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Immediate implant placement, Delayed implant placement, Osseointegration, Post-extraction socket, Implant survival, Esthetic outcomes, Digital implant dentistry

Authors

Abhijeet Satani¹

Neuroscientist, Founder and Scientist,
Department of Neuroscience, Satani Research
Centre, Ahmedabad, Gujarat, 380054

E mail- abhijeetsatani@gmail.com

ORCID ID: 0000-0001-7418-6109

Dr. Deblina Saha²

Postgraduate Trainee, Department of
Periodontology and Oral Implantology, Kalinga
Institute of Dental Sciences, Odisha
Bhubaneswar, 751024,

Email ID: deblinasaha02@gmail.com,

ORCID ID: 0009-0005-9625-2177

Dr. Kartheek Reddy L³

Post Graduate, Oral and Maxillofacial Surgery,
Yenepoya Dental College, Yenepoya Deemed to
be University, Karnataka, Mangalore

Email ID: lkreddyatp@gmail.com

ORCID ID: 0009-0006-2363-8156

Dr. Pratyasha Saha⁴

Post Graduate Trainee, Oral And Maxillofacial
Surgery, Buddha Institute of Dental Sciences
and Hospital, Patna ,800026,

Email ID: pratyashasaha99@gmail.com,

ORCID ID: 0009-0008-8891-2261

Dr Shetty Diya Ganesh ⁵

Postgraduate Student, Department of
Prosthodontics and Crown and Bridge, AB
Shetty Memorial Institute of dental science
Nitte (Deemed to be University), 575018

Email ID: drdiyashetty04@gmail.com

ORCID ID: 0009-0002-6760-1639

Dr Rahul Puthenkandathil⁶

Lecturer, Department of Prosthodontics and
Crown and Bridge. AB Shetty Memorial
Institute of Dental Sciences,
Nitte (deemed to be University), Karnataka
Mangaluru - 575018 Karnataka, India

Email ID: rahulputhenkandathil@gmail.com,

Orcid ID - 0000-0002-7207-7782

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Evaluation of Immediate and Delayed Dental Implant Placement in Post-Extraction Sites: A Comparative Clinical Study

Abstract

Dental implant placement in post-extraction sites remains a critical aspect of contemporary implant dentistry, with the timing of implant insertion significantly influencing clinical and esthetic outcomes. Immediate and delayed implant placement protocols are widely utilized, each presenting distinct biological, surgical, and prosthetic considerations. Immediate implant placement involves insertion at the time of extraction and aims to preserve alveolar bone architecture, reduce treatment duration, and enhance patient satisfaction. In contrast, delayed implant placement allows for complete healing of the extraction socket, providing a more stable and predictable environment, particularly in cases with infection, bone defects, or compromised soft tissue conditions. The biological processes following tooth extraction, including bone remodeling and soft tissue healing, play a fundamental role in determining implant success. Immediate placement relies on achieving primary stability within the residual bone, whereas delayed placement benefits from secondary stability through bone maturation. Comparative clinical evidence indicates that both protocols demonstrate high survival rates when appropriate case selection and surgical principles are followed. However, differences may exist in marginal bone loss, esthetic outcomes, and complication risks, which are influenced by factors such as implant positioning, soft tissue biotype, and loading protocols. Advancements in surgical techniques, biomaterials, and digital technologies have enhanced the predictability and accuracy of implant placement, allowing clinicians to tailor treatment approaches to individual patient needs. A comprehensive understanding of biological principles, clinical protocols, and modifying factors is essential for optimizing outcomes. The selection between immediate and delayed implant placement should therefore be guided by an evidence-based and patient-centered approach to achieve long-term functional and esthetic success.

Introduction

There is now predictability and general acceptance in the use of dental implant therapy as a replacement of missing teeth in this modality which provides high levels of survival chances and good functional and esthetic outcomes. The time of exposing the tooth to the implant after the removal of the tooth is a decisive factor of the outcome of the treatment and it still is a subject of clinical controversy. Instead, immediate implant placement, which is the insertion of the implant in the extraction socket during the extraction stage, has been advocated to save on treatment time and maintain alveolar bone structure as opposed to delayed implant placement where the extraction site is completely healed before the implant can be inserted. Choosing between these methods involves taking a keen interest in the biological, mechanical and patient factors [1].

A number of clinical and retrospective studies have shown that immediate and delayed implant placements can result in high survival rates in cases of proper selection of cases and surgical practices. Comparative studies have

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shown that there might be no significant differences in survival outcome with either approach; but there is a difference in terms of marginal bone loss, soft tissue stability and esthetic outcomes [2]. Extensive, retrospective and multicenter assessments also contribute to the trustworthiness of implant therapy in the ordinary clinical practice that the success depends on the operation procedure, the planning of the prostheses and the compliance of the patient [3]. These reports and systematic reviews have put increased emphasis on patient-reported outcomes and esthetic concerns, especially in the anterior maxillary area where soft tissue form and gingival architecture are important predictors of success [4]. There is a correlation between immediate implant placement and greater maintenance of soft tissue contours though higher risk of complications may be seen in those cases of insufficient primary stability or extraction site infection. Systematic reviews of the comparative results of protocols done in the case of immediate and delayed placement give indications that survival rates are similar, but immediate placement should have benefits in terms of briefing treatment time and preserving alveolar sizes [5].

