

RESEARCH

Open Access



Immediate implant placement for single failed maxillary anterior teeth after trauma: a case-series study

Zinan Yang¹, Xiao Chen¹, Jingyun Chen¹, Yinyin Li¹ and Qian Liang^{2*}

Abstract

Background The purpose of this retrospective evaluation was to assess the treatment outcomes following immediate implant placement for single failed maxillary anterior teeth after trauma. Moreover, both objective and subjective esthetic assessments were conducted.

Methods Immediate implant placement was performed on thirty-two patients who had a single untreatable, traumatic tooth in the anterior maxilla. At the one-year mark following the final restoration, marginal bone changes, pink/white esthetic scores (PES/WES), and patient satisfaction data were collected. Factors such as age, sex, gingival biotype, thickness of the buccal bone wall, and size of the jumping gap were considered potential influences on the clinical results, with their relationships being examined.

Results The implant survival rate was 100% after one year of final restoration, with marginal bone changes measuring -0.17 ± 0.31 mm mesially and -0.22 ± 0.28 mm distally. Additionally, the PES averaged 10.7, whereas the WES averaged 7.3. On the patient side, esthetic satisfaction scored an average of 8.89 on the visual analog scale. Interestingly, no significant correlations were found between potential factors and esthetic scores or patient satisfaction.

Conclusions In the initial year following the final restoration, immediate implant placement for single failed maxillary anterior teeth post-trauma demonstrated promising clinical outcomes both objectively and subjectively.

Keywords Dental implants, Esthetic region, Immediate implant, Dental trauma

*Correspondence:

Qian Liang

lqskywalker@163.com

¹Stomatological Hospital, School of Stomatology, Southern Medical University, Guangzhou 510280, China

²School and Hospital of Stomatology, Guangdong Engineering Research Center of Oral Restoration and Reconstruction & Guangzhou Key Laboratory of Basic and Applied Research of Oral Regeneration Medicine, Guangzhou Medical University, Guangzhou 510140, China



© The Author(s) 2025. **Open Access** This article is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits any non-commercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if you modified the licensed material. You do not have permission under this licence to share adapted material derived from this article or parts of it. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by-nc-nd/4.0/>.

Background

Injuries to the teeth in the anterior maxilla are commonly observed. In some cases, teeth that have been severely damaged and are unable to be restored may need to be removed and replaced by a dental implant. Experiencing the loss of a tooth in the esthetic area can be emotionally challenging for individuals, particularly in cases of dental injuries where patients are caught off guard. Hence, individuals in such circumstances are often eager for implant placement and restoration. Nevertheless, the challenge of maintaining esthetics becomes more pronounced due to the gradual loss of soft and hard tissue after tooth extraction.

The timing, in terms of implant placement post-tooth extraction categorization, can be classified into four types: immediate placement (type 1), occurring within 24 h following extraction; early (type 2), occurring after 6–8 weeks; delayed (type 3), occurring after 3 months; and late (type 4), occurring after more than 6 months. The advantages of immediate dental implant placement are evident compared with delayed implant placement, offering streamlined surgical interventions, reduced treatment duration, and preservation of surrounding soft and hard tissues [1–3].

Numerous investigations have documented favorable outcomes with regards to the placement of dental implants immediately after the extraction of teeth in the anterior maxilla [4–7]. On the other hand, the immediate placement of implants comes with a set of restrictions and dangers, including the possibility of implant failure, infection, peri-implantitis, and issues related to esthetics [8, 9]. Furthermore, few studies have explored the topic of the immediate placement of dental implants after dental injury. Hence, further investigations should be conducted to determine the critical details of the therapeutic process.

Our department has conducted immediate placement of dental implants for maxillary anterior teeth that have been compromised due to trauma over the course of the previous 8 years. The aim of this study was to assess the efficacy, peri-implant tissue response, esthetic results, and patient satisfaction following immediate dental implantation subsequent to trauma in the anterior region of the maxilla while examining potential factors influencing the clinical results.

Methods

Patients and study design

A review of the medical records of individuals who underwent immediate placement of dental implants following injuries to their teeth was performed. During the period spanning from January 2014 to December 2021, patients who participated in this research were treated at the Department of Periodontology and Oral

Implantology, Stomatological Hospital, Southern Medical University (Guangzhou, China). The patients were selected according to specific inclusion and exclusion criteria.

The established criteria were as follows:

1. Presence of a maxillary anterior tooth (canine or incisor) that has been damaged due to trauma in the past two weeks;
2. Underwent immediate dental implant placement;
3. The surrounding teeth have probing depths no deeper than 4 mm;
4. Good oral hygiene

The exclusion criteria are outlined below:

1. Factors such as a complex medical history including alcohol consumption, smoking habits, or overall poor health that could impact the study results were considered.
2. Having a dental history involving bruxism, abnormal habits, and/or an unstable posterior occlusion;
3. Noncompliance.

