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State-Of-The-Art Principles For Achieving Optimal Immediate Single-Tooth Implants In Aesthetic Areas

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Abstract:
The landscape of immediate single-tooth implants in aesthetic zones has been transformed by cutting-edge dental technologies and methodologies. This review outlines essential principles crucial for achieving impeccable outcomes in such cases, emphasizing meticulous treatment planning with advanced tools like Cone Beam Computed Tomography. Strategic implant placement, effective gap management, and the use of smaller-diameter implants are pivotal for preserving the buccal plate and enhancing aesthetic results. Incorporating mineralized bone and soft tissue grafts is indispensable for optimal gingival aesthetics. A multidisciplinary team approach is essential to navigate surgical and prosthetic phases adeptly. Crafting anatomically contoured customized abutments with titanium interfaces ensures a final facial cement line no deeper than 1 mm, enhancing aesthetic excellence. Recent research supports comparable short- and medium-term outcomes between immediate and delayed implant placements when these principles are followed. However, rigorous long-term studies are needed to validate their efficacy over extended periods, given the dynamic nature of soft and hard tissues post-implantation. Achieving successful immediate single-tooth implants in aesthetic areas requires meticulous planning and execution across treatment phases, integrating key elements to minimize complications and deliver optimal aesthetic results.

Keywords:*Immediate Implants,Esthetics; Keys, Extraction socket, Biotype*

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I. Introduction:

The straightforward, advanced, and complex classification system was developed to aid clinicians in categorizing dental implant procedures into straightforward, advanced, and complex categories.[1]The decision to place immediate implants after tooth extraction is dependent on numerous factors. The major debate whether or not to perform immediate implants comes from individual bias, philosophy, where the individual trained and from previous experience.[2] In the era of practicing evidence-based dentistry, there is adequate long-term evidence that immediate implants not only reduce the overall treatment time and the number of surgeries for the patient but also help preserve more bone and soft tissue.[3] Both of these factors are crucial for achieving stable and aesthetically pleasing outcomes in the implant dentistry. Regarding socket type, an ideal Type I socket is preferred for immediate placement in the esthetic zone.[4] While acceptable results may be achieved in Type 2 and Type 3 sockets, they can be unpredictable in terms of aesthetics. The risk of soft tissue and bone recession is significantly higher in patients with a thin gingival biotype, especially when the buccal bone plate is deficient.[5] Recognizing a Type II socket prompts the clinician to stage the implant procedure by grafting the socket at the time of extraction. This approach enhances our ability to regenerate the lost buccal bone plate. Subsequently, the implant can be placed 4-6 months later in sufficient bone volume, ensuring at least 2 mm of facial bone support.[6] Soft Tissue Biotype: A patient's gingival biotype is probably the most important aspect of planning an immediate implant.[7]A thin gingival biotype has a thin buccal plate. There is significantly more

