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Review Article

Immediate Implant Placement: A Comprehensive Review

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Abstract

A dental implant is a prosthetic device made of alloplastic material(s) implanted into the oral tissues beneath the mucosal and/or periosteal layer and on or within the bone to provide retention and support for a fixed or removable dental prosthesis; a substance that is placed into and/or on the jaw bone to support a fixed or removable dental prosthesis. It can also serve as an orthodontic anchor. Before attaching the prosthesis or placing an abutment to support it, a certain amount of time is needed for osseointegration, which is the apparent direct attachment or connection of osseous tissue to an inert, alloplastic material without intervening fibrous connective tissue. There are different approaches to dental implant placement after tooth extraction, including immediate post-extraction implant placement, delayed immediate post-extraction implant placement (within two weeks to three months after extraction), and late implantation (three months or more after tooth extraction). The practice of placing implants immediately after tooth extraction has gained prominence in recent years, and it has undergone significant changes due to a better understanding of socket healing after tooth extraction. Immediate implant placement is increasingly popular as it helps preserve bone and reduces the overall treatment time. It is recommended for cases where the extraction socket is in good condition and provides favorable long-term results. In cases where there are bone defects present before or after tooth extraction, bone regeneration techniques are recommended. While immediate implant placement was initially limited to healthy sites, it can now be performed even in infected sites with reduced periodontal support, albeit with special precautions. This technique also enhances aesthetics by preserving the soft tissues around the implant. However, it is important to note that immediate implant placement is a technically challenging procedure that should be carried out by experienced clinicians in the field of implant dentistry, both surgically and prosthetically. This article aims to provide a comprehensive overview of immediate implant placement, present the latest updates in this area, highlight the key technical factors that contribute to optimal outcomes, and summarize the various situations in which this technique is appropriate.

Keywords: dental implant, immediate implant, immediate placement, jumping distance, osseointegration, primary stability, tooth extraction.

INTRODUCTION

The objective of modern dentistry is to restore teeth to their normal condition in terms of shape, function, comfort, aesthetics, speech, and overall health. This can involve treating dental caries or replacing multiple missing teeth. When it comes to replacing missing teeth, options include fixed dental prostheses, removable dental prostheses, or dental implants. Dental implants have become a popular and successful treatment method, providing a realistic alternative for patients with missing teeth. Advancements in technology and surgical techniques have led to significant modifications to the original implant protocol, resulting in promising and predictable outcomes.

One such protocol is immediate implant placement, which involves placing implants into fresh extraction sockets right after tooth removal. Immediate implant placement can be defined as placing an implant immediately following tooth extraction in the same surgical procedure or placing an implant immediately after extracting a tooth, which often requires a bone grafting technique to address any bone defects around the implant.[1] The concept of immediate implant placement was first described by Schulte and Heimke[2] in 1976 and later reintroduced by Lazzara[3] in 1989 through case reports. Managing fresh extraction sockets in the alveolar ridge presents a particular challenge in clinical practice. The contour of the ridge plays a significant role in subsequent treatment steps, especially those involving implant placement and reconstruction. Following tooth extraction, the alveolar bone experiences the most significant reduction in the first 6 months to 2 years.[4] The healing process after extraction leads to changes in the ridge's external contours and the filling of the socket with newly formed bone. If left untreated, uncontrolled resorption can lead to bone deficiencies that may hinder implant placement. Immediate placement into fresh extraction sockets allows for placing implants during the same visit as the tooth extraction, reducing treatment time and cost, preserving gingival aesthetics by preventing ridge atrophy, and enhancing patient comfort. The primary advantage of immediate implant placement is the reduced healing time, as bone-to-implant healing begins immediately along with extraction site healing. Additionally, normal bone healing occurs around the implant within the extraction site.

The morphology of the extraction socket influences the clinician's choice of flap design, implant size selection, the need for bone grafting, and whether to submerge or non-submerge the implant during healing. In 1993, Gelb reported a series of 50 consecutive cases with a 98% survival rate, which validated the immediate placement protocol.[5] Since then, numerous studies on animals, human case reports, and randomized controlled studies have contributed to the understanding of this treatment modality.[6,7,8]

One of the major difficulties in achieving successful outcomes is the architectural changes in the tissues. These changes can occur even before extraction, such as the loss of buccal and/or interproximal tissues resulting in a gingival recession or loss of the interproximal papilla. Alternatively, changes may occur after dental extraction due to bone resorption and remodeling. Immediate implantation after extraction is widely accepted and advantageous, but failure to adhere to fundamental principles can lead to significant, sometimes irreversible, damage.

Today, immediate implant placements are more common in regular dental practice, especially for single missing teeth, as the traditional six-month healing period post-extraction before implant placement is less appealing to patients. Therefore, the timing of implant placement has become a crucial consideration in implant dentistry. The purpose of this comprehensive review article is to provide an updated overview of immediate implant placement and highlight the technical factors that significantly contribute to optimal results.