All study participants underwent immediate dental implant placement in the esthetic zone, with a portion of them receiving immediate temporary restorations. Following a healing period of 6 months or more, the final restorations were carried out. All patients provided detailed informed consent before treatment

Clinical procedure

During the initial visit, a cranial cone beam computed tomography (CBCT) scan was conducted to assess the injured teeth and rule out any potential bone fractures. The subsequent evaluation of the injured tooth involved consultation with an oral surgeon, prosthodontist, and endodontist to determine its preservation feasibility.

If the wounded tooth could not be kept and the patient chose to have an oral implant, the patient received standard treatment planning and consented to the treatment. In the case of a damaged tooth where the buccal bone wall remains intact and there is sufficient residual bone, minimally traumatic extraction was carefully carried out, and the implant was immediately inserted into the fresh extraction socket in a flapless manner. All implants were placed 1–2 mm below the edge of the socket, to compensate the potential resorption of the buccal wall. The specific implant system utilized in this study was the Zimmer Biomet TSV (Warsaw, Indiana, U.S.). The diameter of the implant was 3.7 mm in all patients. Bone particles (Bio-oss, Geistlich Pharma AG, Wolhusen, Switzerland) were used to fill the space between the implant and the buccal wall.

Patients were instructed to use the broad-spectrum antibiotics cefuroxime (0.25 g, twice per day for 3 days) or roxithromycin (0.15 g, twice per day for 3 days) in the case of cefaclor allergy. 0.5% chlorhexidine was utilized for mouthwash three times daily during the first 2 weeks. The patient received one dose of dexamethasone (5 mg) orally post-surgery. The ice packs were used in the first 48 h after surgery. Patients were advised to consider nonsteroidal anti-inflammatory drugs in cases of pain. Sutures were removed after one week.

For some of the patients with an insertion torque greater than 35 N×cm, a temporary restoration was prepared and placed immediately after surgery. Some temporary restorations were prepared with the fractured

crown of the patient before surgery (see Fig. 1). In cases where immediate provisionalization was not performed, prefabricated healing abutments were placed on the implants. The clinical outcomes were subsequently analyzed and compared between patients who received immediate provisionalization and those who did not. A minimum of four months after the surgery date, the final implant impression was taken using polyether silicone rubber (Minnesota Mining and Manufacturing Company, 3 M, Maplewood, Minnesota, U.S.). A definitive customized crown with gingival emergence established by the provisional restoration was fabricated via Hex-Lock Contour Abutments (Zimmer Biomet). The definitive abutment was torqued to 30 N/cm (manufacturer's recommendation, Zimmer Biomet). The zirconia coping and zirconia crown, which are highly esthetic and natural-looking, were cemented (RelyX U200, 3 M).

Data collection

All examinations and data collection were performed by the same examiner. Assessments were conducted at the time of implant insertion (T0), upon completion of the final restoration (T1), and twelve months after final restoration (T2). The recorded variables included the success or failure of the implant, the marginal bone level, pink/white esthetic scores (PES/WES), and the satisfaction of patients with esthetics. The buccal bone wall thickness and jumping gap distance were measured at the level of implant shoulder through CBCT images at T0.

Marginal bone change

Sequential periapical radiographs and the long cone parallel technique were utilized to assess the changes in the marginal bone. To achieve standardization in angulation and film position to the X-ray beam, an occlusal jig was employed. Marginal bone levels of the implants were measured on the mesial and distal aspects at T1 and T2 under 10x magnification, with accuracy to the nearest 1 mm. The reference point for measurement was established at the apical corner of the implant shoulder, and subsequently, the alterations were calculated. A positive value is denoted when there is more coronal implant–bone contact in comparison to the reference point; conversely, a negative value is assigned when implant–bone contact is more apical than the reference point.

Esthetic assessment

The esthetic scores were objectively evaluated by two blinded prosthodontists who were not involved in the treatment.