remodeling of the socket post-extraction and more soft tissue recession, post implant placement. Implant position and dual zone grafting as described in the following sections; ensure adequate facial bone thickness and soft tissue volume around the implant.[8] Also, delaying the fabrication of the provisional crown till second stage surgery is advisable. A simple yet effective technique is to push extra gingiva towards the facial aspect by making a palatal incision during second stage.This biotype conversion technique allows the clinician to convert a thin biotype into a thick biotype. A thin biotype has a high risk of recession and needs to be managed properly whereas the thick biotype is safe and forgiving.[9] Optimal implant position requires ample bone and soft tissue for long-term success. Previous guidelines of 1-mm of bone around implants are just not enough in the esthetic zone. Placing an implant >2-mm from the facial bone and 1-mm sub-crestal, has resulted in greater preservation of the crestal bone.[10] Placing a one-size narrow implant compared to what implantologists used to, gives us a better chance of maintaining the papilla height. Tooth to implant distance of 2-2.5 mm whenever possible is essential in thin biotype situations rather than the 1.5 mm advocated thus far.[11]Dual zone grafting previously involved clinicians grafting only if the "jumping gap" between the implant and bone exceeded 1.5 mm.[12] Today it is recognized that adding a bone graft regardless of the distance between the implant and bone, has tremendous esthetic benefits in maintaining soft tissue height.[13] Grafting in conjunction with immediate implant placement has helped in not just preventing horizontal bone loss, but also in maintaining crestal bone, hence leading to better soft tissue volume around implants.[14] The key is to graft not just the "bone zone", but also the "soft-tissue zone."[15] In the anterior region, the existing papilla height is always higher than the facial gingival height, so overbuilding the site with the grafting material, a collagen membrane and securing the biomaterials with a high viscosity tissue glue allow us to gain some extra bone height, which brings the extra soft tissue height with it.[16]The timing of the provisional restoration, whether immediate or delayed, does not significantly impact the long-term survival of the implant. Recognizing the patient's soft tissue volume and biotype, helps the clinician plan accordingly; whether to make an immediate provisional or to delay the fabrication of the provisional for 3-4 months in order to gain more soft tissue thickness. This biotype modification procedure is the key for better long-term results. Proper management of tissue contour necessitates prosthetic expertise in provisionalization techniques to effectively shape peri-implant tissues. This sculpting ensures a submerged contour from the implant shoulder to the mucosal zenith, crucial for supporting surrounding tissues. Final impression techniques are crucial to accurately replicate this submergence contour, known as the "transitional zone," in the final crown.[17] Precise 3D implant placement guided by cone-beam computed tomography (CBCT) is essential, with planning focused on restorative considerations.[18] Chen et al.'s 2009 systematic review highlighted potential risks, including a reported up to 30% incidence of facial gingival recession if strict inclusion criteria were not followed for immediate implant placement. Factors such as preexisting defects in facial bone, thin facial bone, thin soft-tissue biotype, and improper implant positioning were identified as risk factors for gingival recession.[19] Recent systematic reviews by Levine et al. and Chen et al., along with consensus statements by Morton et al., emphasize the importance of organized diagnosis, planning, and treatment protocols for single-tooth implants in the esthetic zone, including the management of associated complications.[20] They advocate for a team approach to ensure high predictability in preventing esthetic complications, proposing guidelines aimed at achieving high success rates.[21] Since 2014, several studies have expanded on specific indications and techniques for immediate placement and restoration of implants in the esthetic zone, reporting excellent short- and medium-term outcomes comparable to staged or delayed placement methods. These newer studies offer updated insights and perspectives not covered in earlier systematic reviews.[22] Performing immediate single-tooth replacement in the esthetic zone is a complex procedure under the straightforward, advanced, and complex classification, necessitating meticulous patient selection, comprehensive treatment planning, and precise execution by skilled clinicians to achieve successful long-term outcomes.[23] Achieving long-term esthetic success begins with thorough planning before surgical intervention, emphasizing a restorative-driven approach. Initial patient evaluation in the esthetic zone includes a comprehensive consultation to establish diagnosis and prognosis, considering medical, dental, and compliance histories. Assessment of periodontal and restorative needs is critical.[24] Diagnostic tools such as Cone Beam Computed Tomography, along with diagnostic casts and radiographs, evaluate anatomic landmarks, skeletal relationships, and bone availability, informing meticulous presurgical planning. Skeletal dimensional stability, as assessed through serial cephalometric radiographs, does not guarantee growth cessation in adults. Patients should be aware that alveolar growth may recur, necessitating future restoration adjustments. Intraoral and extraoral digital photographs capturing the patient's smile at rest and full smile determine the lip line relative to surrounding gingival margins. Documenting the location of adjacent interproximal papillae aids comprehensive treatment planning and guides surgical approaches effectively.[25]

II. Discussion:

Here are the 10 key steps for the procedure: Esthetic Risk Assessment, Tomographic Planning, Minimally Traumatic Tooth Extraction, 3D Implant Placement, Use of Narrower Implants, Buccal Gap Bone

Graft, Facial Gingival Grafting, Immediate Contour Management, Custom Impression Coping Technique, and Final Restoration with a Screw-Retained Crown. Use of Narrower Implants: Opt for narrower implants (3.3 mm to 4.3 mm) to maintain a 2 mm to 3 mm buccal gap adjacent to the intact buccal socket wall, based on careful Cone Beam Computed Tomography analysis and the restorative-driven plan.[26]