Retrospective studies have also been done over long term where survival of the implants has been assessed in the long term over a longer follow-up time and the results have revealed that the immediate and delayed implants can accomplish the predictable results when implant is placed in the best circumstances [6]. Cochrane reviews also provide evidence that no one timing protocol could be universally superior and clinical decisions should be made individually, depending on site-specific and patient-related factors [7]. International organization statements on consensus support that timings of implants need to be determined by bone quality, soft tissue and prosthetic needs and not by the one-size-fits-all methodology [8]. The esthetic results are also an important factor especially in single tooth replacements. The systematic reviews comparing esthetic parameters have shown that the timing of implant placement and loading procedures can be rather influential in terms of the stability of the soft tissues and general patient satisfaction [9]. Initial clinical trials have shown that immediate placement is able to preserve a height of the alveolar bone and lessen the necessity of further augmentation surgeries, but a cautious choice of cases is necessary to keep complications down to a minimum [10].

Considering the growing need in the shortening of treatment periods and the enhancement of esthetic results, clinicians frequently have to face the problem of choosing the most suitable timing regimen. The further improvement of surgical methods, biomaterials, and digital technology has increased the opportunities

to place an implant immediately or delayed, which requires a thorough assessment of existing evidence. To tackle the question of whether there is a difference in immediate and delayed dental implant placement in the post-extraction sites in terms of clinical outcome, biological factors, and those that influence it, this review will seek to present a comparative analysis of the two methods. This research is aimed at helping clinicians to make informed and evidence-based decisions based on the needs of individual patients.

2. Assigning the Implant Placement Protocols and Timing

The procedures of dental implant placement are systematically categorized in terms of the applied time in relation to the tooth extraction time since the applied time is directly proportional to the biological state of the extraction area and has a clinical outcome. The most popular classification, which has been suggested in the field of implant dentistry, is the division of the implant placement into the four types: immediate (Type 1), early with soft tissue healing (Type 2), early with partial bone healing (Type 3) and delayed (Type 4). Immediate implant placement entails fitting of the implant immediately after the tooth is extracted directly on the fresh extraction socket [11]. Early placement is further divided into 2 stages, where Type 2 placement is performed after soft tissue healing which is typically performed between 4-8 weeks followed by Type 3 placement performed when partial bone healing is performed, which is normally 12-16 weeks. Delayed implant placement is done when the implant is placed after the full bone healing is done, usually after an interval of 4-6 months or more when the extraction site has fully remodelled.

The timing protocols indicate different biological and clinical situations with impacts on implant stability and treatment outcomes. Primary stability can be exploited with the help of bone structures, which is usually recommended in the placement sites with sound socket walls, sufficient bone volume, and free of active infection. Early placement is frequently a choice that must be made when minor infection or soft tissue deficiency is necessary to be resolved prior to implant insertion to allow a compromise between bone conservation and a healthier biological condition [12]. Delayed placement is viewed as a most conservative and is advised in the instances of prevailing extreme bone loss, periapical pathology or traumatic extraction, where full recovery is required before the placement of the implant to create a stable base on which the implant is to be placed. Table 1 summarizes the various protocols of the timing of implant placement and the respective clinical indication.

Table 1: Classification and Timing of Implant Placement Protocols

Protocol Type	Timing After Extraction	Biological Condition	Indications	Advantages	Limitations
Immediate (Type 1)	At extraction	Fresh socket, minimal healing	Intact socket, good bone	Reduced time, bone preservation	Technique sensitive
Early (Type 2)	4–8 weeks	Soft tissue healed	Mild infection resolved	Better soft tissue control	Partial bone loss
Early (Type 3)	12–16 weeks	Partial bone healing	Moderate defects	Improved stability	Longer time
Delayed (Type 4)	>4–6 months	Fully healed bone	Infection, major defects	High predictability	Increased treatment duration

The decision on the timing of the implants is affected by a number of factors and some of them are the quality of the bone, the type of the soft issues, the health conditions in the body and the esthetic needs. Immediate placement has such benefits as it saves time on treatment and eliminates the necessity to resort to surgical intervention on several occasions, however, it demands high precision of surgical work and a thorough selection of cases. The early placement offers a better soft tissue condition with minimal ridge resorption at the same time [13]. Delays in placement, despite its relation to a prolonged treatment period, enables more control over the bone regeneration and positioning of implants. Improvements in ridge preservation methods, biomaterials and computer-aided planning have broadened the guidelines of previous protocols in relation to bone resorption minimization and precision. Clinicians should really understand the protocols of classifications and timings to be followed before making their decisions on the importance of the implantation to maximize the success.

3. Biological Foundation of Post-Extraction Healing and Osseointegration

Tooth extraction triggers a series of biological processes that are intricate and well organized that eventually dictate the appropriateness and the timing of dental implant placement. This is immediately followed by the formation of a blood clot in the socket as a preliminary matrix of cellular migration and tissue repair. The next step is an inflammatory stage where neutrophils and macrophages are involved in debridement of necrotic tissue, bacteria, cytokine, and growth factors. These intermediates activate the angiogenesis and fibroblast, which develops into the granulation tissue. The replacement of this tissue by woven bone proceeds over the course of the next few weeks and the woven bone is then remodeled into mature lamellar bone under the control of osteoclastic resorption and osteoblastic deposition [14].

