IMMEDIATE IMPLANT – HEALING- A REVIEW

Dr Gayathiri G, Dr Thaarani S*, Dr Vijay Sagar, Dr Vandhana Shanoy, Dr Mohammed Afrodh

Affiliation: Department of oral & Maxillofacial Surgery**,** Thai Moogambigai Dental College & Hospital, Dr M.G.R University, Chennai, Tamil Nadu, India.

Corresponding author: Dr Thaarani S

Abstract

Immediate dental implantation has gained popularity as a time-efficient and esthetically favorable alternative to conventional delayed protocols. Healing following immediate implant placement is a multifactorial process influenced by surgical technique, host factors, and implant surface characteristics. This review article examines the biological principles and clinical factors influencing the healing of immediate dental implants. Immediate placement involves inserting an implant directly into a fresh extraction socket, offering advantages such as reduced treatment time, preserved alveolar bone, and improved aesthetics compared to traditional delayed protocols. The healing process is a complex sequence of cellular and molecular events, including blood clot formation, osteoconduction, and osseointegration, which is the direct biological bonding of the bone to the implant surface. Key factors affecting healing include the patient's systemic health, bone density, surgical technique, implant design, and postoperative care. While immediate implants boast high success rates and numerous benefits, challenges like achieving primary stability and managing soft tissue recession must be addressed through careful case selection and meticulous execution.

Keywords: Immediate Dental Implants, Osseointegration, Bone Healing, Extraction Socket, Implant Dentistry.

Introduction

Immediate dental implants represent a significant advancement in implant dentistry, marking a shift from traditional delayed placement protocols toward more time-efficient and biologically favorable approaches. In this technique, the implant is inserted directly into the extraction socket within 0–48 hours after tooth removal, thereby eliminating the conventional waiting period of several months for natural healing before placement.[1] The rationale behind this approach lies in its multiple advantages, such as reducing the overall treatment time, minimizing the number of surgical interventions, preserving the alveolar bone that would otherwise resorb following extraction, and maintaining the natural contours of the gingiva for superior esthetic outcomes, particularly in the anterior region. Moreover, by capitalizing on the fresh extraction socket, immediate implants can help achieve better alignment with the patient's existing anatomy and potentially improve patient comfort by consolidating procedures.[2] Despite these benefits, the technique presents inherent challenges, including an increased risk of postoperative infection due to the open socket environment, the possibility of soft tissue recession that could compromise esthetic results, and difficulties in achieving optimal primary stability—especially in cases with compromised bone quality or quantity.[3] Central to the long-term success of immediate implants is the complex and multifaceted healing process, which involves coordinated soft tissue repair and the critical biological phenomenon of osseointegration, wherein new bone forms and bonds directly to the implant surface, anchoring it securely within the jaw.[4] This process is influenced by a variety of factors, including the patient's systemic health, bone density, surgical technique, implant design and surface characteristics, and postoperative care.[5] This article gives an overview on healing after immediate implant placement.

Review of Literature

Immediate dental implants have demonstrated consistently favorable healing outcomes, especially when integrated with adjunctive techniques aimed at enhancing soft and hard tissue regeneration. Clinical evidence indicates high success rates for this approach, even in challenging scenarios. For instance, Kilinç et al. (2018) reported a 97.6% success rate in periodontally compromised patients undergoing immediate implant placement, a figure closely comparable to the 98.6% success rate observed with non-immediate implant protocols, underscoring the viability of both methods. Advances in prosthetic components have further contributed to improved clinical results; the use of customized healing abutments has been shown to support the preservation of peri-implant soft tissue contours and underlying bone, effectively mitigating the pronounced resorption typically seen after tooth extraction.[6] Corrado et al. (2023), in a five-year follow-up study, observed stable soft tissue profiles and an absence of crestal bone loss in cases rehabilitated with such abutments. Similarly, surgical innovations such as open-healing techniques—which allow socket healing without complete flap closure—have demonstrated outcomes comparable to closed-healing methods, while offering the added benefit of reduced postoperative discomfort (Zhou et al., 2023).[7,8] From a functional rehabilitation perspective, Menchini-Fabris et al. (2023) reported that immediate implants restored with provisional non-loading prostheses can successfully rehabilitate patients with chronic lesions, maintaining alveolar ridge width with minimal dimensional changes over time.[9] While these findings highlight the clinical effectiveness and potential advantages of immediate implant protocols, some clinicians remain cautious due to concerns regarding potential complications, the need for site-specific grafting, and variability in primary stability. Continued high-quality, long-term studies across diverse patient populations are warranted to further validate and refine these treatment strategies.

