1-2021

Predictable Immediate Implant Placement and Restoration in the Esthetic Zone

Iñaki Gamborena
University of Pennsylvania

Yoshihiro Sasaki

Markus B. Blatz
University of Pennsylvania

Recommended Citation

Gamborena, I., Sasaki, Y., & Blatz, M. B. (2021). Predictable Immediate Implant Placement and Restoration in the Esthetic Zone. *Journal of Esthetic and Restorative Dentistry, 33* (1), 158-172. http://dx.doi.org/10.1111/jerd.12716

Predictable Immediate Implant Placement and Restoration in the Esthetic Zone

Abstract

This article describes a comprehensive step-by-step protocol for immediate implant placement and restoration in the esthetic zone. Clinical Considerations Immediate implant placement into fresh extraction sockets and immediate restoration have become widely accepted, demonstrating long-term success rates that are comparable with traditional delayed implant protocols. However, they are technique sensitive and require proper treatment planning as well as meticulous execution to be predictable and successful in the long term. This is particularly important in the esthetic zone, where even minor aberrations and mistakes can have devastating consequences, and especially in younger patients, where esthetic and functional outcomes should remain stable for years and possibly decades to come. The eight critical steps for predictable immediate implant placement include: provisional restoration of the failing tooth and presurgical phase, atraumatic tooth extraction, initial implant osteotomy, 3D bone graft packing, guided implant placement with a surgical guide, customized abutment insertion, provisional crown relining, and placement of a connective tissue graft from tuberosity. Immediate implant protocols in the esthetic zone require thorough planning and execution in the proper sequence. Each one of the critical steps discussed in this article has its own importance and challenges, which are critically assessed based on current scientific evidence. © 2021 Wiley Periodicals LLC

Keywords

CAD/CAM; digital dentistry; implants; periodontics/prosthodontics

Disciplines

Dentistry

Received: 8 November 2020 | Revised: 18 December 2020 | Accepted: 6 January 2021
DOI: 10.1111/jerd.12716

CLINICAL ARTICLE

WILEY

Predictable immediate implant placement and restoration in the esthetic zone

Iñaki Gamborena DMD, MSD[1,2] | Yoshihiro Sasaki CDT[2] | Markus B. Blatz DMD, PhD[3]

[1]Department of Preventive and Restorative Sciences, University of Pennsylvania School of Dental Medicine, Philadelphia, Pennsylvania, USA

[2]Private Practice, San Sebastian, Spain

[3]Department of Preventive and Restorative Sciences, Digital Innovation and Professional Development, University of Pennsylvania School of Dental Medicine, Philadelphia, Pennsylvania, USA

Correspondence
Markus B. Blatz, Robert Schattner Center, University of Pennsylvania, School of Dental Medicine, 240 South, 40th St., Philadelphia, PA 19104.
Email: mblatz@upenn.edu

Abstract

This article describes a comprehensive step-by-step protocol for immediate implant placement and restoration in the esthetic zone. Clinical Considerations Immediate implant placement into fresh extraction sockets and immediate restoration have become widely accepted, demonstrating long-term success rates that are comparable with traditional delayed implant protocols. However, they are technique sensitive and require proper treatment planning as well as meticulous execution to be predictable and successful in the long term. This is particularly important in the esthetic zone, where even minor aberrations and mistakes can have devastating consequences, and especially in younger patients, where esthetic and functional outcomes should remain stable for years and possibly decades to come. The eight critical steps for predictable immediate implant placement include: provisional restoration of the failing tooth and presurgical phase, atraumatic tooth extraction, initial implant osteotomy, 3D bone graft packing, guided implant placement with a surgical guide, customized abutment insertion, provisional crown relining, and placement of a connective tissue graft from tuberosity. Immediate implant protocols in the esthetic zone require thorough planning and execution in the proper sequence. Each one of the critical steps discussed in this article has its own importance and challenges, which are critically assessed based on current scientific evidence.

KEYWORDS
CAD/CAM, digital dentistry, implants, periodontics/prosthodontics

1 | INTRODUCTION

Endosseous dental implants have excellent long-term success rates.[1,2] Besides restoring intraoral function and biology, esthetic considerations are key when replacing missing or failing teeth in the anterior areas of the jaw. The ultimate goal is to replace missing teeth with implant restorations that are indiscernible from the surrounding dentition in terms of shape, morphology, and color, but also to restore and maintain a natural hard- and soft-tissue architecture, which is considered the frame for any restoration.[3] Soft-tissue aberrations, defects, and deficiencies will render even the most beautiful restoration unsuccessful, not just in the beginning, but also when they happen long after completion of treatment. This is likely the most challenging aspect in implant dentistry, especially in younger patients, where despite any possible orthodontic, biologic, and morphologic changes, functional and esthetic outcomes are expected to be stable over time.

Traditional implant protocols suggest a several-month-long healing period of the crestal bone after tooth extraction and before surgical implant insertion. A similar healing time is recommended before the implant is uncovered and, after another few weeks or months, ultimately restored.[4,5] While these multi-step protocols have been considered to be "safe" and provide long-term stability, especially in compromised situations in respect to general health, bone support or local inflammation, they not only require a long healing and provisional phase with an oftentimes inadequate interim prosthesis, but also multiple surgical interventions. For these reasons, early and immediate implant placement into fresh extraction sockets[5-7] and immediate restoration[6-8] have become widely accepted protocols, demonstrating long-term success rates that are comparable to traditional delayed implant protocols.[4-8] In addition, post-extraction bone and soft-tissue resorption can be limited or even prevented through immediate implant placement and restoration.[9,10] Significantly shortened treatment time, fewer surgeries, and immediate esthetic rehabilitation are some of the key advantages of these protocols from a patient perspective.

However, immediate implant placement and restoration protocols are technique sensitive.[7] They require proper treatment planning and meticulous execution to be predictable and successful in the long term. This is particularly important in the esthetic zone, where even minor aberrations and mistakes can have devastating consequences, and especially in younger patients, where esthetic and functional outcomes should remain stable for years and possibly decades to come.[11]

This article describes a comprehensive protocol for immediate implant placement and restoration in the esthetic zone, detailing critical steps from treatment planning to execution and follow up. The clinical steps and most important aspects are illustrated with the clinical scenario of a fractured maxillary left central incisor (Figures 1 to 4). While one particular implant system was used in the case presented, other systems with comparable features may provide similar outcomes.

