

## Original Article

# Immediate implants show good therapeutic and aesthetic effect in patients with class III and IV bone loss of the anterior teeth

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**Abstract:** Objective: To study the effect of immediate implantation on the restoration effect and aesthetic indicators in patients with class III and IV bone loss of the anterior teeth. Methods: This retrospective study collected the data of 82 patients with single loss of anterior teeth who received tooth implantation. According to the treatment methods, these patients were divided into an observation group (N=43) and a control group (N=39). Patients from the observation group underwent immediate implantation treatment, while those from the control group received conventional implantation processing. Pink aesthetic index (PES) and gingival nipple index (GNI) were used to evaluate the aesthetic indicators. Implant stability quotient (ISQ) was applied to evaluate the stability. The incidences of complications after treatment and the success rate of implantation were also recorded and compared between two groups. Results: At the same day of completed implantation, the observation group had higher various PES index scores than those in the control group (all  $P < 0.05$ ) and no significant differences were found for GNI index between two groups. At the 6<sup>th</sup> month following the implantation, there was no statistical difference in various PES index scores, GNI index, ISQ value of bone type III and IV between the two groups. The treatment time for bone type III and IV in the observation group was obviously less than that in the control group (all  $P < 0.05$ ). There was no significant difference in the total incidence of complications between the two groups (9.30% vs 12.82%,  $\chi^2 = 0.634$ ,  $P > 0.05$ ). The success rate of implantation in the observation group was remarkably higher than that in the control group (95.35% vs 84.62%,  $\chi^2 = 4.1129$ ,  $P = 0.041$ ). Conclusion: An immediate implantation treatment for patients with single loss of an anterior tooth with bone type III and IV could clearly shorten the treatment period and improve the PES scores at baseline and have better restoration and aesthetic effects.

**Keywords:** Single anterior teeth, bones class III and IV, immediate implantation, conventional implantation, restoration effect, aesthetic index

## Introduction

Teeth are an important part of the body and closely associated with human health and quality of life. With the growth of age or the effect of external forces, tooth loss often occurs. Due to a similar appearance and function to physiological teeth, implanted teeth are favored by the majority of patients with tooth loss and become the first choice for oral restoration. With the continuous development and improvement of dental implant technology, the methods of dental implant mainly include conventional implant and immediate implant [1]. The conventional implant method is defined by an operation for the implant which is performed when the alveo-

lar bone heals, which can be from 3 months to half a year after tooth extraction [2]. Conventional implant surgery can effectively improve the rate of tooth implantation, but the treatment cycle is long, and long-term tooth loss brings inconvenience to the lives of patients. Moreover, there are varying degrees of alveolar atrophy which may lead to the degradation of surrounding tissues. Recently, immediate implantation is a new treatment concept for the tooth loss. Immediate implantation is defined by tooth implantation in the tooth socket immediately after the tooth extraction [3]. In addition to reducing the treatment time, immediate implantation technology can perform implantation restoration, which has been wide-

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ly used in clinical practice [4]. Immediate implantation can decrease the operation steps and the time of tooth loss, enable patients to recover early masticatory function, facilitate the accurate implantation of implants in the anatomical position, reduce the absorption of the alveolar ridge, avoid unnecessary gasification in the maxillary sinus cavity, and maintain an ideal alveolar bone height for the central body to the greatest extent [5]. In addition, after tooth extraction, problems such as tooth socket shape, alveolar bone mass, implant selection and how to deal with residual space will affect the stability of implants following implantation [6]. At present, the criteria for the successful immediate implantation are that the implants have early stability, long-term integration and stability following restoration in the alveolar bone, which could restore the normal chewing function with high aesthetics [7].

The type of alveolar bone is one of the important factors that determines the success of implant therapy. Immediate implantation in different bones has different effects on postoperative stability, red aesthetic index, white aesthetic index, complications and treatment time. A study pointed out that the long-term stability of implants was closely related to bone type [8]. Bones could be divided into four types, named type I, type II, type III and type IV. So far, there are little research data regarding the relevant efficacy and aesthetic outcomes of single tooth loss restoration of bone type III and IV. In order to further explore the restoration effect of immediate implantation on bone type III and IV with single tooth loss, 82 patients with single anterior tooth loss of bone type III and IV admitted to the stomatology department of our hospital from January 2020 to January 2022 were selected as the research subjects in this study and the overall efficacy and aesthetic index between immediate implant and conventional implant were compared and analyzed. The results of this study provide clinical reference for the selection of different implantation restoration treatments under the conditions of bone type III and IV.