1. The Esthetic Risk Assessment evaluates each patient's case to determine specific esthetic risk factors for immediate placement in the esthetic zone. During the pre surgical evaluation and consultation, the clinician evaluates the Esthetic Risk Assessment by examining the patient's smile line, aesthetic preferences, and conducting a comprehensive analysis of hard and soft tissue dimensions, including the gingival biotype categorized as thin or thick based on probe visibility. Documentation of the Esthetic Risk Assessment, along with discussion notes, becomes part of the patient's record. The clinician also addresses surgical and prosthetic concerns related to the replacement tooth and adjacent teeth, evaluating factors such as cervical tooth shape, condition of adjacent restorations, parafunctional habits, skeletal and occlusal classification, and overbite/overjet relationship. Articulated study casts or digital records are used to assist in comprehensive treatment planning.[27]

2.Tomographic Planning employs Cone Beam Computed Tomography to craft a precise treatment strategy for dental implant restoration in the esthetic zone. It evaluates buccal bony-wall thickness, sagittal root position, alveolar form, and implant placement specifics.[28] A preoperative cone beam computed tomography scan provides critical insights such as buccal plate width, potential need for bone grafting, expected implant dimensions, and Sagittal Root Position, guiding decisions on adjunctive procedures like orthodontic therapy or vertical extrusion for optimal site preparation.[29] Contemporary research and expert consensus underscore the necessity of maintaining at least ≥2 mm of buccal bone post-healing to support soft tissues and prevent issues such as bone resorption and gingival recession.[30]Cone Beam Computed Tomography also assesses buccal plate dimensions and ridge width, aiding in planning and determining if soft and/or hard tissue augmentation is needed before or during implantation. If buccal bone thickness falls below 1 mm, immediate implant placement with provisionalization may heighten risks of tissue loss and recession, making staged buccal augmentation with early implant placement a safer alternative.[31] Regarding Sagittal Root Position, Kan et al.'s classification of maxillary anterior teeth into Class 1 to Class 4 via CBCT highlights Class 1 as ideal for immediate placement due to minimal cortical plate engagement, whereas Class 4 poses challenges due to significant engagement. Evaluating facial bone integrity via Cone Beam Computed Tomography is pivotal, as Class 1 sockets typically yield favorable outcomes post-implantation with minimal impact on hard or soft tissues.[32] However, certain Class 2 defects, such as buccal dehiscence or bone loss, may exist without visible gingival recession, posing risks for future complications. Integrating Cone Beam Computed Tomography findings with clinical assessments is crucial for customizing a treatment plan that meets restoration needs. Aligning the final tooth position with the planned Sagittal Root Position ensures an emergence profile conducive to precise 3D placement of the implant shoulder, thereby minimizing procedural errors. If achieving the desired Sagittal Root Position and tooth position requires staged augmentation procedures for sufficient bone support, reconsidering immediate placement optimizes outcomes. Immediate implant placement suits carefully selected, healthy patients under the care of seasoned clinicians with robust clinical expertise.[33]

3. Minimally Traumatic Tooth Extraction involves delicately removing the tooth with minimal trauma, ideally without needing to reflect the flap. It utilizes precise techniques such as anterior surgical forceps and elevators to gently extract the tooth and aids for vertically extracting fractured roots when necessary. Care is taken to avoid overheating the osteotomy site and causing trauma to surrounding soft tissues like the papilla and socket walls.[34] If feasible, a flapless procedure without vertical incisions is preferred. Following tooth removal and degranulation of the socket walls, creating multiple bleeding points within the socket is recommended. This technique promotes faster vascularization of the graft material. Piezosurgical devices, using generous amounts of sterile solution, are effective for sectioning fractured roots and creating fine bleeding points. Ensuring the integrity of the buccal and palatal walls is crucial before considering immediate implant placement.[35]

