Review Article

COMPARING IMMEDIATE VS. DELAYED IMPLANT PLACEMENT IN COMPROMISED EXTRACTION SITES: A NARRATIVE REVIEW

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ABSTRACT

Immediate implant placement and delayed implant placement remain two central strategies in contemporary implant dentistry, particularly in compromised extraction sites where the biological environment is suboptimal and the predictability of integration is less certain. Compromised extraction sites often present with periodontal defects, periapical pathology, trauma-related bone loss, thin buccal plates, or ridge deficiencies. These conditions introduce complexity and clinical uncertainty, prompting debate regarding the ideal timing for implant placement. Over the past three decades, research has shifted toward understanding how host biology, surgical technique, defect morphology, and adjunctive biomaterials influence outcomes in both immediate and delayed approaches. The immediate placement protocol offers several advantages, such as reduced treatment times, preservation of soft-tissue architecture, and potentially improved patient acceptance. However, these benefits may be counterbalanced by a higher risk of early implant failure in the presence of infection, inadequate primary stability, or significant bone dehiscence. In contrast, delayed placement provides clinicians with optimal healing conditions and opportunities for ridge augmentation but prolongs treatment and may result in unfavorable soft-tissue collapse or resorption patterns that complicate implant positioning. This expanded review compares biological, clinical, radiographic, and functional outcomes associated with immediate and delayed implant placement in compromised extraction sites. The discussion integrates long-term survival data, bone remodeling behavior, soft-tissue esthetics, complication profiles, and the role of biomaterials. Emerging trends, such as minimally invasive regenerative protocols and digital workflow integration, are evaluated for their potential to improve predictability in compromised sites . The article highlights that while both methods can achieve success, the choice must be individualized according to defect morphology, systemic considerations, aesthetic expectations, and clinician expertise. Ultimately, both strategies remain viable, but neither is universally superior.

Key words: Delayed implant, Immediate, Narrative review, Compromised extraction sites.

Introduction

Dental implants represent the gold standard in replacing missing teeth owing to their excellent long-term success rates and ability to restore function and esthetics. However, the ideal timing for implant placement following tooth extraction has long been debated in implant dentistry. Classical protocols placed implants months after extraction, allowing full recovery of bone and soft tissues. Contemporary trends favor immediate placement wherever possible to reduce treatment time and preserve natural anatomical contours [1]. Yet, this shift must be cautiously interpreted when managing compromised extraction sites, where infectious or structural challenges may predispose to complications.

Compromised extraction sites are clinically defined by the presence of one or more unfavorable conditions, including chronic periapical infection, periodontal destruction, vertical or horizontal bone defects, traumatic loss of alveolar walls, endodontic failures, or thin buccal bone phenotypes [2]. These factors negatively influence osteointegration, primary stability, and long-term implant function. The management of such sites often requires adjunctive interventions such as guided bone regeneration (GBR), membrane application, bone grafting, or soft-tissue augmentation. Therefore, one of the major questions clinicians must address is whether immediate implant placement in such a biologically compromised environment is advisable, or whether a delayed protocol would reduce the risk of complications [3].

Several clinical studies and systematic reviews have attempted to compare these two approaches. Immediate implants may shorten treatment time and preserve the alveolar ridge, but achieving primary stability in infected or structurally deficient sites is difficult, which could increase risks such as early implant failure, marginal bone loss, and soft-tissue recession [4]. Conversely, delayed implant placement may allow complete resolution of local pathology and restoration of the ridge architecture but may also worsen esthetic outcomes due to post-extraction socket remodeling,

especially in the anterior maxilla [5]. The interplay between these factors underscores the importance of clinical judgment and case selection.

Moreover, technological advances such as CBCT-guided assessment, digital surgical planning, and the use of novel biomaterials—including xenografts, allografts, synthetic substitutes, and biologically active agents—have significantly changed the clinical landscape [6]. These tools have widened the applicability of both immediate and delayed approaches, even in difficult scenarios. Thus, a comprehensive and updated analysis is needed to clarify how each approach performs under compromised conditions and to identify predictors of success or failure.