### Material and methods

#### *General information*

This is a retrospective study. From January 2020 and March 2022, 82 patients with single

loss of anterior teeth, who were prepared to receive tooth implantation were selected as the research subjects. According to the method of treatment, these patients were divided into the observation group and the control group. There were 43 patients from the observation group who underwent immediate implantation, while 39 patients from the control group received conventional implantation. Hospital Ethics Committee approved this research (No. 2019-108).

Inclusion criteria: (1) Patients were diagnosed with single loss of maxillary anterior teeth. (2) Patients had class III and IV bone loss of the anterior teeth. (3) Their age was over 18. (4) Patients were not accompanied with serious injuries of periodontal tissue. (5) Complete medical records were obtained, and patients voluntarily participated in this study. Exclusion criteria: (1) The inflammation occurred in the planting region. (2) The tissues from the planting area were seriously injured. (3) Patients were allergic to therapeutic drugs. (4) Patients with mental disorders who could not cooperate with treatment or communicate normally. (5) Patients with coagulation dysfunction. (6) Patients who had contraindications of immediate planting.

#### *Methods of treatment*

Immediate implantation was performed in patients from the observation group. The details were as follows: The oral cavity was cleaned before surgery. Then, local anesthesia was conducted after disinfection and aseptic towel draping. The apical membrane of the alveolar ridge was cut open through the minimally invasive triangular incision. The unhealthy teeth were pulled out and the affected area was rinsed repeatedly using normal saline. The granulation tissue in the alveolar fossa was scraped off. The implant system (Noble Active, Switzerland) was used to prepare the suitable implant sockets and implants according to the height, width and degree of alveolar bone. The dental implant machine (Type: iCHIROPO, Swiss Bianan Company) was applied to keep the implants to their three-dimensional positions by the rotation method. The exposed parts of dental sockets and implants were filled with bone powders and covered with BioGuide artificial periosteum (Bishihai Company, USA). The temporary crowns made of resin were fixed with

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screws. After 3 months, the mold was taken. The dental crowns were worn following the stable implants.

Conventional implantation was conducted in patients from the control group. Briefly, it was performed according the previous study. At two months after tooth extraction, the dental implants were performed. After local anesthesia, the flap was opened along the alveolar ridge, and the tooth was implanted in a suitable three-dimensional position. The surgical method and equipment were the same as those in the observation group.

### *Observed index*

The pink aesthetic score, gingival nipple index and implant stability quotient were considered as the primary indicators, while the treatment time, complications and success rate of implantation were considered as the secondary indicators.

The pink aesthetic score (PES) was used to evaluate the aesthetic effect in patients from the two groups at the same day of completed dental implant and half a year after the implantation [9]: The evaluative criteria were as follows: The marginal gingival level was 2 points. The proximal and distal gingival papillae were 4 points. The appearance, texture and color of soft tissue were 6 points. The appearance of alveolar bone was 2 points. The total score was 14 points, and the aesthetic repair was more than 9 points.

The assessment of gingival nipple index (GNI) was conducted at the same day of completed dental implants and six months after the implantation [10]. According to the height changes of the proximal and distal gingival papilla at half a year after restoration, GNI assessment was divided into five grades. The details were as follows: Grade zero indicated that there was no gingival papilla. Grade one indicated that the number of gingival papilla was less than 50% of the dental space. Grade two indicated that the number of gingival papilla was greater than 50% of the dental space. Grade three indicated that the dental space had filled with gingival papilla. Grade four indicated that the gingival papilla had grown excessively and exceeded the dental space.

Implant stability quotient (ISQ) evaluation was conducted in both of groups at six month following completed implantation. The normal value of ISQ was between a score of 55 and 85 points [11]. ISQ evaluation was finished using CVP830 Resonance Spectrum Analyzer (Beijing Haicheng Xinfeng Technology Co., Ltd., China).

In additional, the treatment time was compared between the observation group and the control group. The treatment time was defined as the time from surgery to completed treatment [12]. The complications and success rate of implantation were also recorded and compared between two groups. The complications following the operation included metal exposure, swollen gums and tooth mobility.

### *Statistical methods*

All the clinical data collected in the research were analyzed using SPSS version 21.0. The measurement data were described as Mean  $\pm$  Standard deviation, and the comparison was performed by t test. The count data was described as percentages/cases. The comparison among groups was performed using  $\chi^2$  test.  $P < 0.05$  suggested significantly statistical differences.

## **Results**

### *Basic data*

As described in **Table 1**, there were 43 patients with immediate implantation and 39 patients with conventional implantation in this research. There was no significant difference in the gender, age, weight, number of teeth lost and classification of cementum between the observation group and control group (all  $P > 0.05$ ).