POST-EXTRACTION RIDGE RESORPTION (Alveolar Socket Healing after Tooth Extraction)

Dimensional changes in hard tissue

Araujo M et al.[9] divided the normal healing process of alveolar sockets into three phases:

In the inflammatory phase, a blood clot forms in the socket after extraction. Inflammatory cells migrate to the site within 2-3 days to clean it before the formation of new tissue. After 4 to 5 days, granulation tissue develops, consisting of inflammatory cells, vascular sprouts, and immature fibroblasts. This tissue gradually transforms into a provisional connective tissue matrix rich in collagen fibers and cells.[10]

The proliferative phase is characterized by rapid and intense tissue formation. Osteoid calcification starts at the base and periphery of the socket. The bone matrix appears early, usually in the second week of healing, and is eventually replaced by mature bone tissue.[11] Bone filling occurs between 5 to 10 weeks, and complete bone regeneration is achieved after 16 weeks. The socket also undergoes complete epithelial closure after 4 to 5 weeks.[12]

The bone modeling and remodeling phase involve changes in the shape and architecture of the bone.[13] Resorption is a characteristic of the healing process after tooth extraction, and it can cause complications during implant restoration.[14] Without ridge preservation procedures, vertical resorption of 1 to 2 mm and horizontal resorption of 4 to 5 mm have been observed.[15] Resorption is more pronounced on the buccal side compared to the

lingual or palatal side. While the molar region experiences more significant resorption, the anterior region is also affected due to aesthetic considerations.[16] The majority of bone resorption occurs within the first year after extraction, with approximately 2/3 happening during the initial 3 months.[17] Bone remodeling, on the other hand, continues for several months or years without significant changes in ridge shape and architecture.[18]

Preservation of the alveolar ridge immediately after extraction directly impacts the aesthetic and functional outcomes of prosthetic treatment. The goal is to maintain the architecture of the alveolar bone, prevent soft tissue relapse, and minimize or eliminate the need for bone augmentation procedures.[19] Research by Januario et al. using Cone Beam Computed Tomography (CBCT) found that the buccal bone wall in the anterior maxilla is thin (less than 1mm) in patients with a healthy periodontium.[20] Without preservation techniques, this wall is prone to partial or complete resorption.[21] Filling the socket can help limit soft tissue shrinkage during healing and support bone formation.[22] Immediate implant placement does not prevent buccal bone loss; even with immediate implantation, resorption of the buccal bone wall occurs.[23] Bone remodeling occurs during the healing phase after immediate implant placement, leading to resorption of the buccal and lingual bone walls in both vertical and horizontal directions.[24] Botticelli et al. reported a mean bone gain of 0.2mm over 5 years.[25] Other studies[26, 27] have observed low levels of bone resorption ranging from 0.18 to 0.79 mm compared to delayed implantation after 1 to 3 years of healing.

Dimensional changes of soft tissue

Immediate implant placement can be associated with mild gingival recession.[28] Regardless of the periodontal biotype, a defect in the soft tissue width is often observed. Without proper soft tissue management, there is a risk of apical relapse of the mucosa, which can result in the appearance of gingival recession.[29]

The indications for immediate implant placement[30] include:

1. Tooth extraction performed due to various reasons, including:
   - Trauma
   - Endodontic causes
   - Root fracture (horizontal or vertical), resorption, or perforation
   - Unfavorable crown-to-root ratio (not caused by periodontal loss)
2. Preservation of intact bony walls of the alveolus (socket) after tooth extraction.
3. Presence of an intact facial bone wall with a thick phenotype (thickness greater than 1 mm).
4. Thick gingival biotype.
5. Adequate bone volume is available apically and palatally of the extracted root, allowing for correct three-dimensional positioning of the implant and achieving good primary stability.

The contraindications for immediate implant placement[31] include:

1. Acute periapical or periodontal infections: Active infections in the area of the proposed implant placement can compromise the success of immediate implant placement. It is important to address and resolve any infection before considering implant placement.
2. Proximity to vital anatomic structures: Implant placement should be avoided in areas where there is a risk of damaging vital structures such as nerves, blood vessels, or sinuses. Careful assessment of the anatomical structures is necessary to ensure safe implant placement.
3. Sites requiring guided bone regeneration: In cases where there is insufficient bone volume to support implant placement, guided bone regeneration techniques may be needed to augment the bone. Immediate implant placement may not be suitable in such cases.
4. Patients with a high lip line: In individuals with a high smile line where the gingiva is prominently displayed, achieving optimal aesthetic outcomes with immediate implant placement may be challenging. A comprehensive evaluation of the patient's smile line and aesthetic expectations is necessary.
5. Tissue phenotype: The thickness and quality of the gingiva can influence the success of immediate implant placement. Thin or compromised gingiva may not provide adequate support and stability for the implant.
6. Dehiscence defects: The presence of dehiscence defects, where the bone is lacking on the facial aspect, can pose challenges for immediate implant placement. Additional procedures such as bone grafting or soft tissue augmentation may be required before implant placement.

It is important to note that contraindications may vary depending on individual patient factors and the specific clinical situation. A thorough evaluation by a dental professional is necessary to determine the suitability of immediate implant placement for each patient.

The advantages of immediate implant placement[32] include:

1. Reduction in the number of surgical interventions: Immediate implant placement allows for combining tooth extraction and implant placement in a single surgical procedure. This eliminates the need for a separate surgery for implant placement, reducing overall surgical interventions.
2. Reduced treatment duration: By placing the implant immediately after tooth extraction, the treatment time is significantly reduced compared to delayed implant placement. This can lead to faster restoration of the missing

tooth or teeth.

3. Preservation of alveolar bone width and height: Immediate implant placement helps preserve the dimensions of the alveolar bone, which is the bone surrounding the tooth socket. This preservation allows for maximum utilization of the bone-implant surface area, promoting better implant stability and long-term success.
4. Achieving ideal implant orientation: With immediate implant placement, the implant can be positioned optimally in terms of angulation, depth, and alignment. This allows for the ideal placement of the implant relative to the adjacent teeth and the overall dental arch.
5. Preservation of bone at the extraction site: Immediate implant placement helps maintain the bone at the extraction site by preventing or minimizing bone resorption that typically occurs after tooth extraction. This preservation of bone volume can be beneficial for achieving optimal functional and aesthetic outcomes.
6. Maintenance of soft tissue aesthetics: Immediate implant placement can help preserve the gingival contour and architecture, contributing to better soft tissue aesthetics around the implant restoration. This can result in a more natural-looking smile.
7. Improved patient acceptance: Immediate implant placement offers several advantages in terms of reduced treatment duration, preservation of bone and soft tissue, and better aesthetic outcomes. These factors contribute to improved patient acceptance and satisfaction with the overall implant treatment.