2 | THE PREDICTABLE IMMEDIATE IMPLANT CONCEPT

The predictable immediate implant placement concept includes several key stages from planning to final restoration delivery (Figure 5). The first step, after optimized preparation of the failing tooth and fabrication of an ideal provisional crown, is the digital planning of the implant with the Cone Beam Computed Tomography (CBCT) and an implant planning software (DTX Studio, Nobel Biocare). An optimized preparation provides critical information while the provisional crown supports the tissues in an ideal manner until implant surgery. The preparation finish line and position of the tooth to be extracted serve

FIGURE 1 Preoperative intraoral view: maxillary left central incisor with root fracture

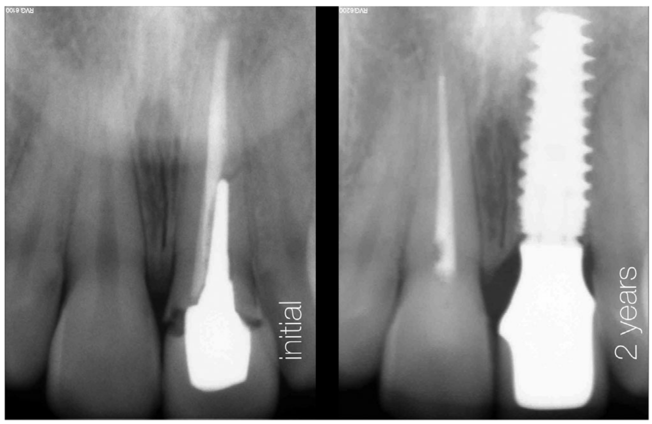

FIGURE 2 Periapical radiographs of the preoperative situation, indicating root fracture of the maxillary left central incisor, and of the postoperative situation 2 years after immediate implant placement

FIGURE 3 Two-year postoperative clinical situation

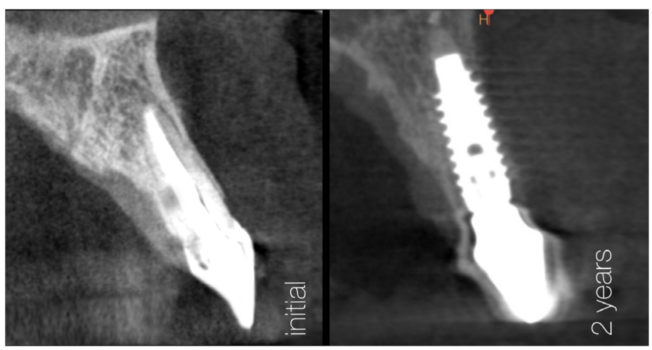

FIGURE 4 Pre- and 2-year postoperative situations in CBCT image

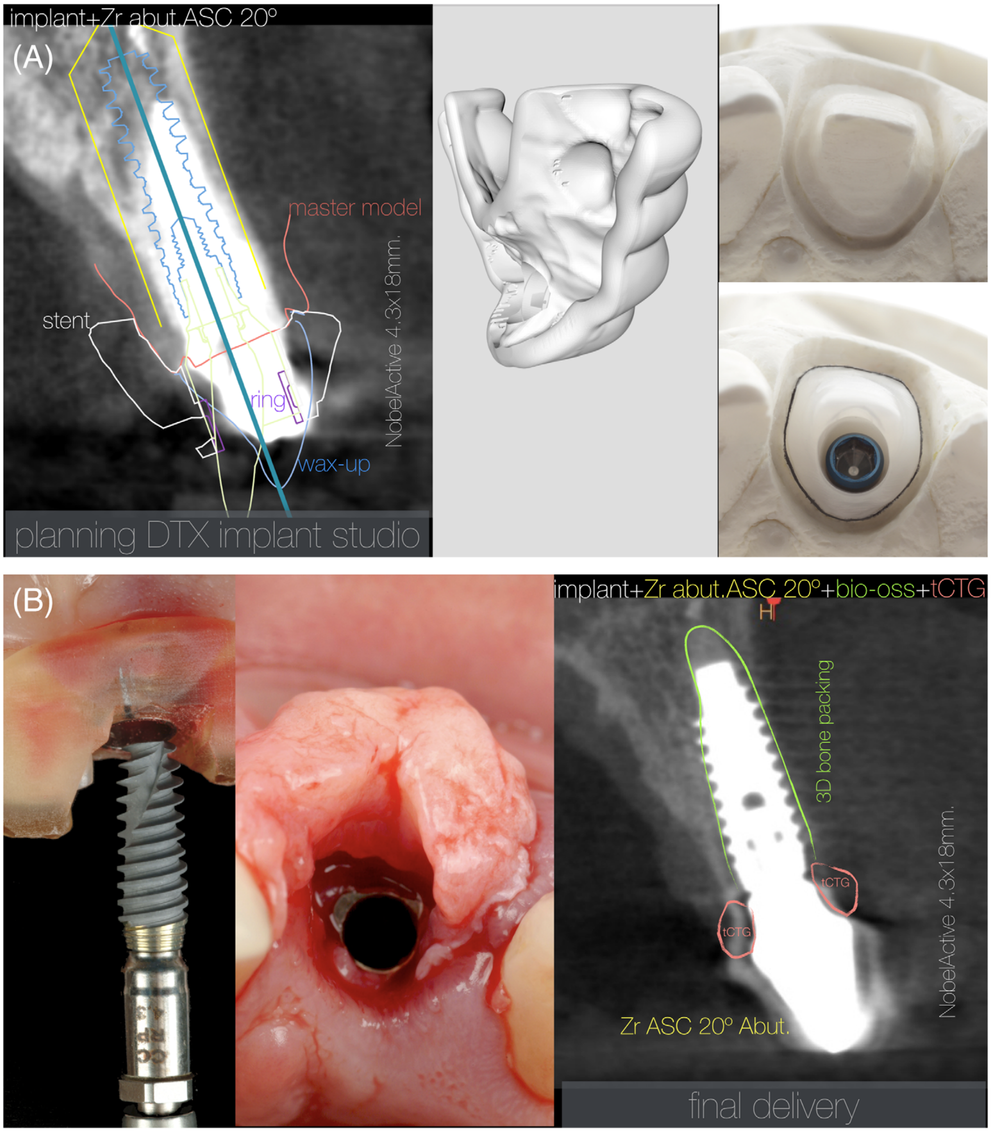

FIGURE 5 Key stages for predictable immediate implant placement: digital planning (planning implant position and angulation based on the preparation finish line of the original tooth), surgical stent, transfer of the tooth preparation to the abutment, implant placement, and grafting