4. Platform-Switched Implant Along Palatal Wall3D Implant Placement: Position the implant in healthy, available bone, ensuring adequate support both apically and along the palatal wall. Use an anatomically correct surgical guide template for precise placement. Opt for a platform-switched implant to minimize tissue trauma during immediate single-tooth implant placement. Ensure the osteotomy site follows along the palatal wall for a palatal or cingulum trajectory, ideally for a screw-retained provisional restoration. Reference the implant depth from the anticipated final midfacial mucosal zenith of the planned restoration to achieve a gradual prosthetic emergence profile.[36] Position the implant shoulder 1 mm apically to the buccal osseous crest if the coronal buccal wall remains intact, to compensate for expected crestal bone loss. Consider using a tapered-design implant for sites with bony undercuts apical to the implant to minimize the risk of buccal fenestration. Ensure meticulous site preparation using manufacturer-recommended twist drills and adequate cold saline irrigation. Confirm the absence of buccal vibration or fenestration by tactically assessing with an index finger

along the buccal bone plate. Perform minimally traumatic tooth extraction without flap reflection, if possible, and evaluate the buccal plate status.[37]

5. Use of Narrower Implant: Treatment decisions should be based on Cone Beam Computed Tomography analysis prior to surgery. Expect buccal bony-wall resorption following immediate implant placement. This means that after inserting the implant into the correct 3-dimensional position along the palatal wall, there should be at least a 2 mm or greater gap from the facial aspect of the implant to the internal aspect of the buccal wall for future bone grafting. [37]This gap is crucial to prevent midfacial mucosal recession. Often, using a reduced-diameter implant provides additional space for bone grafting, achieving the desired 2 mm to 3 mm gap. In contrast, wider-diameter implants (≥4.5 mm) may reduce this gap, especially if placed with buccal angulations, potentially leading to marginal gingival recession. Reduced-diameter implants have narrower connections and require slightly deeper placement than standard-diameter implants (e.g., 4.1 mm) to accommodate sub gingival contours. The use of an Accurate Computer-Guided Surgical Template facilitates this critical 3D placement.[38]

6. Bone Graft With Low-Substitution Bone Filler: Clinical studies using an immediate implant protocol (type 1 implant placement) in the esthetic zone strongly suggest bone augmentation of the buccal gap to achieve adequate buccal bony contours, assuming the minimum buccal bone width of 2 mm is valid. This approach helps maintain buccal bony-wall stability over time. Evaluation of facial bone status is crucial during type 1 immediate implant placement due to its association with preexisting defects, a major risk factor for future facial mucosal recession. Kan et al. studied treatment outcomes for vertical buccal wall defects during type 1 immediate implant placement and immediate provisionalization.[39] They observed 1.5 mm or greater facial mucosal recession at 1 year in more than one-third of patients treated with bone grafting for vertical buccal wall defects. Larger facial bone defects correlated with more significant facial recession in their study, which did not include platform-switched implants or other recommended approaches.[40]Januario et al. analyzed 250 Cone Beam Computed Tomography scans, measuring facial bone thickness in the anterior maxilla at various depths from the bone crest in 250 patients. They found that bone thickness was ≤1 mm (≤0.6 mm on average) at almost all tooth sites examined, with the marginal portion of the wall <0.5 mm wide in nearly 50% of sites.[41] These findings suggest that after the loss of a maxillary anterior tooth, the entire marginal buccal bone wall may be lost, and an additional 2 mm of the original socket dimension could disappear during healing.[42]Kan et al. reported ongoing changes in marginal tissue levels up to 8.2 years (mean 4 years) after immediate implant placement without grafting of the buccal gap or use of sub epithelial connective tissue graft .[43]Thin biotypes receded three times more than thick biotypes, and 11% of patients expressed esthetic concerns, subsequently treated with hard- and soft-tissue grafting procedures to improve outcomes.[44]Using low-substitution bone filler for bone grafting in immediate implant procedures is critical for strengthening the buccal bone structure and ensuring long-term stability, especially in areas crucial for aesthetic outcomes. It's essential to evaluate the quality of facial bone during type 1 immediate implant placement because existing defects are linked to a higher risk of future recession of the facial gingiva tissue.[45]Kan et al. found that more than a third of patients with vertical defects in the buccal wall experienced significant recession of 1.5 mm or more within one year, particularly in cases with larger defects. Their study did not incorporate platform-switched implants or other recommended techniques, which could potentially affect treatment outcomes.[46]