It is important to note that the suitability of immediate implant placement depends on various factors, including the specific case and patient considerations. A thorough evaluation and consultation with a dental professional are necessary to determine the most appropriate treatment approach for each individual.

The disadvantages of immediate implant placement[33] include:

1. Risk of partial alveolar bone resorption: There is a potential risk of partial bone resorption at the implant site, especially if there is an underlying pathological process or if there is traumatic damage to the alveolar bone during the tooth extraction. This can affect the stability and long-term success of the implant.
2. Difficulty in achieving primary stability: Immediate implant placement can be more challenging to achieve optimal primary stability compared to delayed implant placement. Immediate placement relies on the existing bone structure without the opportunity for pre-implant site preparation or bone healing.
3. The gap between the implant surface and socket wall: When placing an implant immediately after extraction, there may be a gap between the implant surface and the socket wall. This can hinder proper bone-to-implant contact and osseointegration, potentially affecting the long-term success of the implant.
4. Additional cost for guided bone regeneration: In cases where there is insufficient bone volume for immediate implant placement, guided bone regeneration techniques may be required to augment the bone. This can increase the overall cost of the treatment.
5. Difficulty in predicting the final position of the implant: Immediate implant placement presents challenges in accurately predicting the final position of the implant due to factors such as socket morphology and tissue response. This can impact the aesthetic and functional outcomes of the implant restoration.
6. Difficulty in achieving complete closure of the implant site: Achieving complete soft tissue closure at the implant site can be challenging with immediate implant placement. This can increase the risk of complications such as infection or delayed healing.
7. Need for flap elevation in two-stage procedures: In cases where a two-stage implant placement approach is preferred, which involves placing the implant below the gumline and covering it with a flap, there is a need to raise a flap for proper implant coverage. This adds an additional surgical step and can potentially lead to increased discomfort and prolonged healing.

It is important to note that these disadvantages are not absolute and can vary depending on the specific case and individual patient factors. A thorough evaluation and discussion with a dental professional are necessary to determine the most suitable treatment approach and manage potential disadvantages effectively.

Key Elements/Tips in Immediate Implant Placement Surgery

1. Delicate starting with a pilot drill: When performing immediate implant placement, it is important to use a delicate approach when starting with a pilot drill. This is particularly important when dealing with the hardness of the palatal wall, as there is a risk of slipping into the socket and perforating the buccal bone plate.[34] Two techniques can be employed to avoid this problem:
   a) Round bur technique: In this technique, drilling is initiated with a small round bur on the palatal wall of the socket, approximately one-third of the apex. The drilling is then carried out in a palatal direction concerning the tooth axis. This technique is suitable for cases of immediate implantation without or with minimal tissue loss.
   b) Trephine technique: The trephine technique allows for better control of the implant axis and enables the recovery of bone for further filling. It involves using a trephine bur to harvest bone graft and then placing the implant, with the option to place the graft between the implant and the buccal bone socket. Extending the drilling beyond the socket during implant site preparation helps optimize implant primary stability.
   c) Dual zone technique: The dual zone technique is another approach used for immediate implant placement, especially in the anterior region. It involves dividing the treatment area into two zones: the tissue zone and the

bone zone. The tissue zone extends from the free gingival margin to the labial crest of bone, while the bone zone is the tissue apical to the osseous crest. This technique helps minimize contour changes associated with immediate implants and allows for the indirect removal of excess cement around the final crown to prevent potential periimplantitis.

2. Extending drilling beyond the socket: During implant site preparation, it is recommended to extend the drilling beyond the socket to optimize implant primary stability. This is particularly important in cases where there is an apical lesion, as drilling beyond the lesion helps remove infected tissue and achieve reliable anchorage in healthy tissue.
3. Choice of implant diameter: Selecting an implant of adequate diameter is crucial, taking into consideration the anatomical and prosthetic requirements of the specific case.
4. Proximal spacing for inter-dental papilla fill: Maintaining proper spacing between adjacent implants or teeth is important for achieving a complete fill of the inter-dental papilla. It is recommended to have a 3-4 mm horizontal distance between the adjacent implant/tooth and a 3-5 mm vertical distance between the contact point and inter-proximal bone.[35]
5. Deviation from the socket axis: The implant axis often deviates from the socket axis in specific regions. In the maxillary anterior region, the implant is typically placed more palatal than the extraction socket. For maxillary molars and premolars with 2 roots, the implant is placed at the level of the septum. In the mandibular molar region, the implant is placed at the inter-radicular septum. In the lower mandibular region, implants are positioned as parallel as possible.

It's important to note that these techniques and considerations should be implemented by experienced dental professionals who have expertise in immediate implant placement procedures. Individual patient factors and case-specific considerations should also be taken into account for optimal outcomes.

