Library Progress International *Print version ISSN 0970 1052*
Vol.44 No.2, July-December 2024: P.461-469 *Online version ISSN 2320 317X*

Original Article *Available online at www.bpasjournals.com*

Patient-Centered Outcomes in Immediate vs Delayed Implant Placement: A Randomized Controlled Trial

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How to cite this article: Anil Kumar Jha, Chetan Chandra , Sumi Chandra, Sunakshi Soi, Srinjal Suman,Shreya Rastogi (2024). Patient-Centered Outcomes in Immediate vs Delayed Implant Placement: A Randomized Controlled Trial. *Library Progress International*, 44(2), 461-469.

Abstract

Background:

Dental implants are a widely accepted method for replacing missing teeth, but the timing of implant placement—whether immediate (at the time of tooth extraction) or delayed (after a healing period)—remains a debated topic. Immediate implant placement is believed to preserve alveolar bone and soft tissue contours, potentially improving aesthetic outcomes. However, concerns persist about increased postoperative pain and complications. Delayed implants, on the other hand, are considered more predictable in terms of osseointegration, but they require longer treatment times and multiple surgical interventions. This study aimed to compare patient-centered outcomes, including pain, aesthetic satisfaction, quality of life, implant stability, and bone loss, between immediate and delayed implant placement.

Objectives:

This randomized controlled trial sought to evaluate and compare the patient-centered outcomes of immediate versus delayed implant placement in terms of pain, aesthetics, quality of life, implant stability, and peri-implant bone loss.

Materials and Methods:

A total of 60 patients requiring single-tooth implants in the anterior or premolar region were randomly allocated to either the immediate implant placement group (n=30) or the delayed implant placement group (n=30). Two patients were lost to

follow-up, resulting in 58 participants. Pain levels were assessed using a Visual Analog Scale (VAS), aesthetic satisfaction using the Pink Esthetic Score (PES), and quality of life using the Oral Health Impact Profile (OHIP-14). Implant stability was evaluated using resonance frequency analysis (RFA), and peri-implant bone loss was measured radiographically at six months. Data were analyzed using SPSS 25.0 version

Results:
Patients in the immediate implant group experienced significantly higher pain on the first postoperative day (VAS score = 5.8 ± 1.4) compared to the delayed group (VAS score = 4.1 ± 1.2, p = 0.002), but pain levels equalized by day seven. The immediate implant group had significantly higher aesthetic satisfaction at six months (PES = 10.6 ± 1.1) compared to the delayed group (PES = 9.3 ± 1.5, p = 0.01). Quality of life scores were also better in the immediate group (OHIP-14 score = 5.1 ± 2.8) compared to the delayed group (OHIP-14 score = 7.2 ± 3.0, p = 0.03). Both groups demonstrated comparable implant stability and minimal peri-implant bone loss at six months (p > 0.05), with no implant failures, resulting in a 100% survival rate.

Conclusions:
Immediate implant placement provided superior aesthetic outcomes and enhanced quality of life compared to delayed placement, although it was associated with higher early postoperative pain. Both approaches achieved high implant stability, minimal bone loss, and excellent implant survival. Immediate implant placement may be preferred when aesthetics and rapid restoration are priorities.

Keywords:
Dental implants, Immediate implant placement, Delayed implant placement, Aesthetic satisfaction, Patient-centered outcomes, Implant stability, Peri-implant bone loss

Introduction

Dental implants have transformed the approach to tooth replacement, offering a reliable and long-lasting solution for edentulism. However, the decision regarding the timing of implant placement—whether immediate or delayed—remains a subject of considerable debate among practitioners. Immediate implant placement, defined as the insertion of an implant immediately after tooth extraction, has garnered attention for its potential to reduce treatment time, preserve alveolar bone, and maintain soft tissue contours. Studies have reported success rates for immediate implants ranging between 85% and 95%, depending on various factors such as patient selection, surgical technique, and the presence of infection ([1], [2]).

On the other hand, delayed implant placement, where the implant is inserted after a period of healing, is associated with more predictable outcomes in terms of osseointegration, particularly in sites with compromised bone or soft tissue. Success rates for delayed implants are typically higher, ranging from 90% to 98%, making this approach a safer choice in complex clinical situations ([3], [4]). However, the extended treatment duration, along with the need for multiple surgical interventions, can negatively affect patient experience and overall satisfaction ([5], [6]).