7. In their study on Immediate Implant Placement without bone grafting or buccal gap using a sub epithelial connective tissue graft, Kan et al. found significant differences in facial gingival level changes between thin and thick gingival biotype groups over a mean follow-up of 4 years. The thin biotype group experienced a mean facial gingival level change of -1.50 mm, whereas the thick biotype group showed a positive change of 0.56 mm.[47] This supports findings from earlier studies. After incorporating sub epithelial connective tissue graft into the Immediate Implant After incorporating subepithelial connective tissue graft into the Immediate Implant Placement protocol, another study observed no significant difference in facial gingival level change between thick (0.23 mm) and thin (0.06 mm) gingival biotypes over a mean follow-up of 2.15 years.[48] This suggests that thin gingival biotype may morphologically and behaviorally convert to a thicker gingival biotype, termed as "biotype conversion" The study also reported no significant differences in mesial and distal marginal bone level changes, indicating well-preserved peri-implant papilla.[49]This finding aligns with a study by Fenner et al., where cases that received sub epithelial connective tissue grafts, with baseline facial tissue thickness less than 2 mm, maintained stable papilla height after an observation period of 8 years. In contrast, cases without sub epithelial connective tissue grafts showed a decrease in papilla height between year 1 and year 8.[50]Additionally, in a 1-year prospective study on nonesthetic sites in humans, Linkevicius et al. found that initial gingival thickness at the alveolar crest significantly influenced marginal bone stability around implants.[51] If tissue thickness was 2.5 mm or less, crestal bone loss of up to 1.45 mm occurred within the first year of function, despite a supracrestal position of the implant-abutment interface.[52] They also recommended thickening thin mucosa before implant placement to convert a thin-tissue biotype into a thicker one. The results of Linkevicius et al.'s study align with an animal study by Berglundh et al., which reported a correlation

between thin tissues and crestal bone loss during biologic width formation if a minimum dimension of the biologic width was not preexisting.[53]Bone resorption occurs to facilitate the reformation of the biologic width. Linkevicius et al. discovered that platform switching in a one-stage implant placement approach does not prevent crestal bone loss when mucosal tissue is thin (2 mm or less) at the time of implant placement. In contrast, when dealing with thick soft tissue (>2 mm), the use of a platform-switch implant effectively maintained crestal bone levels with minimal remodeling after one year.[54] Similarly, Puisys et al. found comparable outcomes in a two-stage implant placement approach involving platform switching: thin tissues (≤2 mm) experienced significant crestal bone loss, whereas thick tissues (>2 mm) or thin tissues augmented with acellular dermal matrix showed similar crestal bone maintenance with minimal bone loss at the one-year mark.[55] The combination of subepithelial connective tissue grafts with bone grafting in the implant-socket gap during Immediate Implant Placement in the esthetic zone and utilizing 3D placement has been explored in several additional case studies.[56]Rungcharassaeng et al. investigated facial gingival tissue thickness following Immediate Implant Placement in maxillary anterior teeth, comparing cases with subepithelial connective tissue grafts (n = 31) to those without (n = 24).[57] They noted that patients lacking grafts exhibited a mean facial gingival thickness of 1.42 mm, which falls short of concealing underlying restorative materials, as highlighted in a study by Jung et al.Jung et al. found that at 1.5 mm of gingival tissue thickness, all tested materials caused noticeable tissue color change, including titanium, titanium-ceramic, zirconia-ceramic, and zirconia. They determined that a minimum of 3 mm of gingival thickness was necessary to effectively mask all materials, with only zirconia showing no visible color alteration at 2 mm thickness, according to spectrophotometric analysis.[58]In contrast, cases that received subepithelial connective tissue grafts showed a significantly greater mean facial gingival thickness of 2.61 mm, highlighting the effectiveness of combining Immediate Implant Placement with these grafts to achieve adequate peri-implant tissue thickness and conceal implant restorative materials effectively. At 3 months post-surgery, 5 cases exhibited significant alveolar process remodeling (1 mm or more) and received sub epithelial connective tissue graft via the pouch technique.[59]Additionally, 2 cases experienced advanced midfacial gingival recession (1.5 mm to 2 mm) and also underwent sub epithelial connective tissue grafting. Consequently, 7 cases (31.8% of the total) required subepithelial connective tissue grafting at 3 months due to esthetic concerns. The use of sub epithelial connective tissue grafting consistently improved the Pink Esthetic Score (PES) after 3 months, resulting in a similar PES post-treatment (PES: 11.86) compared to pre-surgery (PES: 12.15). The authors concluded that achieving and maintaining pink esthetics following immediate tooth replacement is feasible but often requires sub epithelial connective tissue grafting, particularly in patients with thick gingival biotypes.[60]Similarly, Chen et al. observed midfacial mucosal recession of 1 mm to 3 mm in 10 out of 30 sites (33%) within the first year. Recent clinical studies have demonstrated positive esthetic outcomes by grafting the buccal gap with freeze-dried cortical bone allograft or deproteinized bovine bone mineral, without sub epithelial connective tissue graft. [61] These methods focus on preserving gingival contours during implant placement using customized contoured healing abutments made of Polyetheretherketone or custom-contoured immediate provisionals to support gingival tissues immediately.. Recommended strategies to minimize the risk of facial mucosal recession during type 1 implant placement include using low-substitution bone fillers in the buccal gap, employing flapless surgery techniques, employing sub epithelial connective tissue grafts as needed, and managing gingival contours promptly during immediate implant placement.[62]