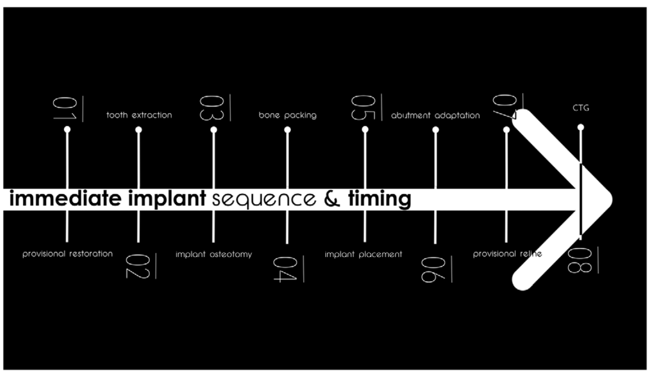

FIGURE 6 The eight critical steps of the predictable immediate implant protocol

as guides for the implant position, depth, and angulation. A surgical guide is designed based on these parameters and 3D printed. An implant analog is placed into the master cast with the guide to simulate ideal implant placement, and a customized zirconia abutment is fabricated based on the dimensions and shape of the original tooth and its preparation. This ensures identical soft-tissue support and seal of the surrounding hard- and soft tissues.

The surgery starts with an atraumatic tooth extraction and an underprepared implant osteotomy. A xenograft bone substitute material is packed directly into the extraction socket to ensure complete fill of any spaces between the implant and the alveolar bone. The implant is then placed as planned digitally, fully guided with the surgical guide to ensure not only proper position and angulation, but also depth. The customized abutment is inserted, and the provisional crown relined and cemented. Finally, a subepithelial connective tissue graft from the tuberositas (TCTG) is placed circularly around the abutment in the concave space between the marginal preparation finish line and the implant head.

The eight critical steps for predictable immediate implant placement in consecutive order (Figure 6):

1. Provisional restoration of the tooth to be extracted and presurgical phase.
2. Atraumatic tooth extraction.
3. Initial implant osteotomy.

FIGURE 7 Preoperative intraoral view: maxillary left central incisor with root fracture. The maxillary right central incisor needed root canal treatment and internal bleaching, restoration with composite

FIGURE 9 Preoperative CBCT of the maxillary left central incisor

4. 3D bone graft packing
5. Guided implant placement with surgical guide.
6. Customized abutment insertion.
7. Provisional crown relining.
8. Circular connective tissue graft from tuberosity.

2.1 | Provisional restoration and presurgical phase

A 30-year-old patient presented with pain on the maxillary left central incisor (Figure 7). Both maxillary central incisors were impacted by

FIGURE 8 Preoperative periapical radiograph indicates root fracture in the area of the apical tip of the post

trauma in the past. Radiographic evaluation revealed a root fracture of the maxillary left central incisor in the area of the endodontic post tip (Figure 8). The maxillary right central incisor was diagnosed with an irreversible pulpitis, which required endodontic treatment and internal bleaching before restoration with a composite resin material. The CBCT provided information about the tooth angulation and remaining alveolar bone support in the area of the maxillary left central incisor (Figure 9). Further evaluation through bone sounding (Figure 10) and fabrication of a provisional crown after tooth preparation with an optimized finish line ensued (Figure 11). The provisional restoration should provide ideal soft tissue support as it will be used to transfer the shape, dimensions, and outline of the natural tooth to the immediate implant restoration. The final impression was made with a polyvinyl siloxane (PVS) impression material.

The master cast was fabricated with an epoxy resin material. This allows to fully seat the 3D printed surgical guide onto the cast without breaking it, which is difficult to achieve with regular die stone. A full-contour wax up of the tooth to be extracted was made and both the master cast and the wax up were scanned. Afterwards, the preparation was reduced to the level of the preparation finish line, while keeping the marginal areas intact (Figure 12). The digital scans of the reduced master cast, the preparation finish line, and the wax up were digitally "fused" together with the CBCT (Smart Fusion Technique, Nobel Biocare), serving as a stable reference for optimal implant

FIGURE 10 A provisional restoration was fabricated for the tooth to be extracted

FIGURE 11 The tooth was prepared and a PVS impression is made

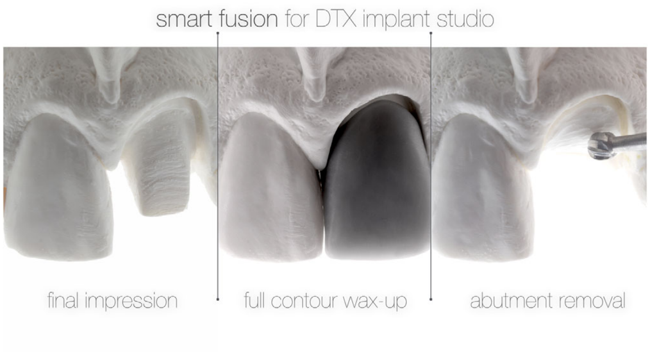

FIGURE 12 A full contour wax-up made on the epoxy-resin master cast. The abutment tooth was removed afterwards, while preserving the crown preparation finish line

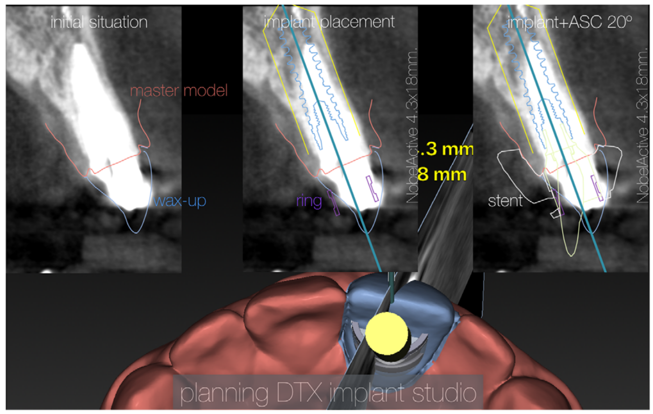

FIGURE 13 Virtual implant planning was done by digitally fusing scans of the model, the preparation finish line, and the wax-up with the CBCT. The preparation finish line of the tooth to be extracted is critical in determining optimal implant depth and angulation, and for the design of the definitive implant abutment with an angulated screw channel