Through this healing process, there are great dimensional changes in the alveolar ridge. Buccal cortical plate, which is commonly thin and is made up of bundle bone, undergoes intense resorption after tooth extraction because stimulus of periodontal ligament has been lost. This leads to a loss of horizontal and vertical ridges especially during the first three months of extraction. Such alterations may affect the placement of implants and esthetic success and particularly in the anterior maxillary area, the soft tissue contour is paramount. Immediate implantation tries to inhibit these dimensional alterations by continuing to stimulate the functional activities in the socket though it does not entirely stop the bone resorption [15]. In turn, bone grafting or guided bone regeneration may be conducted as an adjunctive procedure to maintain the size of the ridges and to maximize the placement of implants.

The basic biological process that is the basis of implants success is Osseointegration which is described as the structural and functional bonding of living bone, and the surface of the implant. Biological and mechanical factors control this process. Immediate implant protocols require that the primary stability is attained during the implant placement process through the mechanical interaction with the surrounding bone. Delayed implant placement, on the other hand, is more dependent on secondary stability that is formed with bone remodeling and maturation on the implant surface [16]. Bone density, the nature of the implant surface, the surgical technique, and lack of infection are some of the factors that determine the rate and quality of the process of osseointegration. These biological processes should be thoroughly understood to choose the time of the influence of implants and guarantee stable clinical results in the long term. Figure 1 depicts the biological sequence of sockets healing and how this is related to implant integration.

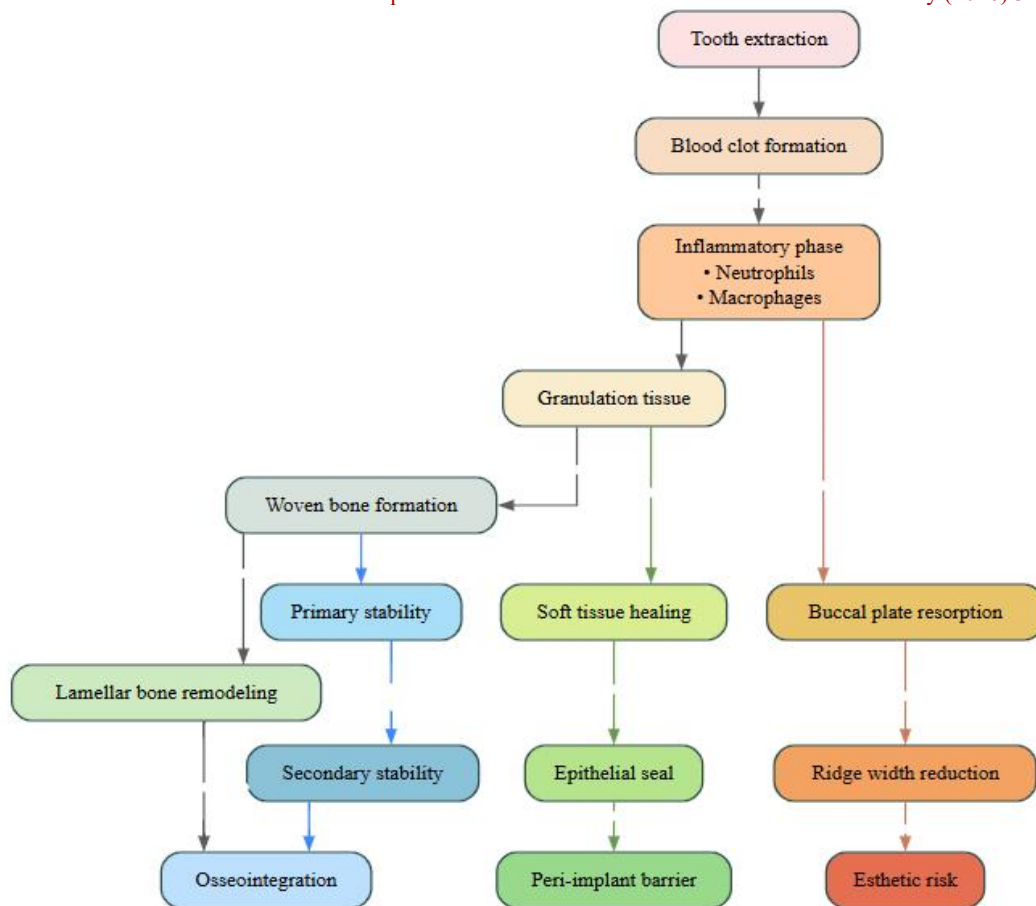


Figure 1: Sequential biological events after tooth extraction and their influence on osseointegration

4. Immediate Implant Placement: Principles and Clinical Protocols

The immediate implant placement can be described as the placement of a dental implant into the extraction socket immediately after removal of the tooth, the chief aim of which is to maintain the alveolar bone and soft tissue architecture, as well as shortening the length of the treatment process. This method has been explained as biological, that is, reduction of post-extraction bone resorption resulting when there is functional stimulation in the socket. An important condition before immediate placement is attained is that the primary stability should have been achieved, and this is usually achieved by involving the apical and palatal or lingual bone above the extraction socket. The safe placement of the implant in a three-dimensional position requires proper positioning to achieve the best biomechanical loading and good esthetic results [17].

The immediate implantation protocols are focused on clinical protocols with the emphasis on atraumatic method of extraction to ensure the integrity of the socket walls and buccal plate in the first place. In order to reduce trauma and preserve bone structure, the periostomes, piezosurgery, or sectioning can be used. Socket debridement should be thoroughly done to eliminate granulation tissue and microbial contamination [18]. The placement of the implants must be prosthetically guided and have proper angulation, depth and mesiodistal spacing. One of the typical issues of immediate placement is the fact that there is a gap between the socket walls and the implant surface commonly known as the “jumping distance.

