material achieves osseointegration success rates of up to 100%, with minimal infection risk [24], which may help explain the clinical effectiveness and safety of the modified oral implant restoration in this context. The success of implant restoration is closely related to the degree of osseointegra-

tion with both hard and soft tissues, with high marginal bone absorption being a key factor that compromises clinical outcomes [25]. In this study, we evaluated the effects of the two restoration techniques on peri-implant bone resorption. The data revealed a statistically lower resorption depth in the research group one year after treatment, suggesting that the

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modified oral implant restoration has a more favorable effect on peri-implant bone preservation and enhances overall oral recovery for patients with maxillary anterior tooth loss.

Furthermore, the periodontal pocket depth in the research group at one year after treatment showed no significant change compared to one month after treatment, remaining lower than that in the control group, indicating that modified oral implant restoration has minimal negative impact on the periodontal tissue health of patients with maxillary anterior tooth loss. We also evaluated the aesthetic effect using PES and WES scores, in which PES mainly evaluated the soft tissues around teeth including gums and interdental papillae, and WES focused on the natural dentition and hard tissues [26]. Our research determined significantly higher PES and WES scores in the research group compared to the control group both one month and one year after treatment, suggesting that modified oral implant restoration has excellent aesthetic effect for patients with maxillary anterior tooth loss. In terms of masticatory function and oral function recovery, the research group demonstrated significant advantages over the control group, indicating that the modified implant restoration is highly effective in enhancing chewing function and accelerating oral function recovery. Additionally, when we surveyed patient satisfaction, the research group achieved a satisfaction rate of 94.00%, significantly higher than the control group's 79.17%. This highlights that modified oral implant restoration is better received by patients and more optimally meets their needs compared to traditional methods. In the research conducted by Zhong S et al. [27], the modified dental implant restoration, when compared to traditional fixed partial denture restoration for dentition defects, is more conducive to enhancing the therapeutic efficacy, safety, treatment satisfaction, aesthetic appearance, and masticatory function, aligning with the outcomes of our study. Furthermore, previous research has explored various treatments for tooth loss or defects. For instance, Huang D et al. [28] demonstrated that combining crown lengthening with post and core surgery for patients with maxillary anterior tooth loss was more effective in improving periodontal health, reducing the risk of gingival sulcus bleeding, and enhancing tooth aesthetics and patient satisfaction compared

to post and core surgery alone. Similarly, Barbato et al. [29] showed that minimally invasive surgical and non-surgical treatments for residual pockets with intra-bony defects also demonstrated effectiveness.

There are some limitations in our research that need further consideration. First, the absence of a 5-year long-term follow-up limits our understanding of the long-term effect of modified oral implant restoration. Second, due to the small sample size, the results may lack precision and generalizability. Finally, further analysis of the risk factors affecting treatment outcomes in patients with maxillary anterior tooth loss could provide valuable insights for improving therapeutic efficacy. Future research will focus on addressing these aspects.

In summary, modified oral implant restoration demonstrates remarkable clinical efficacy in patients with maxillary anterior tooth loss, characterized by a high safety profile and minimal impact on peri-implant bone resorption and periodontal pocket depth. It also yields positive results in terms of aesthetic outcomes, masticatory function, and oral function recovery, achieving high patient satisfaction. These findings suggest that modified oral implant restoration is a promising treatment option that deserves wider clinical promotion.

Disclosure of conflict of interest

None.

Address correspondence to: Yi-Liang Ni, Oral and Maxillofacial Surgery Department, Beijing Ni's Dental Hospital Co., Building 19, Daojiayuan, Chaoyang District, Beijing 100025, China. Tel: +86-13911327550; E-mail: 13911327550@163.com

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