planning in the design software (DTX Studio, Nobel Biocare). The preparation finish line is critical for determining the depth of the implant, and its angulation should be oriented along the long axis of the tooth. The position and angulation of the abutment screw access channel (20 degrees in this case) was determined and integrated in the design of the Angulated Screw Channel (ASC, Nobel Biocare) abutment (Figure 13). The surgical guide was designed, and 3D printed (Figure 14). The implant surgery was simulated on the epoxy model with the surgical guide, and an implant analog was placed into the model in the exact same position as clinically (Figure 15). The flat wall of the hexagon of the implant placement guiding mount should be marked on the surgical guide with a pencil to preserve its location for the surgery. This allows the surgeon to transfer the exact implant position and abutment orientation from the model to the mouth to ensure optimal seating of the definitive abutment and provisional crown. The emergence profile was created on a plastic temporary abutment with composite. The abutment should match the diameter, shape, and preparation finish line location of the tooth to be extracted in areas at and above the prospective soft-tissue levels (Figure 16). Below the peri-implant soft-tissue margin, the abutment should have a concave shape to provide space for a CTG and support soft-tissue stability. The A silicone index of the prepared tooth served as guide to trim the plastic abutment and give the implant abutment the same shape as the tooth. An abutment with the same shape and diameter as the root of the failing tooth provides a seal for the underlying tissues and initial vertical support for the soft tissues. It supports formation and stability of a blood clot and the connective tissue graft.[12,13] The custom-made composite abutment is scanned and designed with the proper angulated screw channel (Figure 17). The definitive zirconia abutment is an exact replica of the custom-made composite abutment (Figure 18). Figure 19 depicts appliances and prosthetic components prepared during the presurgical phase for the implant surgery. The provisional crown remained in the patients' mouth to provide continued and stable support of the soft tissues until the surgery.

FIGURE 14 The master cast was made from epoxy resin and prepared to simulate optimal implant placement through the 3D printed surgical guide

2.2 | Atraumatic extraction

Atraumatic tooth extraction is the first step of the surgical phase. Damaging the alveolar bone during tooth extraction can have severe consequences and cause unnecessary resorption.[14] A fundamental rule is to never force any instrument between the crestal bone and the root. Similarly, pliers should not be used as they require forceful eccentric movements, which distort and damage the alveolar bone. Instead, extraction systems where, for example, a post is screwed into the root and then pulled out of the socket vertically with a lever arm system and without touching the bone are recommended (Figure 20)

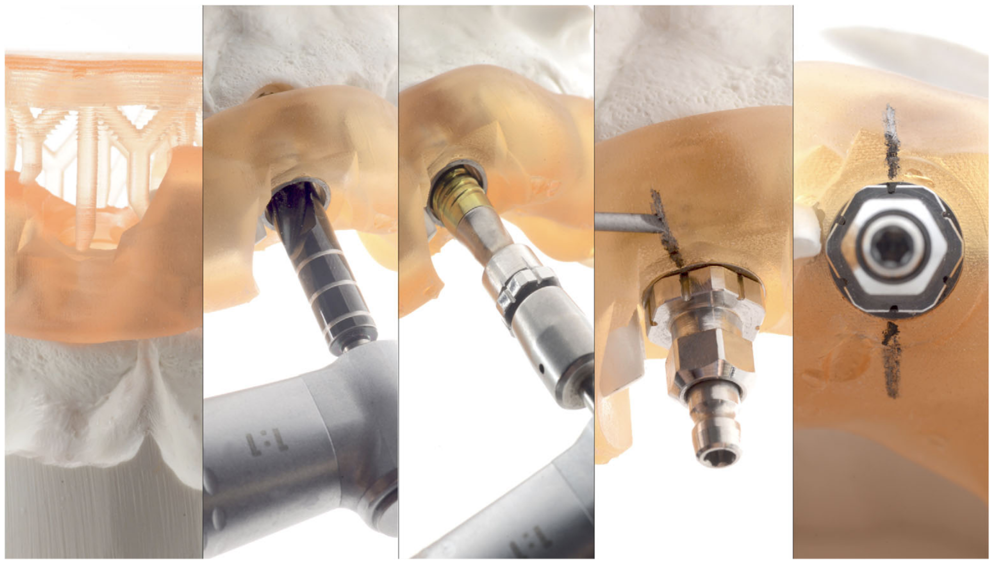

FIGURE 15 Step-by-step procedure of placing the implant analog in the master cast. The flat wall of the hexagon of the guiding mount is marked on the surgical guide with a pencil. This allows the surgeon to transfer the exact implant position and orientation from the model to the mouth to ensure exact seating of the abutment

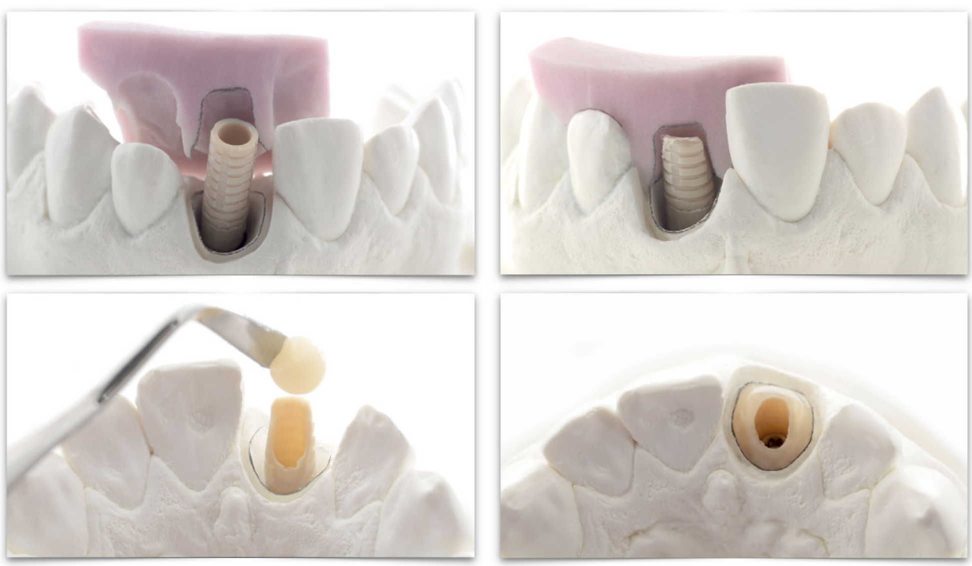

FIGURE 16 The emergence profile is created on a plastic temporary abutment with composite, based on the diameter and preparation finish line location of the tooth to be extracted. A silicone index of the prepared tooth serves as guide