The common way of dealing with this gap is to use bone graft materials or biomaterials to ensure bone regeneration and minimize dimensional changes.

In immediate implant placement, the soft tissue management is a key factor of success especially in the area of esthetic. Minimally invasive or flapless methods are commonly used in order to avoid blood loss and suggest less recession of soft tissue. It can be proposed to consider immediate provisionalization in the selected cases having appropriate primary stability, which will allow better esthetic results and patient satisfaction [19]. But the loading of the occlusals should be closely monitored so as to escape the excess load which may interfere with the integrity of the loading. However, in spite of its benefits, there is insufficient experience with immediate implant placement, which is technique-sensitive and needs careful case selection. It should not be used in the presence of active infection, the inadequacy of bone volume, or bad soft tissue conditions. In the event that it is done in the best conditions and with correct surgical and prosthetic planning, immediate implant placement can demonstrate foreseeable clinical outcomes with less treatment time and higher esthetic results.

5. Delayed Implant Placement: Principals and Clinical Guidelines

Delayed implant placement entails placement of the dental implant after the dental extraction has healed over some time permitting complete resolution of inflammation and development of bone tissue. This is

deemed as the most conservative and foreseeable protocol especially where the extraction location is present with infection, bone defect or bone compromised soft tissue conditions [20]. The period of healing is between 3 and 6 months, whereby the extraction socket is subjected to remodelling and changing to mature lamellar bone. This offers a favorable and biologically stable environment on which the implants can be placed.

Among the main benefits of delayed placement of implants, the control of the biological conditions of the surgical site should be mentioned. The development of mature bone improves the capacity to attain primary stability during the implant placement period, which decreases the chances of the early failures of the implants. Also, delayed placement could provide the opportunity to apply the ridge preservation or augmentation methods at the time of healing [21]. The loss of bone volume and the enhancement of ridge contour may be done through the implementation of procedures like guided bone regeneration, socket

preservation, or block grafting to enable optimal implant placement and long-term stability.

Delayed implant placement however is related to some constraints. The length of the treatment is one of the greatest disadvantages, as it might influence patient adherence and satisfaction. Moreover, the issue of natural bone resorption that occurs after extraction may also result in a significant change of the size of ridges, which may require further surgical procedures in order to achieve sufficient bone volume [22]. The procedures can complicate, add, and raise the morbidity of the treatment. In spite of these, delayed placement can still be a good method in situations that are complicated and urgent placement cannot be done. Radiography and positioning of implants with the help of the prosthetic should also be carefully planned to provide positive results [23]. In general, the placement of the implants late gives a strong and predictable base of implant therapy, particularly in compromised locations. Figure 2 shows the staged procedure of healing, site re-assessment and implant insertion in delayed placement.