8. The management of Emergence Profile involves utilizing either a flat or under-contoured custom anatomical screw-retained provisional restoration or a customizable Polyetheretherketone abutment to shape the soft tissues, particularly focusing on the transition zone. This initial step in restorative care begins with collecting patient data and planning treatment.[63] Following diagnosis, the team collaborates to develop a plan leading to the fabrication of an anatomically contoured screw-retained provisional restoration, crucial for ensuring the implant's correct three-dimensional position and effectively developing the transition zone.[64]There is no clear advantage between screw-retained and cement-retained final restorations. Historical issues with screw loosening, attributed to older screw materials and external hexagon butt-joint designs, have been largely resolved with precise tolerances and controlled interfaces or internal connections provided by genuine manufacturer components. Cement-retained restorations pose significant risks of biological and infection complications due to mishandling of excess cement by operators. Therefore, screw-retained restorations are preferred to mitigate these risks and their adverse effects on adjacent tissues.[65]A screw-retained provisional restoration not only applies pressure to the soft tissues but also shapes the transition zone during site optimization and tissue conditioning. Soft tissue thickness around implants is crucial for achieving lasting aesthetic results. The provisional restoration design plays a pivotal role in this process. The facial contour of the implant prosthesis should differ from that of a natural tooth to promote natural soft tissue proliferation. However, an ill-fitting provisional can exert excessive pressure, potentially causing mucosal thinning and facial recession. Adjusting the provisional to the correct height of the proposed mucosal margin is crucial to avoid tissue blanching, typically observed for about 5 minutes empirically. Initially, an immediate provisional

restoration is typically under-contoured, allowing for adjustments as the tissue matures over multiple appointments. These provisional restorations can be fabricated intraorally or indirectly in the laboratory. In the indirect method, a presurgical cast is modified after an intraoral impression of the dental implant is taken. [66]Various types of abutments, including titanium and Polyetheretherketone, and materials such as polymethyl-methacrylate (PMMA), bisphenol A-glycidyl methacrylate (bis-GMA), denture teeth, or the patient's original crown or tooth, can be used. It is crucial to control the emergence contour in the esthetic zone, ideally achieved with a custom-contoured, screw-retained abutment in cases without a provisional, or a custom-contoured, screw-retained provisional in restored cases. Customized Polyetheretherketone abutments are effective in shaping the transition zone, starting before placing a screw-retained provisional in the laboratory after 12 weeks. For aesthetic enhancement, temporary titanium abutments often require modification to conceal their gray color using light-cured opaque resin, preventing darkening of the peri-implant mucosa.[67] The provisional restoration should be shaped with the correct or slightly under-contoured emergence profile, ensuring the gingival embrasure aligns with adjacent teeth, even if a black triangle is initially present. Further adjustments to the transition zone can be made with the provisional restoration by adding or removing subgingival restorative material, allowing the gingiva to mature. Full papillary height may take several months to develop following provisionalization.[68]According to Choquet et al., when the papilla fills the space between an implant and a natural tooth, the average distance between the gingival part of the proximal contact and the interproximal bone is approximately 3.8 mm, although this measurement varies among patients. Initially opening the gingival embrasure in the provisional restoration promotes papilla maintenance or regrowth.[69] The provisional should be regularly evaluated to decide whether to close spaces or adjust shapes. A provisional restoration in the esthetic zone may be worn for an extended period. Deciding the optimal time to take a final impression for fabricating the permanent restoration is a clinical decision, as interproximal tissues continue to mature and increase in height for a year or longer.[70]