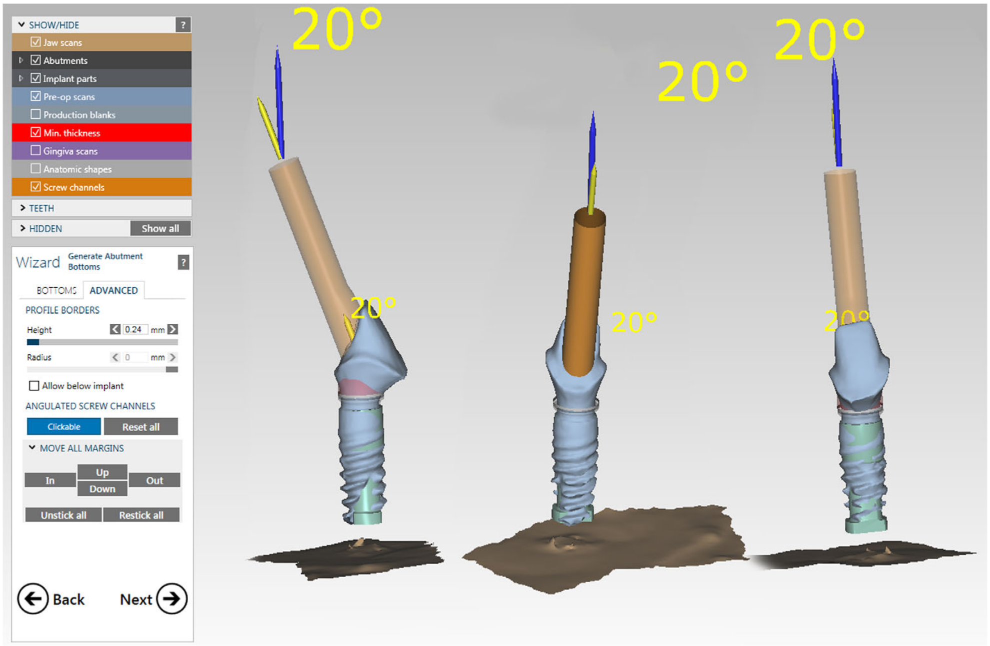

FIGURE 17 The composite abutment is scanned and designed with the proper angulated screw channel

FIGURE 18 The definitive zirconia abutment is a replica of the custom-made composite abutment and the original prepared tooth

FIGURE 19 Prosthetic components needed for predictable immediate implant placement

for atraumatic tooth extraction (Easy X-Trac System, A.Titan Instruments, Orchard Park).[15]

2.3 | Initial implant osteotomy

Primary implant stability with an insertion torque of at least 35 Ncm is critical for successful osseointegration.[16] The first step is proper selection of implant type, shape, diameter, and length.[17-20] While it may be easier to reach the recommended torque with a wider-diameter implant, the space to place bone graft material between the implant and the bony walls of extraction socket would be smaller and more difficult to fill. Implant length and especially shape may, therefore, be more important. Self-tapping conically shaped implants such as NobelActive (Nobel Biocare) can reach excellent primary stability,

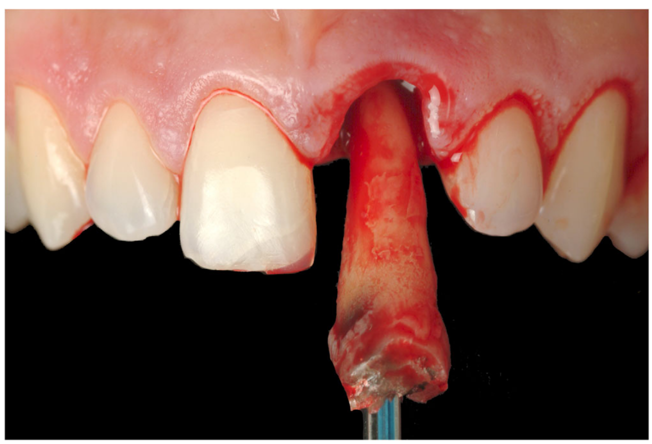

FIGURE 20 Atraumatic tooth extraction with a special extraction system is the first step of the surgical phase

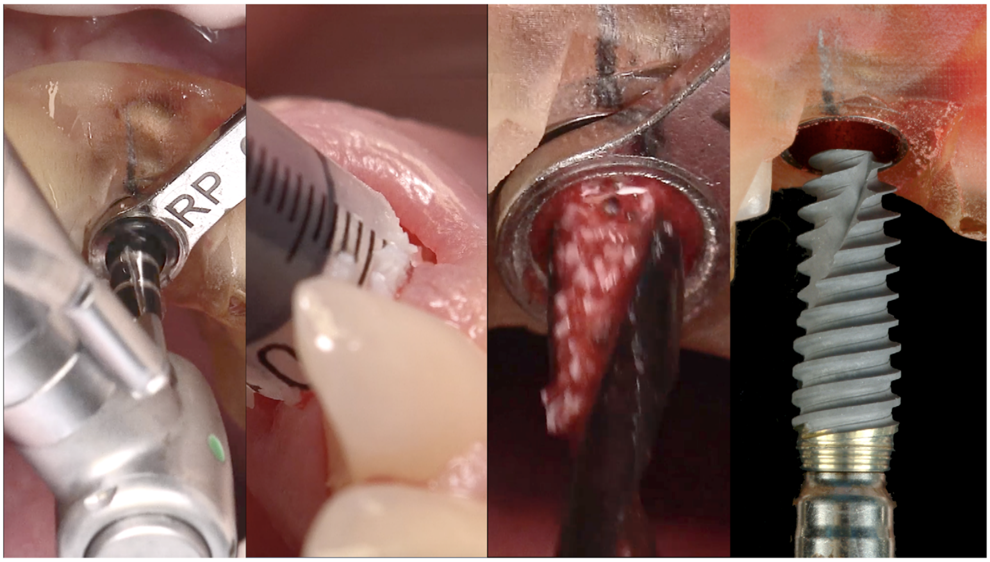

FIGURE 21 Treatment sequence of osteotomy, 3D bone packing, and implant insertion, always with a surgical guide. The osteotomy was underprepared based on the implant diameter and xenograft bone substitute material packed into the socket