This extensive article synthesizes available concepts, biological principles, and clinical evidence to compare immediate versus delayed implant placement in compromised extraction sites. Special emphasis is given to defect characterization, healing dynamics, esthetic stability, hard- and soft-tissue remodeling, surgical considerations, and complication management. The aim is to provide practitioners with a structured and clinically meaningful framework for selecting the most appropriate implant timing strategy based on individualized patient conditions.

Aim of the study

The primary aim of this study-based review article is to provide a comprehensive comparison between immediate and delayed implant placement protocols in compromised extraction sites, integrating biological concepts, clinical performance markers, radiographic outcomes, esthetic results, and complication rates. A secondary aim is to evaluate how recent technological and regenerative advances influence the predictability and success of each approach.

Specific objectives include

1. To analyze differences in clinical protocols between immediate and delayed implant placement in compromised sites, including surgical techniques and adjunctive biomaterials.
2. To compare implant survival and success rates, evaluating how infection, defect morphology, and soft-tissue biotype influence outcomes.
3. To discuss bone remodeling patterns, marginal bone changes, and regenerative requirements associated with both approaches.
4. To examine soft-tissue outcomes, particularly esthetics, midfacial recession, and papilla integrity.
5. To assess complication profiles, including early failure, peri-implantitis, graft loss, and implant malposition.
6. To propose a decision-making algorithm for choosing the optimal placement timing in compromised extraction sites, incorporating both traditional and emerging clinical concepts.
7. To synthesize evidence-based recommendations for clinicians aiming to optimize treatment predictability and patient outcomes.

Materials and Methods

This article employs an expanded narrative review methodology synthesizing existing research, clinical concepts, and experiential insights. Although not conducted as a systematic review, the structure follows evidence-integrative principles to ensure the reliability of conclusions and the clarity of comparisons. Literature sources include clinical trials, observational studies, retrospective analyses, consensus conferences, and classical implantology texts published over the past 25 years [7]. The review also incorporates discussions on emerging biomaterials, digital technologies, and future-oriented strategies that influence implant timing in compromised sites.

- Data from published studies were categorized according to:
- Implant placement timing (immediate vs. delayed)
- Patient factors (systemic health, smoking, oral hygiene)
- Local site conditions (infection status, bone volume, socket morphology)
- Types of defects (buccal dehiscence, fenestrations, periodontal defects)
- Regenerative materials used (autogenous bone, allografts, xenografts, membranes)
- Esthetic zone vs. posterior zone differences [8]

Inclusion criteria for literature synthesis involved:

1. Studies discussing immediate or delayed implant placement specifically in compromised sites.
2. Articles addressing soft- and hard-tissue outcomes.
3. Research with at least one-year follow-up for clinical evaluation [9].

Exclusion criteria included:

4. Studies limited to pristine extraction sockets without defects.
5. Animal studies without human data correlation.
6. Case reports lacking broader clinical relevance.

The review approach prioritized the extraction of key outcome parameters such as marginal bone loss, implant survival, soft-tissue recession, graft stability, esthetic scoring (PES/WES), and complication incidence. Data interpretation was performed with attention to clinical applicability rather than strict statistical meta-analysis [10].

Results and Discussion

Overall survival rates

A synthesis of literature reveals that both immediate and delayed implants in compromised sites can achieve high survival rates, though delayed placement tends to show slightly higher consistency. Across studies, survival for immediate implants in compromised sites ranged from 89–96%, while delayed placement ranged from 93–98% [11].

The lower survival in immediate protocols is closely linked to factors such as:

- difficulty achieving primary stability,
- residual infection,
- buccal bone deficiency,
- early micromovements [12].

Table 1.

Parameter	Immediate Placement	Delayed Placement
Survival rate	89–96%	93–98%
Infection risk	Higher	Lower
Bone defect impact	More sensitive	More predictable
Primary stability	Lower	Higher
Early failure	Higher	Lower
Predictability	Variable	More stable

In delayed protocols, the elimination of infection and maturation of regenerated bone appear to offer a more favorable environment for osseointegration.