While much of the research has focused on clinical outcomes like implant survival, there has been limited attention on patient-centered outcomes, which include factors such as pain, aesthetics, and overall quality of life. It is well-recognized that patient satisfaction is increasingly important in modern clinical practice, particularly in elective procedures like implant dentistry. Studies suggest that immediate implant placement may offer superior aesthetic outcomes due to better soft tissue management, but these results must be weighed against the potential for increased postoperative pain and complications ([7], [8]).

Given the importance of understanding the patient perspective, this study aims to compare immediate and delayed implant placement in terms of patient-centered outcomes. Specifically, this randomized controlled trial will evaluate pain levels, aesthetic satisfaction, functional recovery, and overall quality of life across the two implant protocols. By assessing these factors, we aim to provide a more comprehensive understanding of which approach is more favorable from both a clinical and patient perspective.

MATERIALS AND METHODS:

This randomized controlled trial was conducted to compare patient-centered outcomes in immediate versus delayed implant placement. The study was approved by the Institutional Review Board, and all participants provided written informed consent prior to their inclusion in the study. Ethical guidelines as per the Declaration of Helsinki were strictly adhered to throughout the research process.

Study Population

The study was conducted at Saraswati Dental College and Hospital, Luknow over a period of 18 months. The target population consisted of adult patients aged 18 to 65 years who required single tooth extraction and subsequent implant placement in the anterior or premolar region. Participants were recruited from the outpatient department, where they underwent initial screening and assessment for inclusion in the study. Patients were provided with detailed information about the study objectives, procedures, potential risks, and benefits, and those who agreed to participate were enrolled.

Eligibility Criteria

Patients eligible for inclusion in the study were those who required a single tooth implant in the anterior or premolar region, had good general health, and possessed adequate bone volume (as determined by clinical and radiographic assessments) to support an implant without the need for significant bone grafting. Exclusion criteria included patients with systemic conditions that could affect healing (e.g., uncontrolled diabetes, immunocompromised status), patients with a history of radiation therapy to the head or neck, pregnant or lactating women, smokers exceeding 10 cigarettes per day, patients with active infection at the implant site, and those with poor oral hygiene compliance.

Sample Size

A power analysis was conducted to determine the appropriate sample size for detecting a statistically significant difference between immediate and delayed implant groups, with an alpha value of 0.05 and a power of 80%. Based on previous studies, the expected difference in patient satisfaction and clinical outcomes between the two groups was set at 15%. Accordingly, a total of 60 patients were recruited, with 30 allocated to the immediate implant group and 30 to the delayed implant group. Randomization was achieved using a computer-generated random sequence, and allocation concealment was maintained using sealed, opaque envelopes.

Study Design and Randomization

The study was a parallel-group, randomized controlled trial with two arms: the immediate implant placement group and the delayed implant placement group. In the immediate group, implants were placed immediately after tooth extraction. In the delayed group, implants were placed following a healing period of three months post-extraction. Both groups were treated using the same implant system, and surgical procedures were standardized across both groups to reduce variability.

Participants were randomly assigned to one of the two groups using a computer-generated randomization sequence. Allocation concealment was ensured by using sealed, opaque envelopes that were opened by the surgeon only at the time of surgery. Blinding was not possible due to the nature of the surgical intervention; however, the outcome assessor, who was responsible for collecting patient-reported outcomes and clinical data, was blinded to the group assignments.

Data Collection

Data collection was performed at multiple time points: preoperatively, immediately postoperatively, and at follow-up visits (1 week, 1 month, 3 months, and 6 months post-surgery). Baseline demographic data, including age, gender, and medical history, were collected for all participants. Clinical outcomes such as implant stability, soft tissue healing, and peri-implant bone loss were assessed by the same blinded clinician to ensure consistency.

Patient-centered outcomes, including pain, aesthetic satisfaction, and overall quality of life, were assessed using validated questionnaires. Pain levels were measured using a Visual Analog Scale (VAS) ranging from 0 (no pain) to 10 (worst pain imaginable), while aesthetic satisfaction was evaluated using the Pink Esthetic Score (PES). Quality of life and functional outcomes were measured using the Oral Health Impact Profile (OHIP-14), which assessed the physical, psychological, and social impacts of the treatment on patients' lives. Additionally, patients were asked to report any complications such as infection, implant failure, or discomfort during follow-up visits.

Outcome Measures

The primary outcome measure for this study was patient-reported aesthetic satisfaction at six months post-implant placement. Secondary outcome measures included pain levels, overall satisfaction, implant stability, soft tissue healing, and peri-implant bone loss. Peri-implant bone levels were assessed using standardized intraoral radiographs taken immediately after implant placement and at the six-month follow-up. Implant stability was evaluated using resonance frequency analysis (RFA), which provided a quantitative measure of osseointegration.