Biological Basis of Healing After Immediate Implant Placement

The healing process following immediate implant placement is governed by a complex sequence of cellular and molecular events that collectively enable the stable integration of the implant with the surrounding bone, ensuring its long-term function. Immediately after placement, a blood clot forms within the extraction socket and osteotomy site, acting as a provisional scaffold that supports the infiltration of leukocytes to clear debris, followed by the migration of osteogenic cells.[10] In the early inflammatory phase, typically by day three, osteoprogenitor cells are recruited, and neovascularization begins, establishing the vascular network necessary for tissue regeneration. Bone healing then progresses through osteoconduction, wherein osteoblasts deposit immature woven bone directly onto the implant surface (contact osteogenesis) and from the socket walls toward the implant (distance osteogenesis), gradually replacing the blood clot scaffold. This woven bone undergoes remodeling into mature lamellar bone with organized osteons—a process known as osseointegration—which usually stabilizes over a period of three to six months. Mechanical forces during functional loading further influence bone adaptation through mechanotransduction, with osteocytes sensing strain and regulating osteoblast and osteoclast activity via pathways such as Wnt signaling to optimize bone strength and architecture.[11] Compared to the natural healing of an extraction socket—progressing from clot formation to granulation tissue, woven bone, and eventual lamellar bone remodeling over 16–24 weeks—immediate implant placement initiates additional regenerative mechanisms, including the regional acceleratory phenomenon, where surgical trauma stimulates localized bone remodeling by enhancing osteoclast and osteoblast activity. The degree of osseointegration is strongly influenced by the intrinsic healing capacity, density, and quality of the host bone, which determine the extent of bone-to-implant contact. Overall, immediate implant healing represents a dynamic interplay of immune defense, cellular proliferation, bone matrix

deposition, and remodeling, all orchestrated by biochemical signals and mechanical stimuli, resulting in stable and functional integration while helping preserve post-extraction bone and soft tissue architecture.[12]

Factors Affecting Healing After Immediate Dental Implant Placement

Healing following immediate dental implant placement is a multifactorial process influenced by patient-related, site-specific, and procedural variables. The patient's overall health status significantly affects healing potential. Chronic systemic diseases such as diabetes mellitus, osteoporosis, and autoimmune disorders are associated with impaired bone metabolism and delayed osseointegration due to altered vascularity and collagen synthesis. Immunosuppressive states, whether disease-related or medication-induced, can also compromise bone healing.[13] Lifestyle factors particularly tobacco use are well-documented risk modifiers, as nicotine induces vasoconstriction and reduces osteoblastic activity. Similarly, poor nutritional status and alcohol abuse can impair the bone healing cascade. Adequate bone volume and density are critical for achieving primary stability, a prerequisite for successful immediate implant placement. Insufficient bone height or width may necessitate grafting, prolonging the healing phase. Bone density is particularly relevant; Type I and II bone (dense cortical and thick trabecular) found in the anterior mandible generally provide more predictable healing outcomes than Type III and IV bone of the posterior maxilla.[14]

The mandible typically exhibits faster healing and higher survival rates compared to the maxilla, largely due to its higher cortical bone content and lower marrow space. Posterior sites, especially in the maxilla, may pose greater challenges due to reduced bone density and potential sinus involvement, often requiring additional regenerative procedures. The surgical approach plays a pivotal role in minimizing trauma to surrounding bone and soft tissues. Achieving optimal insertion torque (usually 30–45 Ncm) without overheating the bone is critical for

maintaining cell viability and promoting osseointegration. Minimally invasive extraction and flapless or minimally reflected techniques have been shown to preserve periosteal blood supply, reducing bone resorption. The surgeon's experience in immediate implant protocols is directly correlated with reduced complications and improved healing timelines. Modern implant macro- and micro-designs are tailored to enhance healing. Features such as thread geometry, platform switching, and roughened or chemically modified surfaces (e.g., SLA, anodized, hydroxyapatite-coated) promote faster bone apposition. The choice of implant diameter and length is guided by anatomical constraints and the need to achieve mechanical stability in available bone. Titanium remains the gold standard due to its biocompatibility and favorable osseointegration profile, although zirconia implants are gaining interest for their aesthetic advantages in anterior regions.[15]