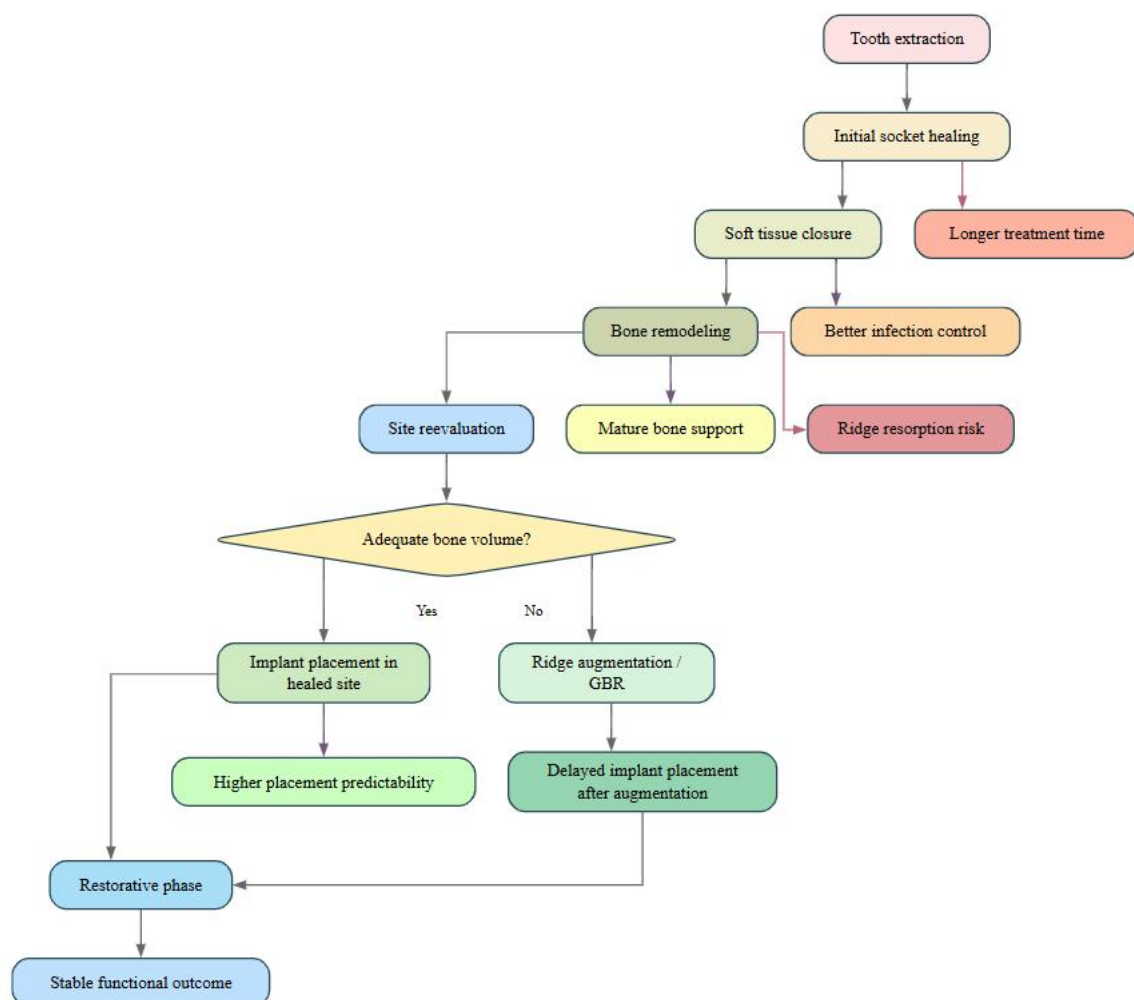


Figure 2: Delayed implant placement pathway after extraction-site healing

6. Surgical Considerations and Techniques

It is important that surgical considerations and techniques are used to establish the success of dental implant placement irrespective of the time protocol adopted. Atraumatic tooth extraction is one of the most valued features of implant surgery that is meant to preserve the integrity of the alveolar and other soft

tissues. It is imperative to minimize the trauma to socket walls, especially on the buccal plate in order to minimize post-extraction bone resorption and ensure positive conditions in which the implants are placed. The use of periostomes, luxators, and piezoelectric devices have been created to help in extracting the

teeth without much invasion and preservation of the anatomical structure [24].

Another important variable that can affect the results of the implantation is the right position of the implants both in terms of their functions and aesthetics. The placement of the implants must be prosthetically guided, that is, the position, angulation and depth of the implant are determined by the final restoration. Poor placement may create problems in the form of poor distribution of loads, esthetics, and the rehabilitation of the prosthesis may be problematic. Cone beam computed tomography (CBCT) and digital planning software has been of great significance in preoperative planning to enhance the accuracy of implant placement. The CAD/CAM produced surgical guides enable the transfer of the planned implant position to the clinical environment, and these guides minimize the possibility of errors [25].

Surgical interventions may be necessary to enhance clinical outcomes, especially when the bone volume or

soft tissue deficiency exists. The bone grafting methods, such as autografts, allografts, xenografts and artificial materials are employed to supplement the deficient sites and enhance the stability of implants [26]. Gingivitis is a condition that is treated with soft tissue augmentation by the use of connective tissue grafts to increase the thickness of the gingiva and provide an appearance of beauty. Also, the use of flapless and open flap techniques is determined by the clinical situation, and flapless methods have some benefits in terms of morbidity decrease and maintenance of blood flow. The complete knowledge of the principles of surgery and the careful implementation of the methods is necessary to guarantee the stability and high success rates of implants. Figure 3 summarises the major decision points and operative variables of surgery that determine the accuracy of implant placement.

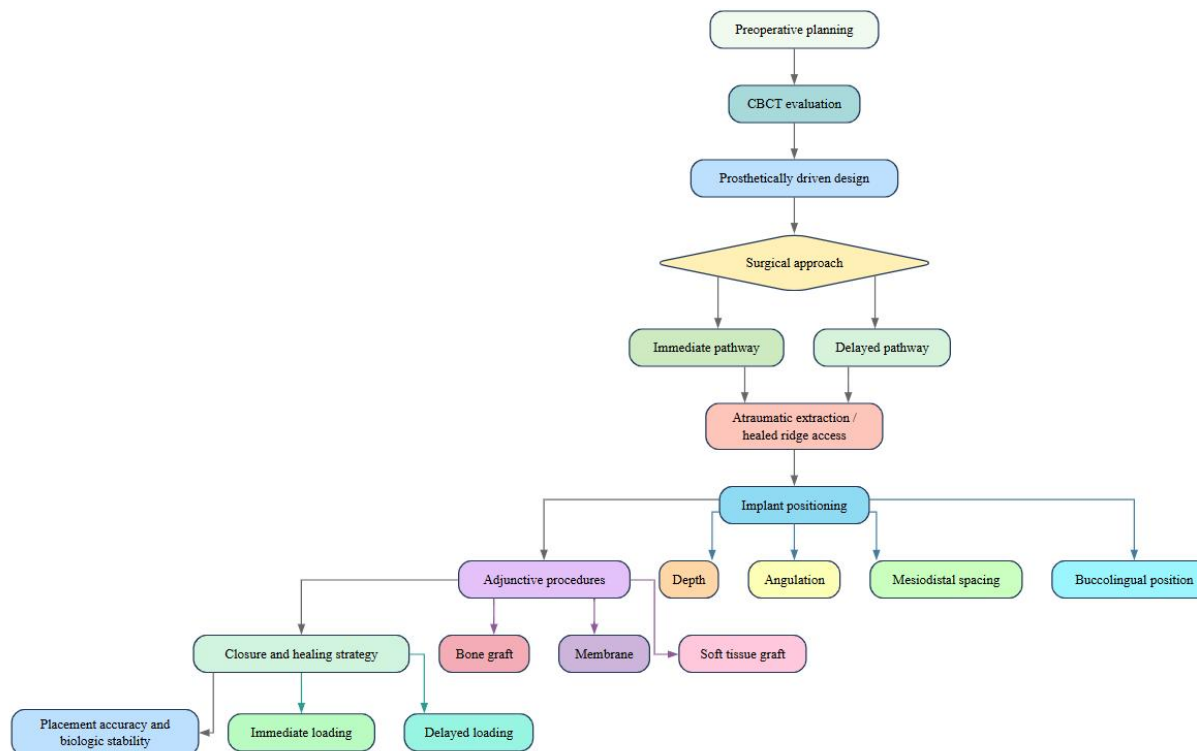


Figure 3: Surgical planning and execution factors governing implant accuracy and stability