Pink esthetic score The pink esthetic score [10] was used to assess all patients, and consisted of seven variables: the mesial papilla, distal papilla, soft tissue level, soft tissue

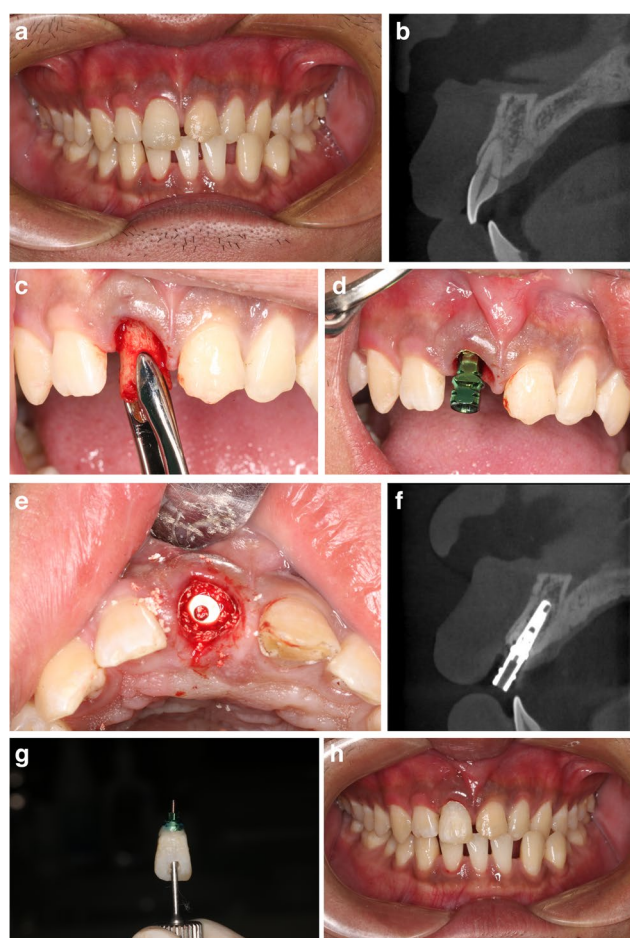


Fig. 1 The patient fell off the bicycle and broke his right upper incisor two days prior. CBCT examination revealed that the tooth was fractured in the neck. The treatment plan was to extract tooth 11, immediately insert an implant (Zimmer TSV, 3.7 mm in diameter, 13 mm in length), and perform immediate restoration with the extracted crown. Front view (a) and parasagittal CBCT slice of 11 before implant surgery b. Surgical process: (c) tooth extraction; (d) implant placement; (e) filling of the jumping gap with bone particles (Bio-oss). f parasagittal CBCT slice of 11 after implant surgery. g the temporary crown. h front view after immediate restoration. One year after the final restoration, the front view (i) and parasagittal CBCT slice of 11 (j) are shown

contour, alveolar process deficiency, soft tissue color, and soft tissue texture. The scoring system assigned a value of 0, 1, or 2 to each factor. The scale ranged from 0, representing the least favorable outcome, to 2, indicating the most favorable outcome for every variable; hence, achieving a total of 14 would signify optimal peri-implant soft tissues. The threshold for clinically acceptable soft tissues was set at 8. A score of 12 or higher was considered to indicate almost perfect peri-implant soft tissues, as previously described.

White esthetic score The White Esthetic Score [11] was utilized to evaluate all patients, encompassing five different variables: the general shape of the teeth, the contour of the teeth, the color of the teeth (including hue and value), the texture of the tooth surface, and the level of translucence. A scoring system of 0, 1, or 2 was applied to each parameter. The scores ranged from the least favorable outcome, represented by 0, to the most favorable outcome, represented by 2, for every variable. The esthetics of the implant-supported tooth were compared with those of the contralateral reference tooth. When the closest resemblance to the contralateral tooth was achieved, a maximum score of 10 was awarded. The thresholds for a clinically acceptable or an almost perfect implant crown were set at 6 and 9, respectively.

Patient esthetic satisfaction

During the one-year follow-up evaluation, an evaluation was conducted to assess the satisfaction of each patient with the overall implant treatment through a subjective outcome questionnaire. The questionnaire comprised five inquiries and a visual analogue scale (VAS) spanning 10 centimeters, ranging from 0 (representing the least favorable outcome) to 10 (representing the most favorable outcome) for evaluating patient content. Each patient's response to the listed inquiries was used to compute an average VAS score.

1. How do you evaluate the shape of your dental implant tooth?
2. How do you evaluate the color of your dental implant tooth?
3. How do you evaluate the shape of the gum around your dental implant tooth?
4. How do you evaluate the color of the gum around your dental implant tooth?
5. What are your overall feelings towards your dental implant tooth?

Data analysis

Means and standard deviations were computed for each clinical parameter during each specific timeframe. GraphPad Prism (version 10, GraphPad Software, Boston,

MA) was utilized to analyze the data. The Wilcoxon signed-rank test was adopted to measure the marginal bone changes in the first year. Two-tailed *t* tests for independent samples were used to define the relationships between potentially relevant factors (i.e., age, sex, gingival biotype, buccal bone wall thickness, jumping gap and immediate provisionalization) and esthetic scores. The Spearman correlation coefficient was used to assess the association between objective esthetic scores and patient esthetic satisfaction (VAS). The Mann-Whitney test was used to compare the VAS scores of patients in different groups according to their potentially relevant factors. Statistical significance was denoted when $P < 0.05$.