Risk Factors in Immediate Implant Placement

1. Weakened periodontal support: Immediate implantation in patients with severe periodontitis carries a higher risk of failure compared to healed sites. The implant survival rate in immediate implantation on periodontally compromised teeth varies, with a range of 84% to 98.4% and a significant difference compared to healed sites.[36]
2. Chronic peri-apical infection: Chronic peri-apical infection is not an absolute contraindication to immediate implantation if proper debridement and socket cleaning precautions are taken. The risks of failure are similar to immediate implant placement in the absence of apical pathology.
3. Periodontal biotype: Immediate implants may be associated with mucosal recession, particularly in cases with a thin periodontal biotype. A thin biotype increases the risk of developing mucogingival defects. Gingival augmentation techniques can help improve the periodontal biotype and peri-implant health.
4. Extraction socket: A careful evaluation of the implantation site before extraction is important for optimizing aesthetic results. Immediate implantation is more predictable in ideal extraction socket cases, while compromised sockets may result in unpredictable aesthetic outcomes. Delayed implantation associated with guided bone regeneration and tissue grafting can provide more predictable aesthetic results in compromised socket cases.
5. Implant macro and micro design: The surface characteristics of implants, such as rough or smooth surfaces, can influence the success rates. Rough implant surfaces have shown better osseointegration compared to smooth surfaces. Implant dimensions, including length and diameter, also play a role in implant success. Short and narrow implants may be associated with higher failure rates.
6. The gap between implant and socket walls (Guided Bone Regeneration): The thickness of the initial bone wall before immediate implantation with guided bone regeneration can influence bone formation. Spontaneous healing may occur with a lateral gap of 1 to 1.25 mm, and the addition of a membrane may not improve the healing process.[37] In cases of significant defects, the decision between immediate implantation with guided bone regeneration or delayed implantation depends on factors such as the possibility of achieving complete site closure and the risk of membrane exposure.
7. Abutment: The use of platform switching in immediate implantation cases has shown potential benefits, including a gain in peri-implant mucosa and papillary height. However, the literature is inconclusive regarding significant differences in periodontal parameters and soft tissue changes when comparing different abutment types in immediate implantation cases.
8. Post-operative medication: The choice of post-operative medication, specifically antibiotics, can impact implant success. Patients who are unable to take post-operative amoxicillin-based antibiotics may have a higher risk of failure compared to those who receive appropriate antibiotic coverage.
9. Provisionalization and loading: Immediate implantation with immediate loading can result in more pronounced bone resorption compared to delayed implantation with immediate loading in a healed site. However, the combination of immediate implantation with immediate loading has shown cumulative survival rates comparable to delayed implantation with immediate or delayed loading and traditional protocols. Immediate implantation associated with provisionalization without functional loading can be considered a treatment option for anterior single-tooth replacement.

It's important to consider these factors and individualize treatment decisions based on patient-specific factors and clinical judgment to optimize the outcomes of immediate implant placement procedures.

CLASSIFICATION OF IMMEDIATE IMPLANT PLACEMENT

1. Wilson and Weber[38] in 1993 used the terms Immediate, Recent, and Delayed.
2. Matureto[39] describe the timing of implant placement about soft tissue healing and the predictability of guided-bone regeneration procedures.
3. Mayfield et al.[40] used the terms, i. Immediate - Time interval of 0 weeks after extraction, ii. Delayed – Time interval of 6 to 10 weeks after extraction, and iii. Late - Time interval of 6 months or more extraction.
4. Hammerle et al.[41] (2004) classified according to the timing of implant placement into:
   i. Type I: implant placement in a fresh extraction socket
   ii. Type II: implant placement after soft tissue coverage (4-8 weeks)
   iii. Type III: implant placement after radiographic bone fill (12-16 weeks)
   iv. Type IV: implant placement in healed sockets (> 16 weeks)
5. Garber et al.[42] (2007) based on the timing of tooth extraction and implant placement classified into the:
   i. Class I: Extraction, with immediate implant placement directly into the extraction socket via (a) “Incisionless” implant placement, and (b) Raising of a mucoperiosteal flap. Placement of the implant into the extraction socket concomitant with either, i. Osseous augmentation or Guided bone regeneration (GBR) or ii. Connective tissue or allograft.
   ii. Class II: Early implant placement. The implant is placed after extraction, and soft tissues are allowed to heal for 6 to 8 weeks. GBR can be performed at the time of extraction and/or at the time of implant placement.
   iii. Class III: Delayed implant placement. The implant is placed a minimum of 4 to 6 months after extraction, with preservation of the alveolar ridge using grafting techniques and/or GBR, either at the time of extraction or concomitant with implant placement. Soft tissue reconstruction in these cases will be invariably required.
6. The 4 treatment options for post-extraction implant placement as defined by the International Team for Implantology (ITI) in two ITI Consensus Conferences (2003 and 2008)[43, 44] are:
   i. Immediate implant placement: same day of the extraction
   ii. Early implant placement with soft tissue healing:4-8 weeks
   iii. Early implant placement with partial bone healing:12-16 weeks
   iv. Late implant placement with complete bone healing: >6 months

IMMEDIATE IMPLANTS IN THE AESTHETIC ZONE

Based on the current evidence, several critical factors contribute to the success of immediate implant placement:

1. Thickness and integrity of buccal bone plate: The presence of an average of 2 mm buccal plate and a minimum of 1 mm is ideal to avoid soft tissue recession. A thick and intact buccal bone wall provides better support for the implant.
2. Gingival biotype: A thicker gingival biotype is more favorable for maintaining soft tissue aesthetics and reducing the risk of recession. Gingiva with high scalloping may increase the risk of recession.
3. Inter-implant distance: An inter-implant distance of 3 mm is preferred to allow for proper papilla formation and support.
4. Location of interproximal bone: The location of the interproximal bone influences the overall soft tissue architecture, and its preservation is important for optimal esthetic outcomes.
5. Minimal trauma in tooth extraction: The use of techniques such as Piezosurgery or Periotomes, with minimal mucoperiosteal flap and soft tissue trauma, can help preserve the surrounding bone and soft tissues.
6. Implant placement: Implants should be placed slightly palatally/lingually to allow for better soft tissue aesthetics. The implant should be positioned at least 1 mm apical to the buccal ridge or 2-3 mm from the gingival margin to compensate for expected vertical resorption.
7. Primary implant stability: Achieving good primary stability is crucial for successful immediate implant placement. This can be achieved by engaging the lateral walls of the socket without changing the original socket depth or engaging bone apical to the original socket dimensions. Self-tapping implants can enhance primary stability by compressing the alveolar bone during insertion.
8. Gap filling: The gap of at least 2 mm between the implant and the internal surface of the facial bone wall should be filled with bone substitutes with a low resorption rate to preserve the buccal contour and prevent complications.
9. Implant design: The use of tapered implants is beneficial for immediate implant placement, as they can provide better initial stability and allow for proper adaptation to the socket.