FIGURE 22 The zirconia abutment was inserted with the proper torque. Next, the provisional crown made for the fracture tooth was adapted and relined on the abutment

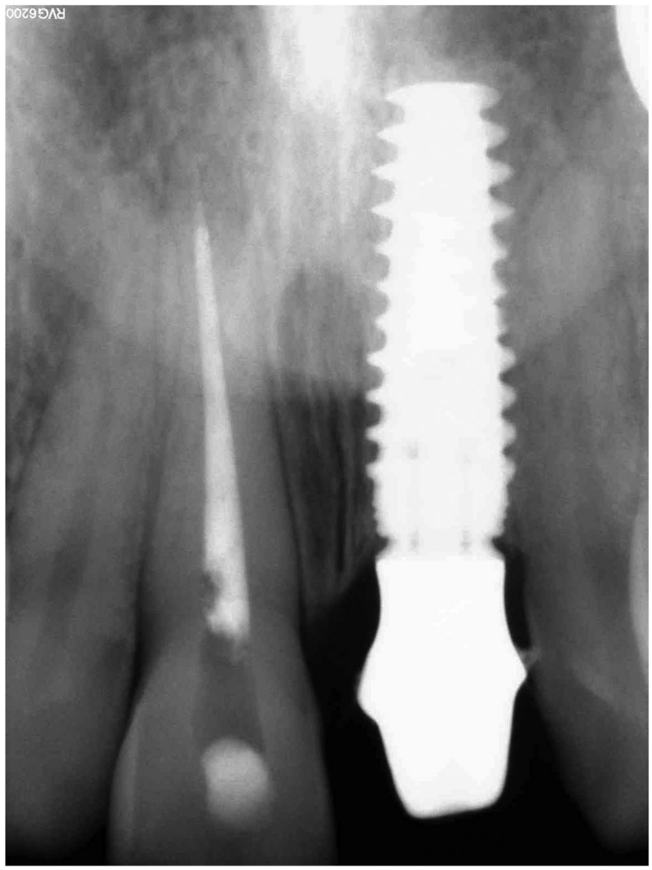

FIGURE 23 Periapical radiograph after implant placement and abutment connection

with a torque of up to 70 Ncm. They are ideal for immediate implant placement since they cut, compress, and expand bone and can be re-orientation during the insertion without significant loss of torque.

It is difficult to gain optimal primary stability when the implant bed is prepared too widely. Therefore, the initial osteotomy should be executed with a bur size that is the same size or smaller than the diameter of the tip of the implant—always with the surgical guide.

2.4 | Bone graft packing

It has been recommended to fill the space between the implant body and the bony walls of the extraction socket with allografts or, as we prefer, xenograft bone substitute materials.[21,22] Typically, these are placed after implant insertion to fill any existing gaps, which may leave hard-to-reach areas unfilled. Packing the bone graft material after the initial osteotomy into the extraction socket before implant insertion not only ensures complete fill of all spaces but also promotes primary implant stability. This approach, however, requires re-drilling of the osteotomy with same bur used for the initial osteotomy. It should be done with the surgical guide at a very slow speed and without water spray to keep the xenograft particles in place.

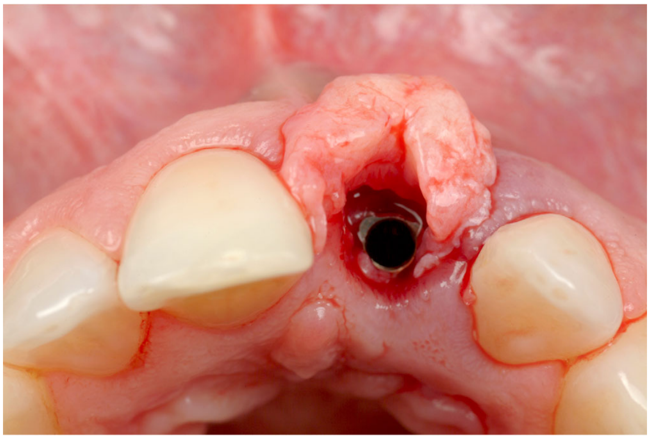

FIGURE 24 A CTG from the tuberosity (TCTG) was placed circumferentially in the space around the abutment

FIGURE 25 Insertion of the abutment, which was shaped concavely in the areas below the marginal finish line

FIGURE 26 The TCTG should not be exposed to the oral cavity due to its poor vascularization. It was, therefore, covered with soft tissue and sutured in place

FIGURE 27 The relined abutment inserted with temporary cement

2.5 | Guided implant placement

Long-term clinical esthetic and functional success is directly dependent on optimal 3D implant placement.[23-27] All immediate implants should be inserted fully guided with a computer- or model-based surgical guide to place the implant exactly in the planned position, angulation, and depth. Clinical studies have shown that the implant should not be placed too far toward the buccal aspect of the extraction socket to limit resorption of the buccal plate.[17-20] Dependent on the morphology of the socket, a slightly palatal or central implant position seems ideal, with no significant difference in respect to bone loss between them, as long as here is space for bone graft material.[21,22] However, a centered placed implant, directed along the long axis of the tooth and toward the incisal edge has several advantages.[17] From a prosthetic standpoint, it facilitates the design of a circularly uniform emergence profile to mimic the natural tooth without the bulbous shape necessary for a palatally placed implant. Surgically, it avoids large gaps and facilitates circumferential CT grafting. The reasoning that a palatally placed implant provides better access to the abutment screw for screw-retained restorations has also been undermined by the introduction of systems that feature angulated screw access channels (ASC, Nobel Biocare), which can compensate for up to 25° of implant angulation.

The implant depth is dependent on the existing soft-tissue morphology and determined during the presurgical phase in reference to the preparation finish line of the original tooth. The implant head should be placed ~0.5 to 1 mm below the labial crest of bone, making sure that the flat aspect of the hex is oriented in the same manner as on the model, as indicated with a pencil mark on the surgical guide. The implant placement (Nobel Active 4.3 × 18 mm, Nobel Biocare) and bone graft application sequence is illustrated in Figure 21.