9. Custom Impression Coping Technique: Custom Impression Coping Technique: Use a customized impression coping technique to replicate the soft-tissue aesthetics achieved in the provisional stage. Transfer this replication to the laboratory model for final restoration. Once the implant has integrated into the bone and the soft-tissue architecture and transition zone are deemed satisfactory during the provisional phase, communicate the implant position and transition zone details to the dental laboratory technician.[71] Upon removal of the provisional restoration, the soft tissues tend to collapse immediately due to the circular fibers of the peri-implant connective tissue. In esthetic-zone cases, conventional impression copings fail to preserve tissue shape adequately, resulting in imprecise replication of the transition zone. To address this challenge, Hinds proposed a method for creating a custom impression coping that precisely replicates the transition zone, eliminating the need for estimation by the technician.[72] Patras and Martin further refined this technique by incorporating photopolymerizing materials like flowable composites.[73] The provisional restoration, which embodies the desired transition zone shape, serves as both a template and support. A polyvinyl siloxane material captures this shape on an implant analog, followed by adaptation of a stock impression coping—open or closed tray—to the analog. The space between the impression coping and the polyvinyl siloxane material, representing the transition zone, is filled with flowable composite and light-cured. Subsequently, the custom impression coping is removed from the analog and intraorally positioned at the implant site, accurately supporting adjacent tissues similar to the provisional during the final impression. Following the impression process, an analog is attached to the custom impression coping, facilitating the creation of a soft-tissue model thereafter.[74]

10. Final Restoration: For optimal outcomes, prioritize screw-retained restorations to avoid the complexities of removing excess cement from deep inter proximal areas when direct screw retention is not feasible. Use anatomically contoured customized abutments with a titanium implant interface, ensuring the final facial cement line remains under 1 mm circumferentially. When cemented restorations are necessary, utilize radiopaque cement and minimize volume using techniques like the copy abutment method. Materials for final implant restorations vary widely in dental practice. While ceramic fused to metal with a "cast to" abutment historically offered durable outcomes and aesthetic appeal, advancements in dentistry now include metal-free options and milled ceramic/titanium abutments. These innovations aim for consistent aesthetics and efficiency in manufacturing.[75] Concerns about using zirconia abutments on titanium implant interfaces primarily focus on their long-term durability, potential fractures at the zirconia-titanium junction, and the wear of titanium implant walls near the abutment. These issues can lead to micro-movements, abutment fractures, or discoloration of surrounding soft tissues due to fretting.[76]To address these concerns, a titanium bonding base can be utilized, ensuring a secure interface with the dental implant and serving as a bonding component for a ceramic abutment complex. The "Ti base" concept involves milling a titanium interface as a single-piece abutment, onto which a ceramic crown is cemented externally by the laboratory and then secured intraorally using a screw (known as the "screw-ment" design).[77]Alternatively, a zirconia abutment can be milled and directly bonded to the Ti base, with porcelain applied directly to the zirconia before bonding.[78] Studies have shown no significant difference in success rates for single-unit restorations whether final restorations are cemented onto custom abutments