Results

From 2015 to 2021, 32 patients with single traumatized teeth in the esthetic area underwent immediate implant placement. There were 17 males and 15 females, with a mean age of 36.0 years (range 18–67). Thirty central incisors and 2 lateral incisors were included. Thirty-two threaded hydroxyapatite-coated tapered implants (Zimmer Biomet, TSV) were immediately inserted within two weeks after trauma. Six of them had immediate provisionalization. At least one year after the final restoration (ranging from 12.1 to 73.1 months, average 21.3 months), all 32 implants exhibited stability. The overall cumulative implant success rate was 100%, with no instances of osseointegration loss. Furthermore, the average buccal bone thickness was 0.83 mm, and the average jump gap between the bone and the implant was 2.38 mm. A summary of the patients' basic information and clinical features can be found in Table 1.

Marginal bone changes

Statistically significant marginal bone changes were noted after 1 year, with mean changes of -0.17 ± 0.31 mm mesially (Wilcoxon signed-rank test, $P = 0.004$; median = 0.00, range -0.84 mm to 0.20 mm) and -0.22 ± 0.28 mm distally (Wilcoxon signed-rank test, $P = 0.0058$; median = -0.10 , range -0.92 mm to 0.20 mm).

Esthetic outcomes

At the patients' one-year revisit, the esthetic outcomes, including the PES and WES, were evaluated. The PESs of 30 cases are acceptable or almost perfect, and the WESs of 27 cases are acceptable or almost perfect. The average PES was 10.7 (ranging from 4.5 to 14, standard deviation ± 5.44 , median 11), and the average WES was 7.3 (ranging from 3.0 to 10, standard deviation ± 4.05 , median 7.75), with a mean total esthetic score of 18.0. Details on the distribution of PES and WES scores can be found in Table 2.

Age, sex, gingival biotype, buccal bone wall thickness and jumping gap are not correlated with the esthetic

Table 1 Patient basic information and clinical features

	No. of cases	Average
Age distribution		36
18-40y	20	
40-60y	10	
Over 60y	2	
Sex		
Male	17	
Female	15	
Gingival Biotype		
Thick	12	
Thin	20	
Buccal bone wall thickness		0.83 mm
below 1 mm	24	
above 1 mm	8	
Jumping gap		2.38 mm
below 2 mm	8	
above 2 mm	24	
Implant position		
central incisor	30	
lateral incisor	2	
Length of implant		
11.5	11	
13	16	
16	5	
Sagittal root position classification		
Class I	31	
Class II	1	

Table 2 The number and percentage of grades of the esthetic score

	Number of cases	Percentage
Pink esthetic score		
Poor (≤ 7)	2	6.3%
Acceptable (7–12)	21	65.6%
Almost perfect (≥ 12)	9	28.1%
White esthetic score		
Poor (≤ 5)	5	15.6%
Acceptable (5–8)	11	34.4%
Almost perfect (≥ 8)	16	50.0%

scores (two-tailed *t* test for independent samples, $p < 0.05$ as significant). The PES of immediate provisionalization cases is significantly higher than those of no immediate provisionalization cases ($p = 0.03$). The correlations between potentially relevant factors and esthetic scores are summarized in Table 3.

Visual analog scale and subjective outcome questionnaire

The average VAS score was 8.89 ± 1.24 , ranging from 5.2 to 10.0. Below are the mean, and median values, and the score range for each question:

Question1. “1. How do you evaluate the shape of your dental implant tooth?” The mean patient rating was

calculated as 8.94 ± 1.22 (range 5–10). The median score was 9. Thirty patients responded with a score of ≥ 8 .

Question2. “2. How do you evaluate the color of your dental implant tooth?” The mean patient rating was calculated as 8.81 ± 1.96 (range 5–10). The median score was 9. Twenty-eight patients responded with a score of ≥ 8 .

Question3. “3. How do you evaluate the shape of the gum around your dental implant tooth?” The mean patient rating was calculated as 8.84 ± 1.68 (range 5–10). The median score was 9. Twenty-seven patients responded with a score of ≥ 8 .

Question4. “4. How do you evaluate the color of the gum around your dental implant tooth?” The mean patient rating was calculated as 8.97 ± 1.64 (range 5–10). The median score was 9. Twenty-eight patients responded with a score of ≥ 8 .