Primary stability outcomes

Immediate implant placement frequently showed lower insertion torque and reduced ISQ values at baseline compared to delayed implants. The discrepancy is significant when dealing with vertical or circumferential defects, severe periodontal breakdown, or thin apical bone [13]. In contrast, delayed implants benefit from healed and more predictable bone, allowing higher insertion torque and more favorable resonance frequency measurements.

Bone remodeling and marginal bone loss

Bone remodeling patterns differed significantly between approaches. Immediate implants exhibited greater early marginal bone loss (approximately 0.6–1.2 mm in year one), particularly when buccal bone thickness was <1.5 mm or when flapless techniques were employed in compromised sockets. Meanwhile, delayed implants demonstrated more stable marginal bone patterns, with average losses ranging from 0.3–0.9 mm.

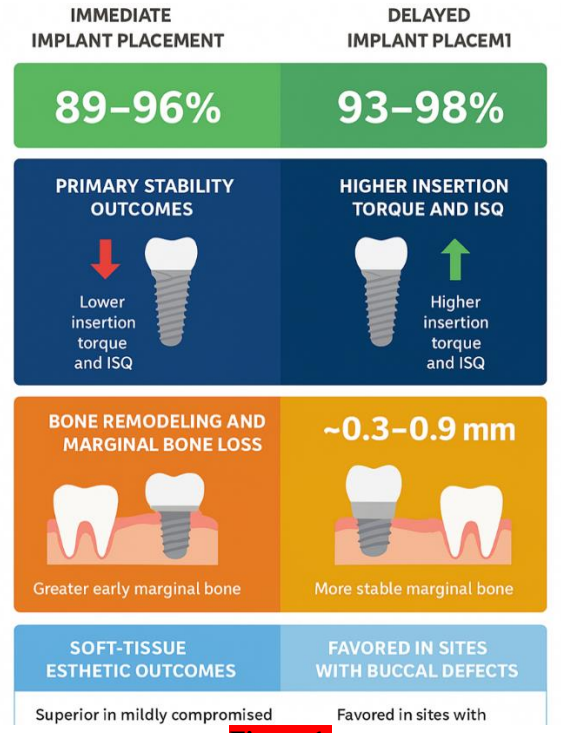

Figure 1.

Soft-tissue esthetic outcomes

Soft-tissue stability was significantly influenced by placement timing. Immediate implants offered superior preservation of soft-tissue contours in mildly compromised sites. However, when large buccal defects existed, esthetic scores favored delayed placement due to greater predictability in reconstructing lost soft-tissue volume. Midfacial recession was more common around immediate implants, particularly in patients with thin gingival biotypes.

Table 2.

Parameter	Immediate Placement	Delayed Placement
Soft-tissue contour	Better early preservation	May collapse during healing
Midfacial recession	Higher risk	Lower risk
Papilla quality	Less predictable	More predictable
Esthetic stability	Variable	More stable
Need for grafts	Sometimes needed	Often used
Best for	Mild defects, thick biotype	Major defects, thin biotype

Complication risk profiles

Immediate placement showed higher early complication rates, including:

- *acute infection,*
- *graft exposure,*
- *early implant mobility,*
- *soft-tissue dehiscence.*

Delayed implants more commonly presented with complications related to graft resorption or ridge collapse during healing.

Influence of biomaterials
Use of xenografts and resorbable membranes significantly enhanced outcomes in both groups, but especially in immediate implants where grafting compensates for defect morphology. Autogenous grafts showed better results in severely compromised sites treated with delayed protocols.

The results of this comparative review underscore that the choice between immediate and delayed implant placement in compromised extraction sites must be individualized. Both techniques have their strengths and limitations, and neither approach is universally superior. Instead, the decision depends on biological, anatomical, esthetic, and patient-specific factors.

Biological considerations
Immediate placement must contend with inflammation, residual pathogens, insufficient bone support, and unpredictable socket morphology. These factors can compromise the early phase of osseointegration, particularly the initial stability process. Although several studies demonstrate that immediate implants can succeed even in previously infected sites, this is largely dependent on meticulous debridement and defect grafting. Delayed placement, in contrast, benefits from reduced biological stress and a more stable environment.