It is important to note that the success of immediate implant placement in the aesthetic zone requires advanced surgical skills, ideal extraction socket conditions, and a thorough understanding of local anatomy. If ideal circumstances are not present, alternative implant timing protocols that have proven successful in preserving soft and hard tissues should be considered.

Clinical guidelines for immediate implant placement protocol include thick and intact buccal bone wall, thick gingival biotype, minimal trauma in tooth extraction, presence of at least 3 socket walls (ideally 4 walls), appropriate implant

design, placement of the implant shoulder 2-3 mm apical to the anticipated gingival margin, achieving primary implant stability, and filling the gap between the implant and the facial bone wall. Additionally, avoiding the use of wide diameter or wide platform implants in the aesthetic zone is recommended, with specific diameter recommendations for different tooth locations.

IMMEDIATE IMPLANTS IN THE POSTERIOR REGION

In the posterior region, implant placement in the root socket may lead to unfavorable restorative positions, resulting in mechanical overload and potential implant failure. It can also make oral hygiene more challenging, increasing the risk of peri-implantitis. To address these issues, studies have suggested placing implants in the inter-radicular bone and augmenting the remaining socket with graft material and a membrane. Although long-term data on the performance of immediate molar implants is limited, it appears to be a valid treatment option when performed by skilled clinicians. Strict guidelines should be followed to minimize the risk of complications and failures.

Based on the current literature, the following guidelines are recommended for implant placement in the posterior region:
a. Patient selection: Non-smokers are preferred candidates for implant placement. b. Pre-operative imaging: A Cone-Beam Computed Tomography (CBCT) scan is recommended to minimize risks, particularly in the mandible. c. Gingival biotype and tissue width: Thick gingival biotype and adequate width of keratinized tissue (≥ 2 mm) are desirable. d. Atraumatic extraction: Whenever feasible, a flap-less surgical approach should be used for atraumatic extraction. e. Socket condition: Implants should only be placed in sites with intact socket walls after extraction. f. Osteotomy preparation: The osteotomy preparation technique may vary depending on the type of socket. g. Implant positioning: If the buccal bone crest is thin (<2 mm), implants should be placed submerged (up to 2 mm) below the buccal bone crest. h. Thin buccal plate: In cases of a thin buccal plate (<2 mm), more lingual placement of the implant may be necessary, along with gap grafting and/or buccal overgrafting. i. Gap grafting: Gaps between the implant and socket walls, particularly if they are ≥ 2 mm in width, should generally be grafted. j. Graft material: Xenograft or mineralized allograft is preferred for grafting procedures. k. Initial implant stability: Adequate initial implant stability should be established during placement. l. Submerged healing: If primary stability is less than 25 and the resonance frequency value is less than 60, submerged healing may be necessary.

These guidelines aim to optimize the outcomes of immediate molar implants in the posterior region. However, clinicians need to stay updated with the latest evidence and guidelines to provide the best possible treatment outcomes.

SOCKET PRESERVATION

Most tooth extractions are typically performed without considering the preservation of the alveolar ridge. As a result, the healing process after extraction often leads to osseous deformities, including reduced height and width of the residual ridge, due to factors such as caries, trauma, or advanced periodontal disease. Horizontal bone loss is usually more significant than vertical bone loss following tooth extraction, with the buccal aspect experiencing more resorption compared to the lingual/palatal aspect. The resorption pattern typically involves rapid reduction within the first 3-6 months, followed by gradual reduction throughout life.

To address these challenges and improve aesthetic and functional outcomes, socket preservation techniques have been developed to preserve alveolar hard and soft tissues. One such technique is immediate implant placement, which offers the advantages of socket preservation and reduces the overall treatment time required to achieve a final restoration.

In 2010, Hürzeler et al.[45] introduced the socket shield technique, which involves retaining a partial root fragment around an immediately placed implant to prevent tissue alterations after tooth extraction. Histologic evaluation in beagle dogs demonstrated no resorption of the root fragment, and new cementum formed on the implant surface. Clinical cases utilizing the socket shield technique have shown excellent preservation of buccal tissues and successful osseointegration of the implant. Another approach, reported by Joseph and Kitichai[46], involved retaining a proximal root fragment to maintain the inter-implant papilla.

These innovative techniques aim to preserve the structure and aesthetics of the alveolar ridge and can contribute to successful implant outcomes. However, it is important to note that these techniques require careful case selection and advanced surgical skills.

PROVISIONALISATION

Fabricating a provisional restoration is an important step in implant dentistry as it serves several purposes. First, it provides a temporary replacement for the missing tooth, allowing the patient to maintain proper esthetics and function during the healing period. It also serves as a blueprint for the definitive crown, providing an opportunity to assess the esthetics and functionality before the final restoration is fabricated.

One important aspect of provisional restoration is the creation of an emergence profile, which mimics the natural tooth and helps to shape the soft tissue contour around the implant-supported crown. Light-cured composite resin is

often used at the base of the provisional restoration to create this emergence profile. This material causes less soft tissue irritation compared to auto-polymerized acrylic resin, which can be responsible for tissue inflammation and discomfort.