Statistical Analysis

Data were analyzed using SPSS software (version 25.0; IBM Corp., Armonk, NY). Descriptive statistics, including mean, standard deviation, and frequency distribution, were calculated for baseline demographic variables and outcome measures. Comparisons between the immediate and delayed implant groups were made using the independent t-test for continuous variables and the chi-square test for categorical variables. Pain scores, aesthetic satisfaction scores, and quality of life measures were analyzed using repeated-measures analysis of variance (ANOVA) to account for changes over time. A p-value of less than 0.05 was considered statistically significant.

Additionally, a Kaplan-Meier survival analysis was performed to compare the implant survival rates between the two groups over the study period. Cox proportional hazards regression was used to identify any factors associated with implant failure, with variables such as age, gender, smoking status, and implant location included in the model.

RESULTS

A total of 60 patients were initially enrolled in the study, with 30 allocated to the immediate implant group and 30 to the delayed implant group. Two patients from the immediate implant group were lost to follow-up, resulting in a final sample size of 58 patients. The mean age of the participants was 42.6 years (SD ± 9.2), with 32 males and 26 females distributed evenly between the two groups. There were no significant differences in baseline demographics or clinical characteristics between the immediate and delayed implant groups ($p > 0.05$).

Patient-Reported Outcomes

Pain Scores

Pain levels were recorded using the Visual Analog Scale (VAS) at multiple time points. On the first postoperative day, patients in the immediate implant group reported significantly higher pain levels (mean VAS score = 5.8 ± 1.4) compared to those in the delayed implant group (mean VAS score = 4.1 ± 1.2) ($p = 0.002$). However, pain levels decreased significantly over time in both groups. By the seventh day, there was no significant difference in pain scores between the two groups, with mean scores of 1.2 ± 0.7 for the immediate group and 1.1 ± 0.6 for the delayed group ($p = 0.56$) as seen in Table 1.

Table 1: Pain scores across time intervals

Time Point	Immediate Implant (Mean ± SD)	Delayed Implant (Mean ± SD)	p-value
Day 1	5.8 ± 1.4	4.1 ± 1.2	0.002*
Day 7	1.2 ± 0.7	1.1 ± 0.6	0.56 (NS)
Day 30	0.3 ± 0.4	0.2 ± 0.3	0.47 (NS)

*=Significant; NS=Not Significant

Aesthetic Satisfaction (Pink Esthetic Score - PES)

Aesthetic outcomes, as evaluated using the Pink Esthetic Score (PES), were assessed at the six-month follow-up visit. The immediate implant group demonstrated higher PES scores (mean = 10.6 ± 1.1) compared to the delayed group (mean = 9.3 ± 1.5) ($p = 0.01$). This finding suggests that immediate implant placement resulted in better aesthetic outcomes, likely due to the preservation of soft tissue contours.

Table 2: Aesthetic Satisfaction between groups

Group	PES Score (Mean ± SD)
Immediate Implant	10.6 ± 1.1
Delayed Implant	9.3 ± 1.5
p-value	**0.01***

*=Significant; NS=Not Significant

Quality of Life (OHIP-14)

Patient quality of life was assessed using the Oral Health Impact Profile (OHIP-14) at baseline, three months, and six months. At baseline, there were no significant differences in OHIP-14 scores between the groups (p = 0.49). By the three-month follow-up, both groups reported significant improvements in quality of life, but the immediate implant group reported greater improvement. At six months, the immediate implant group had a mean OHIP-14 score of 5.1 ± 2.8, while the delayed group had a score of 7.2 ± 3.0 (p = 0.03), indicating that immediate implant placement led to better patient satisfaction and quality of life.

Table 3: Oral health related quality of life in both groups across time intervals

Time Point	Immediate Implant (Mean ± SD)	Delayed Implant (Mean ± SD)	p-value
Baseline	18.2 ± 3.6	17.8 ± 4.2	0.49(NS)
3 Months	7.8 ± 2.9	9.3 ± 3.1	0.08 (NS)
6 Months	5.1 ± 2.8	7.2 ± 3.0	0.03*

*=Significant; NS=Not Significant

Clinical Outcomes

Implant Stability

Implant stability was measured using resonance frequency analysis (RFA) immediately after placement and at the six-month follow-up. In the immediate implant group, the initial implant stability quotient (ISQ) was 67.2 ± 4.5, and this increased to 72.1 ± 3.9 at six months. In the delayed group, the initial ISQ was 71.3 ± 3.8, which increased to 74.6 ± 3.4 at six months. Although both groups demonstrated significant improvements in stability over time, the delayed group showed slightly higher ISQ values at both time points, but the difference was not statistically significant at six months (p = 0.07).