intraorally or not.[79] However, effective management of excess cement is crucial, especially in subgingival areas where detection and removal can be challenging, particularly at depths exceeding 1 mm. Therefore, precise fabrication of 3D custom abutments with margins aligning with or extending no more than 1 mm subgingivally is recommended to mitigate these challenges.[80] Radiopaque cements containing zinc are preferred for their visibility on radiographs and bacteriostatic properties, which aid in managing excess cement along the abutment interface.In their research on immediate implant placement and provisionalization in the esthetic zone, Kan et al observed that without bone grafting of the buccal gap or subepithelial connective tissue grafting, the thin gingival biotype group exhibited a significant increase in facial gingival level changes (-1.5 mm), whereas the thick gingival biotype group showed minimal change (0.56 mm).[81]Typically, facial gingival recession after immediate tooth replacement ranges from -0.5 mm to -0.8 mm.However, Kan et al. discovered that applying bone graft material in the buccal gap and performing subepithelial connective tissue grafting during immediate implant placement and provisionalization resulted in no significant difference in facial gingival level change over a mean follow-up of 2.15 years between patients with thick and thin gingival biotypes (eight patients and twelve patients, respectively).[82]This suggests that thin gingival biotypes can transform structurally and behaviorally to resemble thicker biotypes—a phenomenon termed "biotype conversion." Therefore, incorporating bone grafting and subepithelial connective tissue grafting seems effective in equalizing facial gingival level changes between thin and thick biotypes after immediate implant placement and provisionalization.[83] Cook et al. highlighted variations in labial plate thickness between biotypes, while Linkevicius et al. emphasized the impact of initial gingival thickness on marginal bone stability around implants.[84]They recommended thickening thin mucosa before implant placement to potentially induce biotype conversion, aligning with insights from animal studies by Berglundh et al.Facial gingival recession typically ranges from -0.5 mm to -0.8 mm post immediate tooth replacement.[85]Furthermore, Cook et al. noted variations in labial plate thickness when comparing thin and thick biotypes.[86] In a one-year prospective study at non-esthetic sites in humans, Linkevicius et al. discovered that the initial thickness of gingival tissue at the alveolar crest can impact the stability of marginal bone surrounding implants. They noted that when tissue thickness was ≤2.5 mm, crestal bone loss of up to 1.45 mm occurred within the first year of function, irrespective of the position of the implant-abutment interface above the crest.[87]The researchers recommended thickening thin mucosa prior to implant placement to transform a thin tissue biotype into a thicker one. This observation resonates with findings from an animal study by Berglundh et al., which identified a link between thin tissues and crestal bone loss during theformation of the biologic width, particularly in cases lacking a sufficient initial dimension of the biologic width.[88]

III. Future Prospects:

It is often said that "bone sets the foundation, but soft tissue is essential." Today, there is a strong emphasis on promptly regenerating both bone and soft tissue immediately after tooth extraction to optimize outcomes. The extraction socket provides an optimal environment for successful bone grafting. With meticulous planning, clinicians can ensure adequate bone and soft tissue volume around implants. In the realm of esthetics, every millimeter matters, highlighting the importance of precise implant selection and placement in extraction sockets. Unlike implant crowns, which can be replaced, the loss of bone and soft tissue is irreversible. Learning from past experiences, we now strive to achieve exceptional soft tissue profiles around implants. Effectively managing peri-implant tissue is crucial for achieving long-term esthetic success. The future of regenerative dentistry holds promise with advancements in techniques and biomaterials. While technology enhances outcomes, it cannot substitute thorough treatment planning and clinical expertise.[89]

IV. Conclusion:

Thorough assessment, including CBCT analysis for evaluating facial buccal bone and sagittal tooth position, is essential. Optimal implant placement on the palatal aspect with strategic management of gaps and utilization of smaller-diameter implants is recommended. Integration of mineralized bone grafts and soft tissue grafts plays a pivotal role in preserving and enhancing gingival aesthetics. A collaborative approach involving specialists in both surgical and prosthetic aspects ensures comprehensive care. Precision in creating provisional restorations, meticulous impression techniques, and thoughtful selection of restorative materials are critical for achieving favorable long-term results. Current evidence from short- and medium-term studies indicates comparable outcomes between immediate and delayed implant placement, though continuous research is necessary to validate long-term efficacy.

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