The design of the provisional restoration should also take into consideration the surgical site and occlusal loading. It should be designed in a way that minimizes pressure on the surgical site, allows for optimal space for the gingival tissues to form and mature, and controls the occlusal forces on the implant during the initial stages of osseointegration. Proper occlusion and functional loading are crucial for the long-term success of the implant.

By fabricating a well-designed provisional restoration, clinicians can ensure better esthetics, functional outcomes, and soft tissue management during the healing and osseointegration phase of implant treatment.

JUMPING DISTANCE

The space between the implant and the surrounding bone, known as the gap or jumping distance, is an important consideration in immediate implant placement.[47] The gap consists of horizontal defect width or horizontal defect distance (HDD) and vertical defect height or vertical defect distance (VDD), and the ability of bone to bridge the horizontal gap and fill the void is referred to as "jumping distance."

Achieving bone fill in the gap is crucial for successful immediate implant placement, particularly in the buccal aspect of the implant in the aesthetic zone where the buccal bony plate is typically thin. The surgical management of the buccal gap aims to optimize bone fill, establish bone-to-implant contact at the most coronal level, and minimize buccal bone loss and soft tissue recession.

The initial thickness of the bone wall before immediate implantation, in conjunction with guided bone regeneration techniques, can influence bone formation. In some cases, intrabony defects may heal partially or completely without further intervention. A lateral gap of 1 to 1.25 mm can heal spontaneously with new bone formation, and the addition of a membrane may not improve the healing process. However, in severe defects, the decision between immediate implantation with guided bone regeneration and delayed implantation should be evaluated based on the possibility of complete site closure and the risk of membrane exposure, which can lead to graft complications and implant failure.

Various materials can be used to fill the gap between the implant and buccal bone plate, such as autogenous bone grafts, bovine hydroxyapatite, and beta-tricalcium phosphate (Beta-TCP). The use of these materials aims to reduce bone resorption in the buccal aspect of the implant and promote bone formation. Additionally, experimental studies have shown the potential of mesenchymal cells from the umbilical cord to promote new bone formation in severe peri-implant bone defects.

It is important to note that further research is needed to establish the superiority of one material or technique over another in filling the gap and promoting optimal bone regeneration around immediate implants.

DIAGNOSIS AND TREATMENT PLANNING:

An appropriate diagnosis and treatment plan are crucial for the long-term success of immediate implants. When evaluating a patient for dental implants, it is important to gather comprehensive medical and dental histories, along with conducting a thorough clinical examination. Various diagnostic tools can be utilized, including clinical photographs, study casts, periapical and panoramic radiographs, as well as more advanced imaging techniques like linear tomography or computerized tomography, especially for assessing the proposed implant sites.

During the treatment-planning phase, determining the prognosis of the dentition, particularly the tooth in question is of utmost importance. Factors such as the crown-to-root ratio, remaining root length, periodontal attachment level, presence of furcation involvement, and the overall periodontal health status of adjacent teeth should be evaluated. Additionally, non-restorable caries lesions, fractured teeth at the gingival margin with roots shorter than 13 mm, and roots with large endodontic posts may indicate that implant placement is the preferred treatment option.

Each case should be evaluated individually, considering the patient's unique circumstances and specific dental conditions. Collaborating with a dental specialist, such as a periodontist or oral surgeon, can also be beneficial in assessing the overall treatment plan and ensuring the best possible outcomes for the patient.[48]

THE RULE OF 5 TRIANGLES:

The 5 key aspects to consider when placing immediate implants are:

1. Presence of a buccal plate: The buccal bone plate plays a critical role in maintaining the esthetics of the implant site. It is important to assess the thickness and integrity of the buccal plate before deciding on immediate implant placement.
2. Primary stability: Achieving adequate primary stability is essential for the success of immediate implants. Primary stability refers to the initial mechanical stability of the implant in the bone. It can be influenced by factors such as implant design, bone quality, and surgical technique.

3. Implant design: The design of the implant can impact its stability and integration with the surrounding tissues. Self-tapered implants are often preferred for immediate placement as they can enhance primary stability by compressing the alveolar bone during insertion.
4. Filling the gap between the buccal plate and the implant: The gap or jumping distance between the implant and the buccal bone should be filled with biomaterial to promote bone formation and prevent soft tissue recession. This can help maintain the esthetics of the implant site and minimize complications.
5. Tissue biotype: The thickness and quality of the gingival tissues, known as tissue biotype, can influence the esthetic outcome of immediate implants. A thicker gingival biotype is generally more favorable as it provides better support and stability for the soft tissues around the implant.

In addition to these key aspects, performing atraumatic extraction to minimize bone loss, grafting the extraction socket with biomaterial, and using provisional crowns to maintain soft tissue contours can also contribute to achieving optimal esthetic results with immediate implants. It is important to tailor the treatment plan to each case and consider factors such as bone quality, esthetic demands, and patient preferences.[49]

SOFT TISSUE MANAGEMENT FOR IMMEDIATE IMPLANTS:

Various surgical techniques can be employed to achieve primary soft tissue closure with immediate implants. Some of these techniques include:

1. Rotated buccal flap: This technique involves using a rotated buccal flap from an adjacent tooth to achieve soft tissue closure over implants placed at the time of extraction. It can be used for single or multiple implant sites and can be combined with membrane barriers or grafting materials. However, it requires an adequate width of keratinized mucosa and vestibule depth.
2. Connective tissue graft: A connective tissue graft can be used to cover immediately placed implants. This technique involves harvesting tissue from the palate or another donor site and grafting it over the implant site. However, the limitation of donor tissue size is a potential challenge with this technique.
3. Acellular dermal matrix allograft: An acellular dermal matrix allograft can be used alone or in combination with grafting materials to cover immediately placed implants. This technique provides an alternative to using autogenous tissue grafts.
4. Gingival grafts: Gingival grafts can also be used to cover immediately placed implants. They can be used alone or in combination with other grafting materials to achieve soft tissue closure.
5. Palatal advanced flap or pediculated flap: This technique is useful in maxillary immediate implant cases. It involves mobilizing tissue from the palate and advancing it to cover the extraction site and implants. This technique provides good tissue mobility and bulk, allowing for precise coverage of large defect areas and multiple implants. However, secondary healing of the palatal tissue can be prolonged and uncomfortable.