Question5. “5. What are your overall feelings toward your dental implant tooth?” The mean patient rating was calculated as 8.88 ± 1.79 (range 5–10). The median score was 9. Twenty-nine patients responded with a score of ≥ 8 .

Spearman’s correlation test failed to reveal any significant associations between the overall mean VAS score and PES, WES or ES ($p = 0.184$, $p = 0.135$, $p = 0.160$, respectively) (Table 4).

Patients were divided into different groups according to age, sex, gingival biotype, buccal bone wall thickness, jumping gap and immediate provisionalization, and their VAS score was analyzed in each group. The VAS score for each group of patients was not significantly different (Table 5).

Discussions

For severely traumatized teeth that cannot be saved in the anterior maxilla, dental implants are one of the options. Dental injury in this area is often accompanied by lip swelling, gingival laceration and dental alveolar fracture. Implant surgery should be performed after the swelling has subsided and the gingiva has healed. Many patients facing this situation prefer to extract the traumatized teeth and insert the implant in one surgery to reduce the number of visits and shorten the period of tooth loss. However, a survey revealed that very few patients were prepared to accept a greater risk of implant failure to reduce the treatment time [12]. Hence, it is crucial for dentists to have a thorough understanding of the advantages and disadvantages associated with the immediate placement of implants in cases of single failed maxillary anterior teeth following trauma before proposing this course of action to their patients.

The success rate was 100% after one year of final restoration in this study. A 5-year, multicenter, prospective evaluation by Cooper et al. [13] reported that the survival rate was 94.6% in immediate implant cases and 98.3% in

Table 3 Potentially relevant factors and esthetic scores

	Pink esthetic score	p value	White esthetic score	p value	Total score	p value
Age		0.55		0.18		0.29
18-40y	10.73		7.28		18.02	
Over 40y	10.29		6.38		16.67	
Sex		0.13		0.63		0.26
Male	10.15		7.12		17.26	
Female	11.40		7.47		18.87	
Gingival biotype		0.30		0.24		0.23
Thick	11.29		7.83		19.13	
Thin	10.40		6.95		17.35	
Buccal bone wall thickness		0.72		0.40		0.83
Below 1 mm	10.65		7.46		18.10	
Above 1 mm	10.93		6.79		17.71	
Jumping gap		0.81		0.29		0.70
Below 2 mm	10.56		7.94		18.50	
Above 2 mm	10.79		7.06		17.85	
Immediate provisionalization		0.03*		0.34		0.08
Yes	12.60		8.00		20.60	
No	10.30		7.10		17.40	

Two-tailed t test for independent samples, * $p < 0.05$ as significant**Table 4** Spearman's correlation test between the VAS score and PES, WES or ES

			PES	WES	ES
Spearman's rho	VAS	Correlation coefficient	0.24	0.27	0.25
		Sig. (two tailed)	0.18	0.14	0.16
		N	32	32	32

VAS Visual analog scale, PES Pink esthetic score, WES White esthetic score, ES Esthetic score

Table 5 Potentially relevant factors and the VAS score

	VAS	p value
Age		0.48
18-40y	8.99	
Over 40y	8.72	
Sex		0.33
Male	8.74	
Female	9.05	
Gingival biotype		0.55
Thick	8.85	
Thin	8.95	
Buccal bone wall thickness		0.85
Below 1 mm	8.92	
Above 1 mm	8.80	
Jumping gap		0.10
Below 2 mm	9.35	
Above 2 mm	8.73	
Immediate provisionalization		0.14
Yes	9.47	
No	8.75	

Mann-Whitney test, $p < 0.05$ as significant

delayed implant cases; this difference was not statistically significant. The authors also noted that all the failures occurred in the first year. A literature review evaluated immediate implant placement and provisionalization with a single crown in the esthetic area and reported a 97.96% success rate [14]. Additionally, a meta-analysis including 8 studies and a follow-up period between 12 and 96 months revealed that implant survival was 94.9% after immediate placement, demonstrating a notable decrease compared with delayed placement, which was 98.9% [15]. Considering the literature and our results, we believe that immediate implantation for trauma to a single tooth in the esthetic area can achieve a satisfactory success rate through the use of appropriate guidelines and careful patient selection.

Throughout this investigation, the marginal bone change following the placement of the implant until one year after the final restoration was found to be -0.17 mm mesially and -0.22 mm distally. A one-year prospective study on the immediate placement and provisionalization of maxillary anterior single implants reported that the marginal bone change one year after implant placement was -0.26 mm mesially and -0.22 mm distally [16]. These findings align with those of a previous study, indicating that immediate implant placement for single failed maxillary anterior teeth after trauma did not lead to more marginal bone loss.