Single-tooth immediate implants generally demonstrate faster healing compared to full-arch or multiple-implant cases, where surgical time, bone manipulation, and soft tissue management are more extensive. Additional procedures such as guided bone regeneration (GBR), sinus lifting, or connective tissue grafting can extend healing requirements. The early post-operative period is critical for avoiding micromotion that can jeopardize osseointegration. Patients must adhere strictly to surgeon instructions, maintain meticulous oral hygiene, and avoid mechanical loading until sufficient bone-implant contact has developed. Adjunctive antimicrobial protocols, both systemic and local, can reduce infection risks during healing. Age-related changes in bone turnover, hormonal status (e.g., postmenopausal osteoporosis), and gender-specific differences in bone density may influence healing outcomes. Additionally, genetic predisposition toward lower bone density or inflammatory overreaction can contribute to delayed integration or peri-implantitis risk.[16]

Healing Timeline After Immediate Dental Implant Placement

Following immediate dental implant placement, healing occurs through distinct but overlapping phases. In the initial 1–2 weeks, patients typically experience swelling, mild soreness, and occasional minor bleeding, which can be managed with prescribed medications and adherence to post-operative care instructions. During this time, the inflammatory phase (0–3 days) involves blood clot formation and migration of white blood cells to initiate tissue repair, followed by the proliferative phase (4 days to 4 weeks), where granulation tissue develops and early woven bone begins to form. From approximately 2 to 6+ weeks, the critical process of osseointegration takes place, during which the titanium implant gradually integrates with the surrounding jawbone; maintaining a soft-food diet and avoiding mechanical stress on the implant site are essential to ensure stability. The early osseointegration phase (4–12 weeks) is characterized by active bone remodeling and an increase in bone–implant contact. Comparative studies indicate that while immediate implants may exhibit slightly greater crestal bone loss in the first 3–6 months than delayed implants, the use of adjunctive bone grafting can significantly minimize such resorption, supporting favorable long-term outcomes.[4,11,15,16]

Comparison of Bone Healing in Immediate vs. Delayed Implant Placement

Immediate and delayed implant placement protocols differ primarily in the timing of fixture insertion relative to tooth extraction, which directly influences the biological healing environment. In immediate placement, the implant is inserted into the fresh extraction socket during the same surgical visit, aiming to preserve alveolar ridge dimensions, reduce treatment time, and minimize surgical interventions. However, fresh sockets often present with peri-implant gaps (“jumping distance”), variable socket morphology, and potential microbial contamination, which can challenge primary stability and bone regeneration. Conversely, delayed placement involves a healing period of 3–6 months post-extraction, allowing for

complete soft tissue closure, initial bone fill, and stabilization of the alveolar crest before implant surgery. This creates a more predictable osseointegration environment, with reduced infection risk and often less crestal bone loss over time.[17] Evidence, including findings from comparative clinical studies, indicates that delayed placement generally results in more favorable crestal bone preservation and radiographic bone fill, regardless of whether bone grafts are used.[18] While grafting materials in immediate placement can help limit bone loss, the differences compared to non-grafted immediate sites are often statistically insignificant. In clinical decision-making, case selection, socket morphology, and soft tissue status remain critical; immediate placement is most predictable in intact sockets with sufficient primary stability, whereas delayed placement offers greater reliability in compromised sites or where infection control is a priority. Both approaches can achieve high survival rates when executed with meticulous surgical technique and sound prosthetic planning.[19]

Advantages and Considerations for Immediate Implant Placement on Healing

Immediate dental implant placement offers several benefits for bone and soft tissue healing. By placing the implant directly after tooth extraction, it helps preserve alveolar ridge dimensions, maintain the natural soft tissue contour, and reduce the extent of jawbone resorption. This preservation not only supports optimal esthetics but also contributes to better functional outcomes, as it avoids the collapse of gum tissue and maintains proper teeth alignment. The immediate placement can also have psychological advantages for patients by eliminating the edentulous period through provisional crowns, which restore appearance and confidence. However, successful healing requires careful patient selection—adequate bone volume, healthy periodontal tissues, and good oral hygiene are prerequisites. In cases where these conditions are not met, additional interventions like bone grafting or delayed implant placement may be necessary. Despite the benefits, certain complications can compromise healing, including microgap contamination leading to peri-implantitis, soft tissue recession, or

implant failure from inadequate primary stability or excessive occlusal loading. Regular follow-up appointments with the dentist or oral surgeon are critical to monitor osseointegration, manage early signs of infection, and ensure long-term implant stability.[3,17,20]

Conclusion

Immediate dental implants can achieve predictable osseointegration and esthetic outcomes if biological principles of healing are respected. Proper case selection, meticulous surgical execution, and postoperative care are essential for optimal healing. The integration of sound biological principles with meticulous clinical practice and patient cooperation forms the foundation for long-term success in immediate dental implant therapy.

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