### *Comparison of PES between observation group and control group*

As described in **Table 2**, at the same day of completed implantation, scores of the marginal gingival, the proximal gingival papillae, the distal gingival papillae level, the soft tissue appearance, the alveolar bone appearance and the soft tissue color in the observation group were significantly higher than those in the control group, and statistical differences were observed between the two groups (all  $P < 0.05$ ).

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**Table 1.** The comparison of basic data between the observation group and control group

Parameters		Observation group (N=43)	Control group (N=39)	t/ $\chi^2$ value	P value
Gender	Male	21	19	0.751	0.376
	Female	22	20		
Age (years)		41.98±6.22	40.36±7.57	0.830	0.341
Weight (kg)		39.14±6.78	38.27±9.22	0.531	0.517
Number of tooth loss		1.32±0.11	1.38±0.14	0.852	0.328
Classification of cementum	Class III	32	30	0.682	0.409
	Class IV	11	9		

**Table 2.** Comparison of PES assessment at the same day of completed implantation between the observation group and the control group

Groups	Marginal gingival level	Proximal gingival papillae	Distal gingival papillae	Appearance of soft tissues	Appearance of alveolar bone	Color of soft tissues
Observation group	1.14±0.13	1.45±0.27	1.25±0.28	0.41±0.17	0.38±0.13	0.45±0.14
Control group	0.62±0.09	0.60±0.11	0.52±0.16	0.25±0.12	0.27±0.12	0.28±0.17
t value	10.1342	13.0987	11.2289	6.4704	4.2981	5.6459
P value	<0.001	<0.001	<0.001	0.012	0.026	0.018

Note: PES: Pink aesthetic score.

**Table 3.** Comparison of PES assessment at 6<sup>th</sup> months after implantation between the observation group and the control group

Groups	Marginal gingival level	Proximal gingival papillae	Distal gingival papillae	Appearance of soft tissues	Appearance of alveolar bone	Color of soft tissues
Observation group	1.49±0.21	1.58±0.22	1.54±0.21	1.25±0.36	1.23±0.21	1.22±0.25
Control group	1.45±0.27	1.61±0.19	1.55±0.17	1.21±0.28	1.24±0.11	1.19±0.21
t value	0.543	0.836	0.630	0.754	0.711	0.477
P value	0.586	0.409	0.542	0.471	0.480	0.639

Note: PES: Pink aesthetic Score.

As shown in **Table 3**, at 6<sup>th</sup> months after implantation, there were no significant differences in the scores of the marginal gingival level, the proximal gingival papillae, the distal gingival papillae, the soft tissue appearance, the alveolar bone appearance and the soft tissue color between the observation group and control group (all  $P > 0.05$ ).

### *Comparison of GNI between observation group and control group*

As shown in **Tables 4** and **5**, on the day of completed dental implant, there were 12 cases with grade 1, 19 cases with grade 2, 11 cases with grade 3 and 1 case with grade 4 in the observation group; while there were 10 patients with grade 1, 16 patients with grade 2, 12 patients with grade 3 and 1 patient with grade 4 in the control group. At half a year after

implantation, there were 2 cases with grade 0, 14 cases with grade 1, 18 cases with grade 2, 9 cases with grade 3 in the observation group; while there was 1 patient with grade 0, 11 patients with grade 1, 17 patients with grade 2 and 10 patient with grade 3 in the control group. On the day of completed dental implants and half a year after the implantation, there was no statistical difference for GNI between the two groups ( $P > 0.05$ ).

### *Comparison of ISQ value between observation group and control group*

As described in **Table 6**, at 6<sup>th</sup> months after implantation, ISQ value in the observation group was 71.52±10.21 for bone type III and 67.41±9.11 for bone type IV, respectively, while ISQ value in the control group was 72.38±9.72 for bone type III and 68.64±8.05 for bone type

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**Table 4.** Comparison of GNI assessment at the same day of completed implantation between the observation group and the control group

Groups	Cases (n)	Grade 0	Grade 1	Grade 2	Grade 3	Grade 4
Observation group	43	0	12 (27.91%)	19 (44.19%)	11 (25.58%)	1 (2.33%)
Control group	39	0	10 (25.64%)	16 (41.03%)	12 (30.77%)	1 (2.56%)
$\chi^2$ value				6.201		
<i>P</i> value				0.231		

Note: GNI: Gingival Nipple Index.