The outcomes from the analysis of both PES and WES in this study were found to be satisfactory. The mean PES in this study was 10.7, which is comparable to that reported by Cosyn et al. [17] (mean PES = 10.7) and higher than that reported by Altay et al. [18] (mean

PES = 9.9). The mean WES in this study was 7.3, which is close to the result of Cosyn et al. [17] (mean WES = 7.8) and that of Angkaew et al. [19] (mean WES = 7.5) but lower than the result of Altay et al. [18] (mean WES = 8.6).

The esthetic outcomes of immediate implant placement and provisionalization are influenced by several intrinsic and extrinsic factors [20]. Intrinsic factors are patient dependent, and extrinsic factors are clinician dependent. In accordance with previous studies [5, 21–23], patient age, sex, gingival biotype, buccal bone wall thickness, jumping gap and immediate provisionalization were chosen as potentially relevant factors that may influence objective and subjective esthetic outcomes.

The PES is significantly higher in cases which had immediate provisionalization in this study. Immediate implant placement and loading is an effective way to preserve the existing gingival architecture, which positively influences the esthetic result [24]. Furthermore, immediate provisionalization facilitates the immediate sealing of the extraction socket and implant, potentially contributing to enhanced osseointegration and mucosal integration. Recent literatures demonstrated in anterior maxilla, the esthetic outcomes are comparable between immediate implant placement and provisionalization cases and immediate implant placement and delayed provisionalization cases [5], or early implant placement with guided bone regeneration and delayed loading cases. That is to say, immediate provisionalization itself doesn't increase the risk of soft tissue recession. Therefore, we believed immediate provisionalization after immediate implant placement for single failed maxillary anterior teeth can help to increase the final Pink esthetic outcomes.

Age, sex, gingival biotype, buccal bone wall thickness and jumping gap are not correlated with the esthetic scores. Nonetheless, only two individuals displayed poor PESs due to significant soft tissue recession around their implant during the follow-up examination. These two patients had both thin gingival biotype and buccal bone wall thickness less than 1 mm. The thin gingival biotype is widely accepted as a risk factor for soft tissue recession in immediate implants [21, 25]. Angkaew et al. [19] reported that patients with a thick gingival biotype presented significantly higher PES/WES scores than did those with a thin gingival biotype. At the same time, it has long been widely accepted that a buccal wall thickness < 1 mm is a risk factor for gingival recession after immediate implantation [26]. However, opposite opinions have also been proposed. Altay et al. [18] indicated that the gingival biotype might not be a crucial factor in the esthetics of single-implant restorations. Meanwhile, Chen et al. [27] suggested that performing buccal bone augmentation at the same time as immediate implant placement can help ensure consistent buccal bone thickness in the anterior maxilla with a thin buccal plate. Considering the

previous studies and our clinical data, special care must be taken for patients with thin gingival biotype or buccal bone wall thickness less than 1 mm before performing immediate implant insertion, especially in cases with combined factors. A systematic review revealed that a combination of an immediate implant and a connective tissue graft can thicken the peri-implant soft tissue and prevent soft tissue recession [28]. This treatment plan may be recommended for patients with thin gingival biotype and buccal bone wall thickness less than 1 mm.

The patient's VAS score was 8.89 on average in this study. Similarly, Angkaew et al. [19] reported that the mean VAS score was 9.15, and Altay et al. [18] reported that the mean VAS score was 8.54. Considering these previous studies and our results, we believe that immediate implant placement for single failed maxillary anterior teeth after trauma can achieve satisfactory results for patients. We analyzed the correlations between potentially relevant factors and the patient's VAS scores and found no significant results. Moreover, we analyzed the relationship between the PES/WES/ES score and the VAS score, and no significant differences were detected, which is consistent with the findings of previous studies [18, 19]. In contrast, Cho et al. [29] reported a statistically significant correlation between ES and the VAS score. In our study, the lowest VAS score was 5.2, and the PES/WES score of this patient was 11/9.5. Moreover, one of the patients had a PES/WES score of 4.5/3, but his VAS score was 7.8. The difference between the PES/WES and VAS may be attributed to the subjective nature of esthetics and the incompatibility of the patient perspective. Therefore, the previous literature and our results indicate that patients' satisfaction levels may not comply with objective evaluations from experts. Some patients may feel unsatisfactory for an implant with perfect pink and white esthetic scores. In contrast, some patients may feel good about having an implant, regardless of its appearance. Overall, we suggest that patients' expectations and subjective evaluations of esthetics should be focused on during the whole therapy process.