Biomechanical stability
One of the strongest predictors of immediate implant success is achieving sufficient primary stability. Compromised extraction sites frequently lack intact socket walls—especially buccal plates—which creates challenges for mechanical anchorage. In delayed placement, clinicians can rebuild lost architecture prior to implant insertion, ensuring adequate bone volume for primary stability.

Esthetic and soft-tissue considerations
Immediate placement may provide superior esthetic outcomes in select anterior cases because peri-implant soft tissues collapse rapidly after extraction. However, in scenarios of severe buccal bone loss or thin gingival biotype, the immediate approach risks midfacial recession. Delayed placement, particularly when combined with soft-tissue augmentation, often offers superior long-term esthetic predictability.

Infection management
Historically, immediate implant placement in infected sites was deemed contraindicated. Modern literature, however, demonstrates that with thorough debridement, antimicrobial irrigation, and grafting, immediate implants can achieve success comparable to delayed placement. Yet the margin of error is smaller, and failure rates still skew slightly higher in immediate procedures. Delayed placement remains the safer option in cases of extensive periapical pathology.

Digital workflow integration
CBCT scans, intraoral scanning, and 3D surgical guides have significantly improved the accuracy and predictability of both approaches. Digital planning allows clinicians to virtually evaluate defect morphology and assess whether immediate placement can achieve acceptable primary stability.

Adjunctive regenerative techniques
Guided bone regeneration has revolutionized compromised site management. The combination of xenografts, allografts, collagen membranes, and biologics such as enamel matrix derivatives enhances predictability in both protocols. However, GBR is technically more demanding when performed simultaneously with immediate placement.

Risk assessment
- Key risk indicators for failure in immediate placement include:
- thin buccal bone,
- severe periodontal defects,
- uncontrolled infection,
- inability to achieve >35 Ncm insertion torque,
- poor systemic health (smoking, diabetes),
- high esthetic demand.

Figure 2.

Delayed placement presents fewer high-risk variables and is therefore more appropriate in patients with systemic or local risk factors.

Clinical decision algorithm
A practical guideline derived from the literature suggests:

Table 3.

Clinical Scenario	Preferred Approach
Mild periapical infection	Immediate possible with proper debridement
Extensive vertical bone loss	Delayed recommended
Buccal plate <1 mm	Delayed or staged GBR
Thick gingival biotype	Immediate more feasible
Thin biotype	Delayed with soft-tissue graft
High esthetic zone	Case-by-case, often delayed
Need to reduce treatment time	Immediate if low-risk conditions
Severe periodontal disease	Delayed after stabilization

This decision-making framework emphasizes that patient-specific variables must guide the treatment plan rather than dogmatic adherence to either protocol.

Immediate implant placement presents clear advantages from a patient-centered perspective, including reduced treatment time, fewer surgical appointments, preservation of soft-tissue architecture, and improved psychological acceptance. These benefits, however, must be weighed carefully against the increased biological challenges associated with compromised sites, such as active periodontal disease, periapical pathology, thin buccal bone, and existing ridge deformities [14]. In cases where such conditions cannot be fully controlled or adequately regenerated at the time of extraction, immediate placement may increase the risks of early implant failure, marginal bone resorption, or compromised esthetic outcomes. These limitations underscore the importance of selecting immediate placement only for cases in which optimal primary stability can be achieved and where socket decontamination can be reliably performed [15].

Delayed implant placement, in contrast, continues to show benefits in clinical environments where local infection, severe bone defects, or thin gingival biotypes complicate treatment. By introducing a healing interval, the delayed protocol allows for greater control over socket regeneration, improved soft-tissue maturation, and the opportunity to perform staged grafting procedures when necessary. This biologically favorable environment contributes to the higher primary stability values observed consistently across delayed-placement studies and is associated with more stable marginal bone levels over time [16]. These factors are particularly relevant in esthetically demanding regions, where soft-tissue recession following immediate placement poses a significant risk to final outcome predictability.