**Table 5.** Comparison of GNI assessment at 6<sup>th</sup> months after implantation between the observation group and the control group

Groups	Cases (n)	Grade 0	Grade 1	Grade 2	Grade 3	Grade 4
Observation group	43	2 (4.65%)	14 (32.56%)	18 (41.86%)	9 (20.93%)	0
Control group	39	1 (2.56%)	11 (28.21%)	17 (43.59%)	10 (25.64%)	0
$\chi^2$ value				3.618		
<i>P</i> value				0.579		

Note: GNI: Gingival Nipple Index.

**Table 6.** Comparison of ISQ value for bone type III and IV at 6<sup>th</sup> months after implantation between the observation group and the control group

Groups	Bone type III	Bone type IV
Observation group	71.52±10.21	67.41±9.11
Control group	72.38±9.72	68.64±8.05
<i>t</i> value	0.761	0.923
<i>P</i> value	0.438	0.315

Note: ISQ: Implant Stability Quotient.

IV, respectively. No statistical differences were found for ISQ value between two groups (all  $P > 0.05$ ).

### *Comparison of treatment time between observation group and control group*

As described in **Table 7**, the treatment time in the observation group was (2.63±0.72) months for bone type III and (3.97±1.17) months for bone type IV, respectively, while in the control group it was (7.16±1.05) months for bone type III and (8.58±1.96) months for bone type IV, respectively. Compared with those in the control group, the treatment time in the observation group was obviously reduced (all  $P > 0.05$ ).

### *Comparison of complication and success rate between observation group and control group*

As shown in **Table 8**, in term of complications, in the observation group, there was 1 case with

metal exposure, 2 cases with swollen gums and 1 case with tooth mobility; while there were 2 cases with metal exposure, 1 case with swollen gums and 2 cases with tooth mobility in the control group. There was no statistical difference for the total incidence of complications between two groups (9.30% vs 12.82%,  $\chi^2 = 0.634$ ,  $P > 0.05$ ). Moreover, the success rate of implantation in the observation group was obviously higher than that in the control group (95.35% vs 84.62%) ( $\chi^2 = 4.1129$ ,  $P = 0.041$ ).

## Discussion

In the recent years, the requirements for the dental implant restoration technology have been increasing [13, 14]. Some studies have shown that implant technology can provide a better treatment idea and method for the restoration of dentition defect and loss [15-17]. Other studies reported that conventional implant operation could effectively improve the implantation rate of teeth, but the treatment time was relatively long. Long-term tooth loss has a certain impact on the quality of life in patients, leading to the atrophy of alveolar bone and subsequently the degeneration of periodontal soft tissue [18, 19].

Another study revealed that immediate implant technology can effectively reduce the number of treatments, decrease the treatment time, shorten the vacancy time of alveolar bone and improve the quality of life in patients [20, 21].

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**Table 7.** Comparison of treatment time between the two groups

Groups	Bone type III (Months)	Bone type IV (Months)
Observation group	2.63±0.72	3.97±1.17
Control group	7.16±1.05	8.58±1.96
t value	11.4938	9.5722
P value	<0.001	<0.001

However; the aesthetic index, stability and complications following immediate implantation are different in various types of bone [22-24]. The assessment of bone quality before treatment could help to formulate effective treatment plans and select suitable implants, which is conducive to improving the success rate of implants [25-27]. Immediate implantation can effectively protect the alveolar bone septum and facilitate the growth of attached gingiva [28, 29]. In addition, some research data revealed that the PES was higher on the day when immediate implantation was completed, but there was no significant difference in term of PES at 1 year after completed restoration [30]. Therefore, the application of immediate implantation has been gradually increasing.

This study focused on the patients with class III and IV bone loss of anterior teeth. The results showed that on the day of completed implantation, the scores of various PES index in the observation group were significantly higher than those in the control group, but there was no significant difference in terms of the scores of various PES indexes between the two groups at half a year after completed implantation, which was consistent with the results reported by previous studies [31]. This result further proved that immediate implantation could obtain good aesthetic effects on the day of completed implantation. The reason may be as follows: immediate implantation can effectively reduce the duration of surgery, the shape of gingival papilla remained relatively normal, the absorption of alveolar bone was relatively reduced, and the height and fullness of periodontal soft tissue were relatively high. On the day of implantation completion and half a year after restoration, there was no significant difference for GNI indexes between the two groups, which indicated that there was no statistical difference regarding GNI aesthetic effects between these two implantation methods, which were similar with the results report-

ed by Halasa [32] and Siegenthaler [33].