The potential limitations of this study include the limited sample size and the bias inherent to the retrospective nature of the study. To validate our conclusions regarding immediate implant placement after dental trauma, future studies should involve larger sample sizes and extended follow-up periods. Moreover, exploring a prospective randomized clinical trial focusing on various timeframes for implant placement following dental trauma could enhance our ability to make informed decisions regarding the incidence of maxillary anterior tooth failure subsequent to trauma.

Conclusions

Immediate implant placement for single failed maxillary anterior teeth after trauma can achieve both objectively and subjectively good clinical results in the first year after final restoration. The success rates and marginal bone loss rates of these cases are comparable to those reported in previous studies of immediate implants in the esthetic area. This study indicates that, with proper indications, immediate implantation is an effective way to treat traumatic single tooth loss in the anterior maxilla, which can shorten the treatment process.

Abbreviations

PES Pink esthetic score
WES White esthetic score
VAS Visual analogue scale

Acknowledgements

Not applicable.

Authors' contributions

Q.L. and Z.Y. designed the study, collected and analyzed the data, and wrote the manuscript. X.C. provided and prepared the figures, and wrote part of the manuscript. J.C. and Y.L. carried out the patient follow-up work, and collected the data. Q.L., X.C., J.C., Y.L. and Z.Y. have made substantial contributions to the conception of this study, and have substantively revised it. All authors have approved the submitted version of this manuscript. All authors have agreed both to be personally accountable for the author's own contributions and to ensure that questions related to the accuracy or integrity of any part of the work, even ones in which the author was not personally involved, are appropriately investigated, resolved, and the resolution documented in the literature.

Funding

This work was supported by the Guangzhou Basic and Applied Basic Research Foundation (Grant no. 2023A04J0430) and the Guangdong Clinical Teaching Base Teaching Reform Research Project (Grant no. 2021JD110).

Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

This study was approved by the Institutional Review Board of Stomatological Hospital, Southern Medical University (Approved No. of the Ethics Committee: NYKQ-EC- [2024]33).

Consent for publication

Written informed consent for publication was obtained from all the participants.

Competing interests

The authors declare no competing interests.