Table 4: Implant stability assessment between groups

Time Point	Immediate Implant (Mean ± SD)	Delayed Implant (Mean ± SD)	p-value
Initial ISQ	67.2 ± 4.5	71.3 ± 3.8	0.01*
6 Months ISQ	72.1 ± 3.9	74.6 ± 3.4	0.07 (NS)

*=Significant; NS=Not Significant

Peri-Implant Bone Loss

Peri-implant bone loss was measured using standardized intraoral radiographs. At the six-month follow-up, the mean bone loss for the immediate implant group was 0.72 ± 0.18 mm, compared to 0.64 ± 0.21 mm for the delayed group (p = 0.18). Although the delayed group demonstrated slightly less bone loss, the difference was not statistically significant.

Table 5: Peri-implant bone loss between groups

Group	Bone Loss (mm) (Mean ± SD)
Immediate Implant	0.72 ± 0.18

Delayed Implant	0.64 ± 0.21
p-value	**0.18 (NS)**

*=Significant; NS=Not Significant

Complications

There were no major complications in either group during the study period. Two patients in the immediate implant group experienced mild infection at the implant site, which was managed with antibiotics and did not affect the overall outcome. No implant failures were recorded in either group, and all implants were deemed successful based on clinical and radiographic criteria at six months.

Survival Analysis

A Kaplan-Meier survival analysis was conducted to compare the implant survival rates between the two groups. No implants failed during the study period, so survival rates were 100% in both groups. Cox proportional hazards regression analysis did not identify any significant predictors of implant failure.

DISCUSSION

The results of this randomized controlled trial comparing immediate and delayed implant placement revealed significant findings in terms of patient-centered outcomes, including pain levels, aesthetic satisfaction, quality of life, implant stability, and peri-implant bone loss. Overall, immediate implant placement demonstrated superior aesthetic outcomes and greater patient satisfaction, particularly in terms of faster recovery of function and improved quality of life at six months postoperatively. However, it was also associated with higher early postoperative pain levels. Both treatment modalities were clinically successful with high implant stability, minimal peri-implant bone loss, and no implant failures, suggesting that either approach can be effective, depending on patient-specific circumstances and clinical indications.

Pain Levels

In this study, pain levels were significantly higher in the immediate implant group on the first postoperative day compared to the delayed implant group. The immediate implant group reported a mean VAS pain score of 5.8 ± 1.4, while the delayed group had a mean score of 4.1 ± 1.2 ($p = 0.002$). This finding aligns with previous literature suggesting that immediate implant placement can be associated with increased pain and discomfort due to the more invasive nature of the procedure, including both extraction and implant placement in a single session [9,10]. However, by the seventh day, pain levels had significantly decreased in both groups and were no longer statistically different. The rapid resolution of pain in the immediate group may be attributed to advancements in surgical techniques and the use of modern anesthesia and analgesics, which have improved postoperative comfort [11]. The reduction of pain over time is consistent with other studies, which report that although immediate implants may induce greater early discomfort, pain levels normalize within the first week postoperatively [12].

Aesthetic Satisfaction

A key finding in this study was the significantly higher aesthetic satisfaction reported by patients in the immediate implant group, as evidenced by higher Pink Esthetic Scores (PES) at six months (mean = 10.6 ± 1.1) compared to the delayed group (mean = 9.3 ± 1.5) ($p = 0.01$). Immediate implant placement preserves the alveolar ridge and soft tissue contours, preventing post-extraction resorption and collapse, which may explain the superior aesthetic outcomes [13]. The ability to maintain gingival architecture and avoid the aesthetic compromises associated with delayed implant placement, such as gingival recession and loss of interdental papillae, has been well documented in previous studies [14]. This is particularly important in the anterior maxillary region, where aesthetics are a primary concern for most patients.

The delayed implant group, while still achieving good aesthetic results, was likely affected by the natural resorption and remodeling that occurs during the healing phase after tooth extraction. Studies suggest that bone loss following extraction is most pronounced in the first three months, leading to unfavorable changes in soft tissue architecture [12]. This may account for the lower PES scores in the delayed group. Despite this, the PES scores in both groups were within acceptable ranges, suggesting that delayed implant placement can still achieve satisfactory aesthetic outcomes, especially in cases where soft tissue grafting or other augmentation procedures are utilized to compensate for tissue loss.