2.6 | Customized abutment insertion

There is a strong trend in implant dentistry toward screw-retained implant restorations that eliminate the cement space between an

FIGURE 28 Healing 15 days postoperatively

FIGURE 29 CBCT verification during the healing process

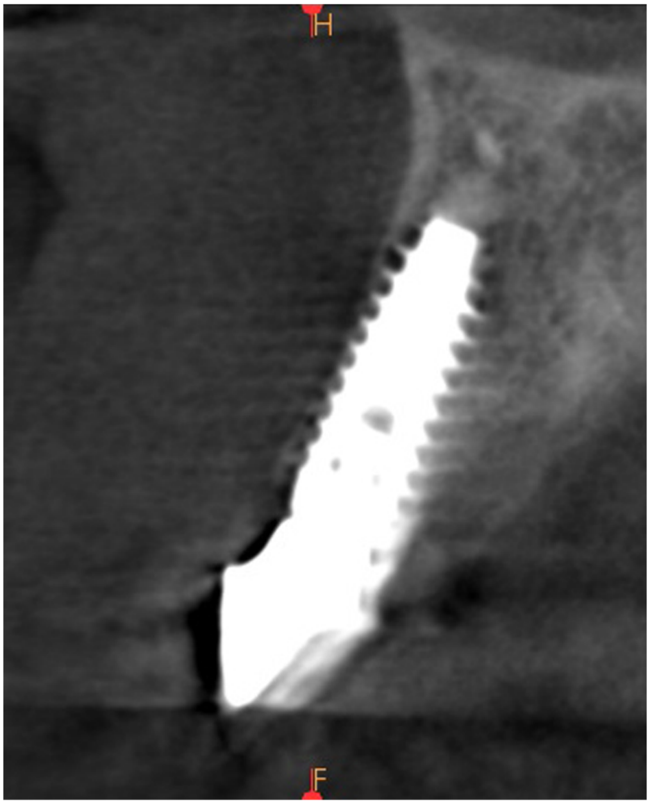

FIGURE 30 Situation 3 months postoperatively

implant abutment and its crown and avoid complications attributed to excess cement after final insertion.[28-30] Still, there seem to be some advantages attributed to cement-retained implant restorations supported by custom abutments.[31,32] While nothing close to the direct fiber connection to the natural tooth's cementum, there is some attachment of the innermost epithelial cell layer to titanium and zirconia abutment surfaces.[11] Frequent removal and reattachment of prosthetic implant components disrupt this fragile interface and may compromise long-term peri-implant soft-tissue and even bone level stability.[33] Especially for immediately placed implants, it is advisable

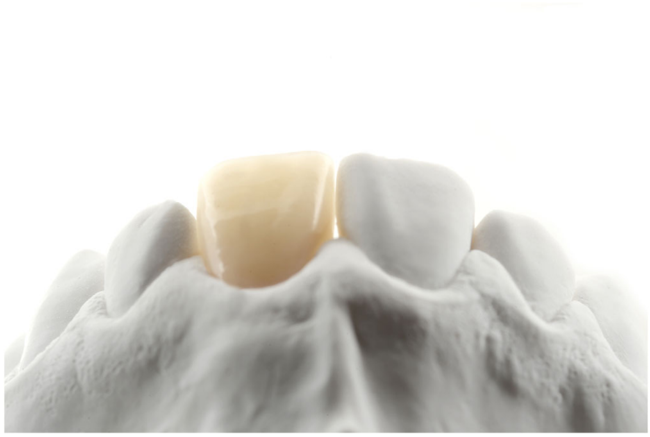

FIGURE 31 Definitive zirconia-based crown

to place the definitive abutment as early as possible and not to remove it again. The provisional restoration can still be relined or adapted, and the definitive crown optimized with the abutment left in place. And if necessary, for example in the event of tissue recessions, the abutment can be modified like a tooth with a new crown preparation without the need to remove it.

Since the definitive zirconia abutment was designed as an exact copy of the prepared original tooth in the areas at and above the gingival margins, it already features all necessary parameters to create an ideal emergence profile and seal of the extraction socket.

2.7 | Provisional restoration reline

The same provisional crown used on the failing tooth to restore function and esthetics while ideally supporting and maintaining the surrounding soft-tissues was placed on the custom zirconia abutment. Since the abutment was shaped like the prepared tooth, proper placement and relining of the provisional crown was fairly simple. The provisional crown was hollowed out and relined in the exact same

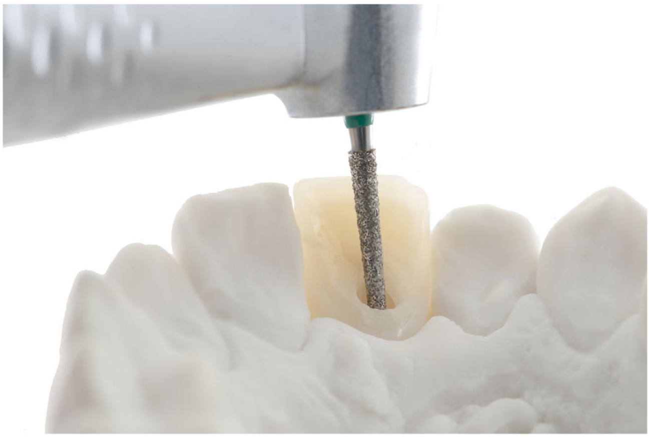

FIGURE 32 A perforation was created on the palatal aspect to access the abutment screw

FIGURE 34 Intraoral palatal view 2 years postoperative

FIGURE 33 The crown was bonded onto the abutment with composite resin, following the proper bonding protocols

FIGURE 35 Intraoral frontal view 2 years postoperative

position as indicated by a silicone matrix. The advantage of using the same provisional crown is that it already features all necessary anatomical, functional, biological, and esthetic parameters (Figure 22). After the provisional restoration was relined, the crown-abutment complex was removed and polished. Figure 23 depicts radiographic verification of proper implant and abutment placement.

2.8 | Connective tissue graft from tuberosity

Several studies have demonstrated the benefits of placing subepithelial connective tissue grafts (CTG) after implant insertion, especially when the implant is placed immediately. This, interestingly, applies to all tissue phenotypes.[34-39] Placing the CTG at the end of the immediate implant procedure allows for proper control of the space around the abutment. It also avoids contamination and desiccation of the graft.