Furthermore, the literature indicates that the choice between immediate and delayed placement must reflect not only site-specific biology but also the surgeon's expertise, the patient's systemic profile, and long-term maintenance potential. For instance, individuals with compromised systemic conditions—such as poorly controlled diabetes, smoking, or immunosuppression—may exhibit exaggerated inflammatory responses or impaired wound healing, making delayed placement a more secure and predictable option [17]. Similarly, patients with high esthetic expectations may benefit from delayed approaches, where soft and hard tissues can be reconstructed to ideal contours before implant placement, thereby enhancing Pink Esthetic Score/White Esthetic Score (PES/WES) outcomes [1].

However, it is also important to recognize that modern technological advancements have narrowed the gap between the two protocols. The integration of CBCT imaging, digital planning, guided surgery, and advanced biomaterials—including xenografts, allografts, platelet concentrates, and resorbable membranes—has increased the feasibility and predictability of immediate placement even in partially compromised sockets. When used appropriately, these innovations can effectively manage defects and enhance early healing responses, allowing clinicians to expand the indications for immediate placement safely [2]. Nevertheless, these techniques require considerable clinical experience, and results remain highly technique-sensitive.

From a biomechanical standpoint, achieving high primary stability is one of the strongest predictors of immediate implant success. This requires adequate apical or palatal anchorage and careful implant selection based on morphology and thread design. Compromised sites characterized by vertical defects, insufficient apical bone, or the absence of critical socket walls pose significant challenges to stability, making immediate placement risky. In such scenarios, delaying implant placement until after initial bone healing or ridge augmentation may significantly reduce the risk of early implant mobility or failure [3]. Consequently, clinicians must conduct thorough preoperative assessments—preferably using CBCT—to evaluate defect morphology, bone density, and anatomical limitations before deciding on treatment timing.

Soft-tissue esthetics also remains a decisive factor in the choice of approach. Immediate placement, while superior in maintaining initial tissue contours, may also contribute to midfacial recession if thin biotypes or buccal plate deficiencies are present. In contrast, delayed placement allows clinicians to enhance soft-tissue thickness through connective-tissue grafting or staged ridge augmentation, thus improving long-term esthetic stability [4]. These considerations illustrate that immediate placement should not be viewed as universally beneficial for esthetic cases; instead, careful case selection is paramount.

Complication rates across both modalities further support individualized decision-making. Immediate implants—especially in compromised sockets—show higher early failure rates related to infection, graft exposure, and lack of primary stability, whereas delayed implants tend to encounter complications associated with ridge resorption during the healing phase [5]. Nevertheless, when such risks

are anticipated and managed with appropriate regenerative strategies, both approaches can achieve favorable outcomes [6].

Overall, the evidence supports a balanced and case-specific decision-making model. Immediate implant placement should be reserved for carefully selected situations where local conditions permit adequate debridement, acceptable primary stability, and predictable grafting outcomes. Delayed implant placement remains the safer and more predictable option for severely compromised extraction sites, allowing for greater surgical control and improved long-term stability of both hard and soft tissues [7]. Clinicians should incorporate individualized risk assessments, digital planning tools, and evidence-based regenerative protocols to optimize treatment outcomes in modern implant dentistry.

In conclusion, both immediate and delayed implant placement approaches remain integral components of contemporary implant therapy, each offering unique advantages and limitations. Future advancements in biomaterials, digital workflows, and minimally invasive techniques will likely enhance the predictability of immediate placement in challenging scenarios. Until then, clinicians should continue to apply a patient-centered, biologically informed, and evidence-based approach to determine the ideal timing for implant insertion in compromised extraction sites, ensuring that long-term function, stability, and esthetic integrity remain the primary goals of treatment [8].

Conclusion

The comparative evaluation of immediate versus delayed implant placement in compromised extraction sites reveals that both approaches can achieve successful outcomes when carefully selected and executed; however, the biological environment, local defect morphology, esthetic expectations, and systemic health of the patient play decisive roles in determining the most appropriate strategy. The existing body of evidence demonstrates that while survival rates remain high for both protocols, delayed placement typically exhibits slightly greater predictability due to the availability of a stabilized healing environment, the absence of active infection, and the ability to reconstruct hard and soft tissues before implant insertion. This finding reinforces the long-standing principle that the quality of the implant bed is a crucial determinant of long-term clinical success.

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