For different bone types, there were differences in the term of implant selection and postoperative stability [34, 35]. In the case of implants in poor bone, the stability of implants was usually

insufficient, and better stability was an important factor to improve the success rate of implantation [36-39]. Type III bone had more cancellous substance and relatively thin bone cortex, and the stress of implants at the bone interface was relatively increased, which could easily lead to the failure of implantation [40, 41]. However, so far there are few clinical studies on type IV bone. The results of this study showed that there was no significant difference regarding the implant stability of type III and IV bone between the observation group and the control group, which indicated that these two implantation methods in this study had no significant impact on the postoperative stability of different bone types. The treatment time of patients with bone type III and IV in the observation group was obviously shorter than that in the control group, which was in accordance with previous studies [42, 43]. These results also suggested that immediate implantation could effectively reduce the time for dental function returning to normal and decrease the time for dental pain, with significant effect.

This study indicated that the major reason for the success of immediate implant was that the implants had relatively good initial stability, and sufficient alveolar bone could provide an important condition for the initial stability of the implants. Therefore, it is necessary to better preserve the integrity of alveolar bone during tooth extraction, which is the key to the treatment of immediate implant. However, due to the anatomical characteristics, even minimally invasive tooth extraction will cause some damage to the alveolar bone to a certain extent. After tooth extraction, there are multiple tooth sockets and interradicular bone ridges. These problems are not conducive to implant implantation and initial stability after implantation. In addition, the effective height of alveolar bone would also be limited by changes in the position of maxillary sinus, inferior alveolar nerve canal, etc. These anatomical structures are difficult problems for immediate implant treatment. The

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**Table 8.** Comparison of complication incidences between the two groups (cases)

Groups	Cases	Metal exposure	Swollen gums	Tooth mobility	The overall incidence (%)
Observation group	43	1	2	1	9.30
Control group	39	2	1	2	12.82
$\chi^2$ value					0.634
<i>P</i> value					0.529

shape of the tooth socket after tooth extraction is mainly determined by the anatomical structure of the dental root. The successful implant implantation was determined by the shape of the tooth socket to a certain extent. There are some differences regarding tooth position between individuals. Using the residual root as the positioning, planting materials are implanted, and then the residual root is removed, which could result in obtaining a satisfactory implantation position. It is conducive to improving the successful rate of implantation. The direction of the planting materials implanted in the alveolar bone would generally follow the long axis of the occlusal force of the posterior teeth. Therefore, after the extraction of the teeth, the planting materials are implanted in one of the root sockets, which may form an obvious angular load, and would produce a cantilever effect in the cheek and palate, and finally would affect the restoration effects of planting materials. The planting materials implanted in an unsatisfactory position also leave hidden trouble behind for the later application of the dental implant. If the surrounding environment of the implant are not kept clean, it increases the probability of inflammation around the implants and is prone to complications such as loosening of implants. The shape of the planting materials implanted in the extraction socket needs to match with the dental socket, which can reduce the periodontal space, effectively ensure the initial and long-term stability of the implant and reduce the incidence of implants inflammation. The morphology and structure of good implants can also create favorable conditions for the implant in the alveolar bone and reduce the complications of planting materials following implantation under the conditions of relatively unchanged alveolar bone mass. According to the stress of the alveolar fossa after tooth extraction, this study believes that it is beneficial to improve the success rate of implant by implanting the implants with relatively large diameter. A large diameter implant can increase the joint area between the im-

plants and the surrounding alveolar bone, maintain the anatomical structure of soft and hard tissues, and effectively disperse the occlusal force to a certain extent. It can also reduce the gap between the abutment and the implants, and the dental crown, which is conducive to keeping the periodontal clean.

So far, implants with a diameter of about 5 mm are usually used clinically, and the length of implants should be selected according to the specific amount of alveolar bone mass. There are two kinds of implant profiles: conical and cylindrical. The conical implants and deep thread design are conducive to obtaining better stability at the initial stage. The conical implants can generate a certain lateral pressure on the alveolar bone during implantation. The deep thread design is used to increase the contact area, thereby increasing torque. The diameter difference between the implants and the final drill should exceed 0.5 mm, in order to prevent excessive heat generation during implantation and affect the bone bonding.

In conclusion, for patients with single tooth loss of anterior bones of Class III and IV, immediate implantation can effectively reduce the patient's treatment time, improve the pink aesthetic score on the day of completed implantation, and has better aesthetic restoration. It is suitable for clinical application. However, this is a retrospective study with limited case size; therefore, more multi-center perspective clinical trials with larger sample volume are warranted to verify these findings.

### Disclosure of conflict of interest

None.

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