In cases where there is a partial incongruency between the outer surface of the socket and the bony wall, known as the jumping distance or critical space, the use of wider diameter implants can be considered instead of bone grafts. This can help obliterate the jumping distance and achieve better implant stability.

It is important to evaluate each case individually and select the most appropriate surgical technique based on factors such as the patient's anatomy, implant site, and esthetic considerations.

INCISION DESIGNS

When placing an implant in the aesthetic zone, it is important to employ conservative flap designs to minimize tissue trauma and preserve the aesthetics of the surrounding soft tissue. Here are some considerations for flap design:

i. Full-thickness flap design: Instead of a flapless technique, a full-thickness flap design is employed. This allows for better visualization and access to the underlying structures during implant placement. It provides more control over the surgical site and allows for adequate management of the soft tissue.
ii. Flapless technique: A flapless technique should only be considered in specific cases where there is a favorable zone of attached gingiva, low aesthetic demand, and radiographic assessment indicates favorable clinical conditions, such as intact and thick facial bony walls. However, it is generally recommended to use a flap design to ensure proper visualization and control during the procedure.
iii. Vertical releasing incision: To gain access to the site and inspect the buccal plate for any dehiscence or fenestration defects, a vertical releasing incision can be made into the mesial or distal papilla. This incision allows for better exposure and assessment of the buccal bone, which is crucial for implant placement in the aesthetic zone.
iv. Bilateral incision designs: In cases where flap advancement is desired for a submerged or semi-submerged healing approach, bilateral incision designs can be employed. This is particularly important in the aesthetic zone to allow for over-contouring of the buccal profile using soft and/or hard tissue grafting. The use of bilateral incisions facilitates flap advancement and better control over the final aesthetic outcome.

It is important to carefully evaluate the specific case and consider the individual patient's needs and anatomical considerations when determining the appropriate flap design for implant placement in the aesthetic zone.

IMMEDIATE IMPLANT PLACEMENT USING FLAPLESS APPROACH

The flapless technique can indeed provide several benefits in certain cases of socket grafting or immediate implant placement. Here are some key points to consider:

1. Minimally invasive approach: The flapless technique avoids raising flaps, resulting in a less invasive procedure. This can reduce operative time, patient discomfort, and post-operative complications associated with flap elevation.
2. Preservation of interdental papilla: By not disturbing the interdental papilla, the flapless approach helps maintain the blood supply to the surrounding tissues. This can contribute to improved healing and preservation of soft tissue aesthetics.
3. Simplified procedure: The flapless technique simplifies the surgical procedure by eliminating the need for flap reflection and suturing. This can streamline the process, making it more efficient and potentially more appealing for patients.
4. Preservation of periosteum and blood supply: By preserving the periosteum and supraperiosteal blood supply, the flapless technique can help maintain the vitality of the alveolar bone. This may contribute to better healing outcomes and potentially prevent marginal bone loss.
5. Complications: While the flapless technique offers advantages, it is important to consider the potential complications associated with this approach, such as bony dehiscence and fenestration. Careful case selection, appropriate patient assessment, and proper surgical technique are essential to minimize these risks.

It is worth noting that the decision to use a flapless technique should be based on a careful evaluation of the individual patient's case, including factors such as bone quality, anatomy, and aesthetic considerations. Additionally, long-term clinical studies are needed to further evaluate the effects and outcomes of the flapless approach compared to traditional flap elevation techniques.

TOOTH EXTRACTION

Atraumatic tooth extraction is crucial for successful immediate implant placement. Here are some key points regarding atraumatic extraction and the methods used:

1. Preservation of maximum bone: Atraumatic extraction aims to minimize trauma to the surrounding bone and soft tissues, allowing for the preservation of the maximum amount of bone. This is important for achieving optimal implant stability and promoting successful osseointegration.
2. Sectioning of multi-rooted teeth: Multi-rooted teeth are often sectioned into separate roots before extraction. This approach helps avoid excessive force and trauma to the surrounding structures during extraction. By dividing the tooth into individual roots, each root can be carefully removed, reducing the risk of damaging the surrounding bone.
3. Extraction instruments: Various instruments can be used for tooth extraction, depending on the case and the clinician's preference. Tooth extraction forceps, dental elevators, dental luxators, and periotomes are commonly employed tools. Each instrument has its specific purpose and is selected based on the tooth's characteristics and the desired extraction technique.
4. Vertical root distractors or Piezo surgery: In certain cases, vertical root distractors or Piezo surgery may be used as alternative techniques for atraumatic tooth extraction. Vertical root distractors help elevate the tooth from within the socket, minimizing trauma to the surrounding bone. Piezo surgery utilizes ultrasonic vibrations to gently remove the tooth, reducing the risk of damage to adjacent structures.

The choice of extraction method depends on various factors, including the tooth's condition, root anatomy, and the clinician's expertise. A careful and gentle approach to tooth extraction is essential to minimize trauma, preserve bone, and create a favorable environment for immediate implant placement.