7. Comparative Clinical Outcomes: Immediate vs Delayed Placement

Comparison between immediate and delayed implants placement has been widely researched in clinical, radiographic, and systematic studies, and the main aim of the research is to identify the variation in survival rate, marginal bone loss, esthetic results, and the pattern of complications [27]. It has always been shown that immediate and delayed implant placement protocols may be used to obtain high survival rates in case proper case selection and surgical principles are observed. Clinical trials and systematic reviews in the long-term have shown that the survival of the implants between the two methods is mostly similar, which implies that timing is not a determinant of success but one of the elements in a multifactorial clinical system

[28]. Marginal bone loss and peri-implant tissue stability are one of the major areas of comparison. Post extraction resorption has also been found to be lower in immediate placement of the implants, which implies that the alveolar ridge dimensions can be preserved better. This benefit however depends on the correct positioning of the implants, control of the gaps and also the control of the soft tissues. Conversely, the implant can be placed after full bone has healed and maturing and thereby they may result in more predictable bone mass in the long run especially in inoculated locations. Radiographic investigations have indicated that although both methods have been found to be acceptable in terms of bone stability, the variations could be as a result of surgical technique,

implant design and loading procedures as opposed to timing [29].

Other vital aspects of comparison are esthetic results and patient satisfaction, particularly in the anterior maxillary area. The immediate implant placement especially with the use of immediate provisionalization has been reported to preserve soft tissue contours and gingival architecture better resulting in even better esthetic outcomes in the specific cases. Nonetheless, the advantages are extremely technique-sensitive and require variables like biotype, socket integrity, and experience of clinicians [30]. Although delayed

placement will develop a longer treatment plan, it will have more control over soft tissue and bone augmentation surgery, which could have more predictable esthetic outcomes in the compromised anatomy cases. Patient centred thinking also favours immediate placement because of less time in the treatment room and fewer surgical operations, but this should be matched with the risk of complications. Table 2 provides a comparative analysis of clinical outcomes of immediate and delayed implants placement.

Table 2: Clinical performance comparison between early and late implant placement approaches

Parameter	Immediate Placement	Delayed Placement	Clinical Interpretation
Survival Rate	High	High	Comparable outcomes
Primary Stability	Technique dependent	More predictable	Depends on bone quality
Marginal Bone Loss	Slightly higher variability	More stable	Technique sensitive
Esthetic Outcome	Superior in ideal cases	More predictable in complex cases	Case-dependent
Treatment Time	Shorter	Longer	Patient preference factor
Complication Risk	Higher in poor cases	Lower overall	Depends on selection

There is also a difference in the complications and risk factors of the two approaches. Premature placement of implants can have increased risk of early failure in situations where primary stability is poor, there is an infection or in low bone quality. Improved results can be achieved through delayed placement which ensures reduced risks as the sites are fully healed and optimized before the implant is inserted. But possibly it can include more operations and longer periods of treatment. All in all, the two protocols can be clinically sound, and decisions about the immediate and delayed implant placement must be made based on a thorough evaluation of the biological states, patient anticipations, and the skills of a clinician to achieve the best results.

8. Esthetics and Patient-Reports

The esthetic results are an essential element of the success of the implant therapy in a case especially in the anterior maxillary area because the visual aspect is an important element in patient satisfaction. The esthetic parameters to be considered are the gingivals contour, papilla height, mucosal colour and harmony between the implant supported restoration and the natural teeth. The importance of placing implants immediately has long been linked with a better preservation of the soft tissue structure as it does not cause much destruction to the gingival structure and data has shown that the natural contour of the extraction site is preserved [31]. This is specifically beneficial in those patients whose gingival biotype is thick and those who have intact socket walls because good esthetic results can be obtained with minimum intervention.

Interdental papilla preservation and marginal gingival level are vital in ensuring that the best esthetic outcomes are obtained. This can be facilitated with soft tissue contours by prompt placement particularly in

combination with prompt provisionalization to decrease the risk of papillary loss. Nonetheless, the results of these will be highly reliant on accurate positioning of the implants and handling of the peri-implant tissues [32]. Delayed placement of the implant in the thin biotype or compromised socket anatomy cases may be a superior method to control soft tissue augmentation procedures and enable clinicians to provide optimal esthetic results with staged interventions. Patient-reported outcomes have become a significant area of assessment of the success of implant therapy, not limited to clinical and radiographic measures. Comfort, treatment duration, functional improvement, and overall satisfaction are some of the key factors to be considered. The placement of implants immediately is likely to lead to increased patient satisfaction since the time of treatment is reduced, and the number of surgical operations is decreased, and one can have an immediate restoration. Nonetheless, the expectations of the patients should be handled with care since not every case can be subjected to immediate procedures [33].