Quality of Life (OHIP-14)

Quality of life, as assessed by the OHIP-14 questionnaire, improved significantly in both groups over the six-month follow-up period. However, patients in the immediate implant group reported greater improvements, particularly at the six-month mark, with a mean OHIP-14 score of 5.1 ± 2.8 compared to 7.2 ± 3.0 in the delayed group ($p = 0.03$). These findings suggest that immediate implant placement may have a more positive impact on patients' psychological and functional well-being, likely due to the shorter treatment time and quicker restoration of function and aesthetics [16].

The superior quality of life outcomes observed in the immediate group may also be attributed to the reduced need for interim prostheses, which can be uncomfortable and aesthetically unappealing for patients. In contrast, patients in the delayed group typically require a temporary removable prosthesis during the healing phase, which can negatively impact their oral health-related quality of life [16]. This is supported by previous studies that have demonstrated the psychological benefits of immediate implant placement, particularly in terms of confidence and social interactions, as patients avoid prolonged periods of toothlessness [13].

Implant Stability

Both groups demonstrated excellent implant stability as measured by resonance frequency analysis (RFA). The immediate implant group had an initial ISQ value of 67.2 ± 4.5, which increased to 72.1 ± 3.9 at six months, indicating successful osseointegration. Similarly, the delayed group had an initial ISQ of 71.3 ± 3.8, increasing to 74.6 ± 3.4 at six months. Although the delayed group showed slightly higher ISQ values at both time points, the difference was not statistically significant at six months ($p = 0.07$), suggesting that both immediate and delayed implants achieve comparable stability in the long term.

These findings are consistent with existing literature, which has shown that implant stability is initially lower in the immediate implant group due to the lack of healing time before implant placement, but this difference diminishes over time as osseointegration progresses [4,6]. The successful osseointegration observed in both groups highlights the importance of careful case selection, particularly in immediate implant placement, where factors such as bone quality, primary stability, and patient compliance are critical for achieving long-term success.

Peri-Implant Bone Loss

The amount of peri-implant bone loss was minimal in both groups and did not differ significantly at six months ($p = 0.18$). The mean bone loss in the immediate implant group was 0.72 ± 0.18 mm, while the delayed group showed 0.64 ± 0.21 mm of bone loss. These values are well within the acceptable range for successful implant outcomes and are consistent with previous studies that have reported comparable bone loss for both immediate and delayed implant protocols [15].

The slightly higher bone loss observed in the immediate group may be attributed to the more invasive nature of the procedure and the potential for increased trauma during the initial healing phase. However, the difference was not statistically significant, suggesting that with proper surgical technique and patient management, immediate implant placement does not pose a higher risk of peri-implant bone loss in the long term [16]. It is also worth noting that modern implant designs, including surface modifications that promote bone integration, likely played a role in minimizing bone loss in both groups [16].

Complications and Implant Survival

No major complications were observed in either group, and all implants remained stable and functional throughout the study period, resulting in a 100% survival rate. This is in line with existing literature, where survival rates for both immediate and delayed implants are typically reported to be above 95% [13]. Two patients in the immediate implant group developed mild infections at the implant site, which were successfully managed with antibiotics. These complications did not lead to implant failure or long-term adverse outcomes, underscoring the importance of postoperative care and infection control measures.

The high survival rates in both groups indicate that immediate and delayed implant placement are both viable options for single-tooth replacement, provided that appropriate case selection criteria are met. Factors such as bone quality, patient health, and compliance with postoperative care are essential to achieving favorable outcomes regardless of the timing of implant placement [14].

CONCLUSION

This study demonstrated that immediate implant placement provides superior aesthetic outcomes and greater improvements in patient quality of life compared to delayed implant placement. However, immediate implants were associated with higher pain levels in the early postoperative period. Both immediate and delayed implants achieved excellent clinical outcomes, including high implant stability, minimal peri-implant bone loss, and 100% survival rates. These findings suggest that immediate implant placement may be the preferred option in cases where aesthetics and quick restoration of function are priorities, particularly in the anterior maxillary region. However, delayed implant placement remains a reliable option, particularly in cases where bone or soft tissue conditions are less favorable. Further research with larger sample sizes and longer follow-up periods is recommended to confirm these findings and explore the long-term outcomes of both approaches.

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