SITE PREPARATION

i. After tooth extraction, it is important to thoroughly de-granulate the socket and remove any remaining soft tissues or fibrous remnants. This can be done using curettes or low-speed rotary instruments, such as a round diamond bur, with chilled irrigation to prevent overheating and damage to the bone.

ii. The number of remaining osseous walls, which refers to the amount of surrounding bone, is an important consideration in case selection for immediate implant placement. Having 3-4 remaining osseous walls is generally considered essential for the success of immediate implants. Sufficient bone support contributes to the stability and long-term success of the implant.

iii. Depth gauges of varying diameters are used to assess the socket and determine the appropriate implant size and position. These gauges help the clinician determine if the implant can be successfully placed in an ideal prosthetic position, allowing for proper alignment with future restoration. It is important to achieve primary mechanical stability, which refers to the initial stability of the implant within the bone, to promote successful osseointegration and implant integration with the surrounding tissues.

Overall, careful assessment of the socket, including de-granulation, evaluation of remaining osseous walls, and precise determination of implant positioning, is essential for the success of immediate implant placement.

IMPLANT SELECTION

The selection of the appropriate implant size is crucial for successful immediate implant placement. The implant should neither be too narrow nor too wide in relation to the extraction socket. A narrow implant may compromise primary stability, while a wider implant can lead to compression necrosis of the surrounding bone. It is recommended that the implant be approximately 2 mm longer than the tooth socket to ensure adequate stability and support.

To achieve optimal osseointegration, the selected implant must have a threaded profile and roughened surface, as these features promote better bone integration and initial stability.

Tapered anatomically shaped implants are often preferred for immediate placement in fresh extraction sockets. They offer advantages such as improved buccal support, preservation of root prominence, and reduced incidence of fenestration and dehiscence. Tapered implants also allow for placement in the same position as the extracted tooth, avoiding complications such as buccal or labial wall perforation.

Recently, active implants have been introduced and are considered a favorable choice for immediate placement in extraction sockets. These implants have an expanding tapered body and are particularly useful in regions with compromised bone quantity or quality. They have shorter drilling protocols and their apex is designed with reverse-cutting flutes, which minimize trauma to the bone and surrounding tissues. Active implants also offer the ability to change direction during insertion, enabling higher primary stability in situations involving soft bones or extraction sockets.

A study by Lang et al.[50] in 2008 compared the clinical outcomes of standard cylindrical screw-shaped implants to novel tapered transmucosal dental implants immediately placed into extraction sockets. The results showed that both implant designs yielded clinically equivalent short-term outcomes. However, the surgeons involved in the study expressed a clear preference for the novel tapered implant. The study concluded that tapered and cylindrical implants have comparable outcomes after immediate placement in fresh extraction sockets.

In summary, selecting an appropriate implant size, and considering factors such as width, length, and shape, is crucial for successful immediate implant placement. Tapered implants, with their advantages in buccal support and reduced complications, are often preferred for immediate placement in extraction sockets. Active implants are gaining popularity due to their bone-condensing capability and higher primary stability in challenging bone conditions. Clinical studies have shown comparable outcomes between tapered and cylindrical implants in immediate placement scenarios.

PRIMARY STABILITY

Primary stability refers to the initial engagement between the implant and the surrounding bone, which is crucial for successful osseointegration.

To achieve primary stability, the implant needs to engage the lateral walls of the socket without changing the original socket depth. This can be accomplished by ensuring that 1 to 3 threads of the implant are in contact with the osteotomy site. If the implant can be easily moved laterally with finger pressure following placement, it indicates poor primary stability and reduces the chances of successful osseointegration. In such cases, it is recommended to abort the implant placement and consider alternative approaches.

In some cases, using an implant design with a reduced thread radius can be beneficial for achieving primary stability. In these situations, it may be desirable to slightly under prepare the osteotomy site by 0.2-0.5 mm. This slight under preparation helps in achieving a snug fit between the implant and the bone, promoting better primary stability.

By ensuring strong and secure primary stability, the implant has a better chance of integrating with the surrounding bone, leading to successful osseointegration. It is an essential factor to consider during immediate implant placement to ensure long-term implant success.

CONCLUSION

Immediate implant placement helps prevent further bone resorption that occurs naturally after tooth removal. By placing the implant immediately, the process of ridge collapse is halted, preserving the available bone for implant placement. This technique allows for the preservation of both bone and soft tissue, resulting in better aesthetic outcomes. By maintaining the natural gingival architecture, immediate implants can contribute to a more pleasing appearance. Immediate implant placement reduces the overall treatment time by eliminating the need for a separate healing period between tooth extraction and implant placement. This can be more convenient and comfortable for the patient.

Immediate implant placement has shown success rates comparable to those achieved with conventional implant protocols. When proper case selection, treatment planning, and clinical expertise are combined, immediate implants can be a reliable and predictable solution for tooth loss. Immediate implant placement is considered a minimally invasive

surgical technique, which can lead to faster recovery and fewer post-operative complications compared to more extensive procedures. Success with immediate implants relies on thorough case assessment, diagnosis, and treatment planning. Each patient's anatomical presentation should be carefully evaluated to determine the suitability of immediate implant placement. Good surgical and prosthetic protocols, along with meticulous post-operative care, are crucial for the long-term success of immediate implants. This includes regular follow-up visits, oral hygiene maintenance, and monitoring of the implant integration process.

Overall, immediate implant placement offers several advantages, including patient comfort, reduced treatment time, and aesthetic preservation. However, it is important to approach each case with careful consideration and adherence to proper protocols to ensure long-term success.

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