Late implantation, albeit with a higher cost of treatment, can offer more predictability when treating complex cases, leading to better long-term satisfaction. The capability of undertaking augmentation surgeries and polishing the contours of tissues before the implants are placed aids in a more consistent aesthetic effect [34]. Finally, the timing of the implants must be based on objective clinical and subjective expectations of the patient and needs to balance the esthetic quality and predictability of the treatment. The interplay between the hard and soft tissue conditions, esthetic parameters, and patient-centered outcomes is illustrated in Figure 4.

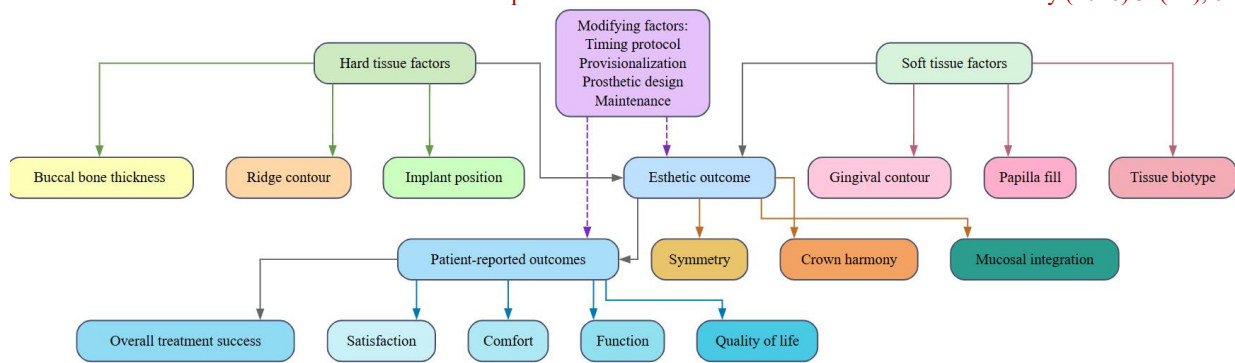


Figure 4: Integration of peri-implant tissue conditions, esthetic variables, and patient-reported outcomes

9. Factors Influencing Implant Success and Failure

Dental implants have an intricate relationship that depends on patient, site specific, surgical and prosthetic factors that affect the success and longevity of dental implants. Systemic health issues like diabetes, smoking habits, and oral health practices are some of the patient factors that can have a major impact on healing and osseointegration [35]. The systemic health or lack of proper control of plaque can augment the danger of peri-implant disease as well as the loss of implant. Thus, the careful patient assessment and risk factors management are the key elements of treatment planning.

The site-specific factors are also important determinants of implant success. One of the most significant determinants is bone quality and quantity which affect the primary stability and long-term integration. The placement of the implant is more likely to be successful in cases where there are sufficient amounts of bone and intact socket walls thus

the earliest possible placement of the implants is more appropriate whilst in other cases with bone defects or infection, it is better to place the implants later [36]. Anatomical position of the implant like anterior or posterior position also influences the outcome because of the variation in bone density and loading conditions. Other factors that promote the success of implants are surgical and prosthetic. Minimizing the number of complications requires precise placement of implants, atraumatic surgical procedure, and proper loading procedures. Implant design, surface properties and type of connection may affect the distribution of stress and stability of peri-implant tissue [37]. Prosthetic factors, such as occlusal design and abutment choice, are essential in the prevention of the mechanical complications and long-term functionality. Table 3 highlights the key biological, mechanical and patient-related factors that contribute to the success and failure of implants.

Table 3: Determinants affecting the prognosis of dental implant therapy

Factor Category	Specific Factors	Impact on Outcome
Patient-related	Smoking, diabetes, oral hygiene	Delayed healing, failure risk
Site-related	Bone quality, volume, socket integrity	Affects stability
Surgical	Implant positioning, technique	Influences osseointegration
Prosthetic	Loading protocol, occlusion	Affects long-term success
Material-related	Implant surface, biomaterials	Influences integration

The combination of the factors highlights the significance of the personalized and holistic treatment of the implant therapy. To maximize the results, clinicians should assess every case on a case-by-case basis and focus on biological, mechanical, and patient-related variables. The inability to consider all these factors may undermine implant success, which is why it is essential to plan and implement it carefully.

10. Digital and technological Implication in Implant Placement

The introduction of digital technologies in the field of implant dentistry has contributed to a significant improvement of the accuracy, predictability, and effectiveness of the process of placing implants. The contemporary process in planning an implant is three-dimensional imaging with the help of cone beam computed tomography (CBCT) that can give a thorough image of the bone structure, surrounding structures and bone available volume. This enables

clinicians to evaluate on key parameters like bone density, ridge morphology and closeness to anatomical features like nerves and sinu cavities. Online planning software also facilitates virtual positioning of implants according to the demands of the prosthetic, and thus, restoratively guided placement of implants will be achieved instead of the convenient placement of implants by the surgeon [38].

Computer aided design and computer aided manufacturing (CAD/CAM) technologies have been used to fabricate surgical guides which convert virtual planning to clinical implementation. These guides allow the accurate management of the angulation, depth, and position of implants and eliminate the possibility of deviations and surgical errors. The popularity of static guided surgery has been attributed to its precision and reliability especially in complicated cases [39]. Dynamic navigation systems are also another development, which enables real-time monitoring of surgical equipment throughout the

implantation process. This technology is a continuous feedback enhancing accuracy and making it possible to do intraoperative corrections without having to use pre-fabricated guides.