Received: 17 September 2024 / Accepted: 1 September 2025

Published online: 14 October 2025

References

1. Ickroth A, Seyssens L, Christiaens V, Pitman J, Cosyn J. Immediate versus early implant placement for single tooth replacement in the aesthetic area: A systematic review and meta-analysis. *Clin Oral Implants Res.* 2024;35(6):585–97.
2. Arora H, Ivanovski S. Immediate and early implant placement in single-tooth gaps in the anterior maxilla: A prospective study on ridge dimensional, clinical, and aesthetic changes. *Clin Oral Implants Res.* 2018;29(11):1143–54.
3. Tonetti MS, Jung RE, Avila-Ortiz G, Blanco J, Cosyn J, Fickl S et al. Management of the extraction socket and timing of implant placement: consensus report and clinical recommendations of group 3 of the XV European workshop in periodontology. *J Clin Periodontol.* 2019;46 Suppl 21:183–94.
4. Sheng L, Silvestrin T, Zhan J, Wu L, Zhao Q, Cao Z, et al. Replacement of severely traumatized teeth with immediate implants and immediate loading: literature review and case reports. *Dent Traumatol.* 2015;31(6):493–503.
5. Slagter KW, Raghoobar GM, Hentenaar DFM, Vissink A, Meijer HJA. Immediate placement of single implants with or without immediate provisionalization in the maxillary aesthetic region: A 5-year comparative study. *J Clin Periodontol.* 2021;48(2):272–83.
6. Bernal G, Ruiz L, Aellos F, Salazar C, Sadowsky SJ. Clinical and cone beam computed tomography outcomes of maxillary anterior implant restorations after immediate implant placement with interim restorations: A 1- to 14-year retrospective analysis. *J Prosthet Dent.* 2025;133(4):1025–32.
7. Pitman J, Seyssens L, Christiaens V, Cosyn J. Immediate implant placement with or without immediate provisionalization: A systematic review and meta-analysis. *J Clin Periodontol.* 2022;49(10):1012–23.
8. Goodacre CJ, Kan JY, Rungcharassaeng K. Clinical complications of osseointegrated implants. *J Prosthet Dent.* 1999;81(5):537–52.
9. Ramanaukaite A, Sader R. Esthetic complications in implant dentistry. *Periodontol.* 2000. 2022;88(1):73–85.
10. Furhauser R, Florescu D, Benesch T, Haas R, Mailath G, Watzek G. Evaluation of soft tissue around single-tooth implant crowns: the Pink esthetic score. *Clin Oral Implants Res.* 2005;16(6):639–44.
11. Belser UC, Grutter L, Vailati F, Bornstein MM, Weber HP, Buser D. Outcome evaluation of early placed maxillary anterior single-tooth implants using objective esthetic criteria: a cross-sectional, retrospective study in 45 patients with a 2- to 4-year follow-up using Pink and white esthetic scores. *J Periodontol.* 2009;80(1):140–51.
12. Hof M, Tepper G, Semo B, Arnhart C, Watzek G, Pommer B. Patients' perspectives on dental implant and bone graft surgery: questionnaire-based interview survey. *Clin Oral Implants Res.* 2014;25(1):42–5.
13. Cooper LF, Reside GJ, Raes F, Garriga JS, Tarrida LG, Wiltfang J, et al. Immediate provisionalization of dental implants placed in healed alveolar ridges and extraction sockets: a 5-year prospective evaluation. *Int J Oral Maxillofac Implants.* 2014;29(3):709–17.
14. Weigl P, Strangio A. The impact of immediately placed and restored single-tooth implants on hard and soft tissues in the anterior maxilla. *Eur J Oral Implantol.* 2016;9(Suppl 1):S89–106.
15. Cosyn J, De Lat L, Seyssens L, Doornewaard R, Deschepper E, Vervaeke S. The effectiveness of immediate implant placement for single tooth replacement compared to delayed implant placement: A systematic review and meta-analysis. *J Clin Periodontol.* 2019;46(Suppl 21):224–41.
16. Kan JY, Rungcharassaeng K, Lozada J. Immediate placement and provisionalization of maxillary anterior single implants: 1-year prospective study. *Int J Oral Maxillofac Implants.* 2003;18(1):31–9.
17. Cosyn J, Eghbali A, De Bruyn H, Dierens M, De Rouck T. Single implant treatment in healing versus healed sites of the anterior maxilla: an aesthetic evaluation. *Clin Implant Dent Relat Res.* 2012;14(4):517–26.
18. Altay MA, Sindel A, Tezerisener HA, Yildirimyan N, Ozarslan MM. Esthetic evaluation of implant-supported single crowns: a comparison of objective and patient-reported outcomes. *Int J Implant Dent.* 2019;5(1):2.
19. Angkaw C, Serichetaphongse P, Krisdapong S, Dart MM, Pimkhakham A. Oral health-related quality of life and esthetic outcome in single anterior maxillary implants. *Clin Oral Implants Res.* 2017;28(9):1089–96.
20. Kan JY, Rungcharassaeng K, Lozada JL. Bilaminar subepithelial connective tissue grafts for immediate implant placement and provisionalization in the esthetic zone. *J Calif Dent Assoc.* 2005;33(11):865–71.
21. Kan JY, Roe P, Rungcharassaeng K, Patel RD, Waki T, Lozada JL, et al. Classification of sagittal root position in relation to the anterior maxillary osseous housing for immediate implant placement: a cone beam computed tomography study. *Int J Oral Maxillofac Implants.* 2011;26(4):873–6.
22. Kan JY, Rungcharassaeng K. Immediate placement and provisionalization of maxillary anterior single implants: a surgical and prosthodontic rationale. *Pract Periodontics Aesthet Dent.* 2000;12(9):817–24. quiz 26.
23. Kois JC, Kan JY. Predictable peri-implant gingival aesthetics: surgical and prosthodontic rationales. *Pract Proced Aesthet Dent.* 2001;13(9):691–8. quiz 700, 21–2.
24. Kan JYK, Rungcharassaeng K, Deflorian M, Weinstein T, Wang HL, Testori T. Immediate implant placement and provisionalization of maxillary anterior single implants. *Periodontol.* 2000. 2018;77(1):197–212.

25. Hammerle CH, Chen ST, Wilson JTG. Consensus statements and recommended clinical procedures regarding the placement of implants in extraction sockets. *Int J Oral Maxillofac Implants*. 2004;19(Suppl):26–8.
26. Hammerle CH, Araujo MG, Simion M, Osteology Consensus G. Evidence-based knowledge on the biology and treatment of extraction sockets. *Clin Oral Implants Res*. 2012;23(Suppl 5):80–2.
27. Chen K, Li Z, Liu X, Liu Q, Chen Z, Sun Y, et al. Immediate implant placement with buccal bone augmentation in the anterior maxilla with thin buccal plate: A One-Year Follow-Up case series. *J Prosthodont*. 2021;30(6):473–80.
28. Lee CT, Tao CY, Stoupel J. The effect of subepithelial connective tissue graft placement on esthetic outcomes after immediate implant placement: systematic review. *J Periodontol*. 2016;87(2):156–67.
29. Cho HL, Lee JK, Um HS, Chang BS. Esthetic evaluation of maxillary single-tooth implants in the esthetic zone. *J Periodontal Implant Sci*. 2010;40(4):188–93.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.