The use of robotic-assisted implant placement is a new technology, which is characterized by a high degree of accuracy and consistency. In such systems, digital planning is integrated with the support of robots to improve the accuracy of the surgery, especially in difficult anatomical cases [40]. Besides surgical innovations, the digital working processes have changed the prosthetic operations. The digital impressions provided by intraoral scanners are very

precise and there is no need of using traditional impression materials and the patient experience is enhanced. Prostheses can be manufactured and produced digitally, which would be highly precise and fit and operate optimally. In spite of these achievements, the success relies on the expertise of clinicians and adequate selection of the case [41]. Technology is an aid and not the substitute of sound clinical judgment and observance of biological principles. Table 4 presents the role of digital innovations and advanced technologies in enhancing the accuracy of implant placement.

Table 4: Emerging digital technologies and their applications in implant dentistry

Technology	Application	Advantages	Limitations
CBCT Imaging	3D planning	Accurate diagnosis	Radiation exposure
CAD/CAM Guides	Surgical guidance	High precision	Cost
Dynamic Navigation	Real-time tracking	Flexibility	Learning curve
Robotics	Automated placement	High accuracy	Limited availability
Intraoral Scanning	Digital impressions	Patient comfort	Equipment cost

11. Clinical Decision-Making and Evidence-Based Recommendations

The process of clinical decision making in implant dentistry must be a systematic well-informed process that incorporates patient specific factors, site factors, and scientific evidence at hand. The decision to make on whether to place the implants immediately or delay the process should be informed by a thorough evaluation of the bone quality, soft tissue status, existing infection and esthetic needs. Randomized controlled trials and systematic reviews show that both methods can also lead to positive results when the relevant protocols are adhered to, and it is essential to plan treatment individually [42].

The assessment of the primary stability is a major aspect of decision-making and is necessary in order to institute implants immediately. Sufficient bone volume and density cases can be placed immediately, and bone defective sites can be better placed after some time to give time to bone regeneration and stabilization [43]. Soft tissue factors such as gingival biotype and keratinized tissue width also play a role in selection of the treatment especially in the esthetic zone. Systemic health, smoking status, and oral hygiene are patient-related factors, which need to be closely evaluated because they might have a drastic effect on the healing process and overall success [44].

The consideration of prototheses is just as vital in planning the treatment. The implant position must be prosthetically motivated, so that there is ideal outcome in terms of functionality and esthetics. The choice of loading protocols, immediate or delayed, ought to be based on the conditions of implant stability and occlusal. The clinicians should also address the patient expectations such as duration of treatment, cost and esthetic requirements. The balanced risk assessment and maximized results of clinical findings are possible through a structured system of decision-making that incorporates the existing evidence. The emergent research needs to be constantly assessed in order to update treatment plans and ensure the high quality level of care [45].

12. Research Limitations and Future Outlines

Although the research on the time of implant placement has a long history, there are several limitations that influence the interpretation and implementation of the existing evidences. The heterogeneity of the study designs, such as differences in patient populations, surgical methods, implant systems, and outcome measures are one of the main challenges. Such disparities render comparisons of studies challenging and it hard to conclude conclusively about the bestness of one protocol compared to another. Also, several studies are retrospective, which can be a source of selection bias, and may constrain externalization of results. The other major limitation is that there is a variation in the follow-up duration between studies. Although the short-term results are usually positive with regard to both early and delayed implant placement, the long-term results are scarce in most instances. The variability of definitions of implant success and failure also makes the comparison even harder since the criteria may be the survival rates, marginal bone loss, or patient satisfaction. This is due to the fact that there has not been standard outcome measures hence the need to come up with standard reporting guidelines to enhance the quality and comparability of research conducted in the field of implant dentistry.

Further studies are needed to use well-constructed randomized controlled trials using standardized protocols and follow-up to develop more solid evidence. Biomaterials, advancements in implant surface technology, and regenerative procedures would improve the process of osseointegration and shorten the healing process. Digital technologies (artificial intelligence, machine learning) can become another way of enhancing the process of treatment planning and outcome prediction. One of the new directions is paying attention to individual-level practices that are conditioned by patient-specific factors, including genetic predisposition and systemic health. Innovation and quality-based research should be continued to

reduce the existing limitations and develop the field towards more predictable, effective, and patient-centred implant therapy.

13. Conclusion

The immediate and delayed implant placement protocols show a high success and survival rate in case proper case selection and clinical principles are observed. The time of resuscitation is not uniformly universal but is based on the biological, mechanical and individual consideration of the patient. The benefits of immediate implant placement include a shorter treatment period, retaining of alveolar bone and better patient satisfaction especially in cosmetically sensitive areas. Nevertheless, it demands rigid selection of cases, optimum primary fixity and accuracy of the surgery to reduce the chances of complications. Late implantation, however, enhances a more controlled and predictable environment of healing, particularly with situations of infection, bone defects, or weakening soft tissue. Even though it takes more time to treat and can also need further augmentation, it is a stable method that has a stable clinical outcome. The innovations in digital technologies, surgery methods, and biomaterials have only increased the predictability of the two protocols. An evidence-based, multifaceted treatment that encompasses clinical evidence with patient expectations is the key to the best treatment planning. Finally, the personal approach to decision-making is the key to successful implant therapy that guarantees the achievement of effective functional and esthetic results in the long-term.

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