Varying results on the amount of stability and resorption of CTGs over time have spurred evaluations of various CTG donor sites. Traditionally, the palate was the preferred connective tissue donor site due to its abundance of tissue and relatively easy access.[40] Limiting anatomical structures on the palate, great variations in thickness, and significant patient discomfort are some of the reported disadvantages.[41-45] Another CTG donor site is the maxillary tuberosity,[46-48]

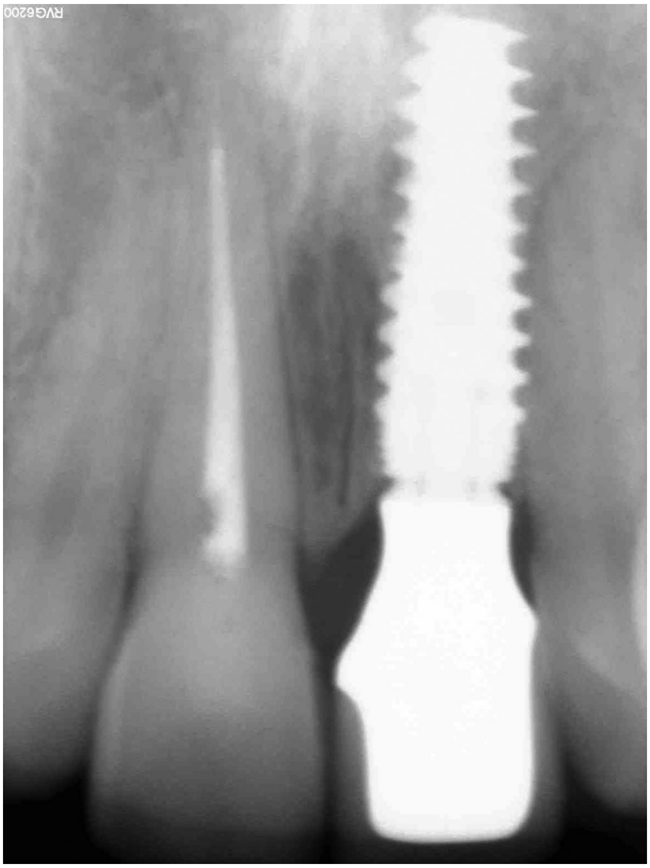

FIGURE 36 Periapical radiograph at 2-year follow up

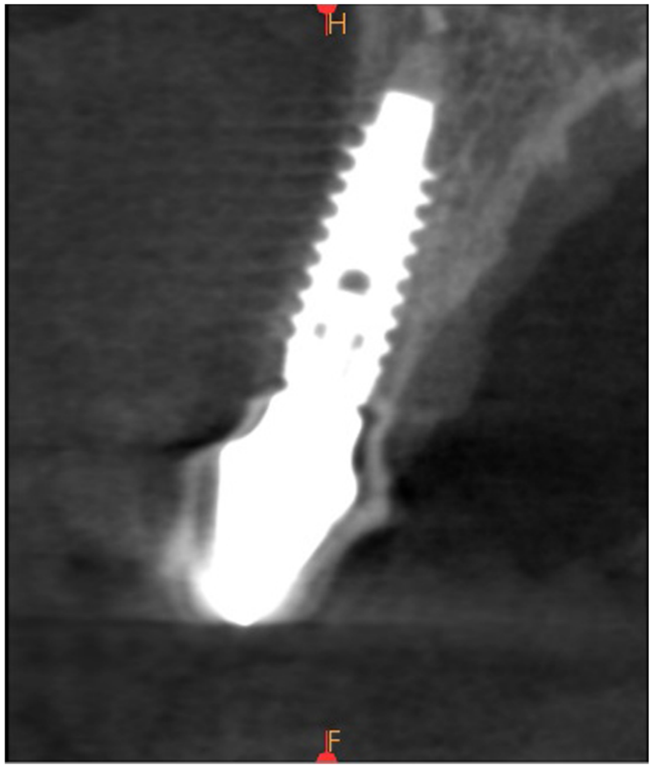

FIGURE 37 CBCT of the implant at 2-year follow up

which is less favored due its more complicated surgical access. However, patient discomfort is less compared to palatal donor aeras. In addition, tissue thickness is typically greater and more consistent among patients. Unlike palatal subepithelial connective tissue, it is denser due its higher collagen fiber content and contains less fat, making it less prone to postoperative resorption. The high degree of density and, therefore, compromised vascularization make it necessary to cover the TCTG completely with a flap to prevent necrosis.[49,50]

Figure 24 depicts circular placement of a TCTG, filling the space around the concave-shaped implant abutment (Figure 25). The TCTG was covered with soft-tissue and stabilized with a suture to the buccal flap to prevent any exposure (Figure 26). The relined provisional restoration was inserted with a provisional cement (Figure 27).

2.8.1 | Healing phase and final insertion

The postoperative clinical situation and healing, as documented after 15 days (Figure 28) and 3 months (Figure 29), did not reveal any adverse events. A CBCT taken at 3-month follow-up demonstrates stable peri-implant conditions (Figure 30).

After a healing phase of 3 months, the definitive crown was fabricated (Figure 31) and perforated on the palatal aspect to allow access to the angulated screw channel (Figure 32). It was adhesively bonded to the definitive abutment with composite resin following common zirconia-bonding protocols, which include air-particle abrasion and application of a special zirconia primer (Figure 33).[51] The screw access opening was closed with composite resin. Figures 34 and 35 demonstrate the intraoral clinical situation 2 years postoperatively. The periapical radiograph (Figure 36) and CBCT (Figure 37) taken during the same visit do not reveal any complications.

CBCTs of virtual implant planning and realization after placement of the implant and the definitive restoration are depicted in Figure 38.

3 | DISCUSSION

The protocol for immediate implant placement and restoration in the esthetic zone described in this article serves as a clinical guide for the practitioner. Immediate implant placement and loading have demonstrated excellent long-term success rates.[4-8] It was shown that, in general, oral wellbeing was significantly better after implant therapy, but that patient satisfaction was particularly greater when implants were loaded immediately.[52]

Among the greatest challenges, however, is that in the esthetic zone even the slightest changes can have devastating consequences. These problems are magnified in younger patients, where treatment outcomes should be expected to last for many years or even decades. Progressing soft- and hard tissue recessions are often difficult to manage and even if they can be grafted, the more surgical interventions

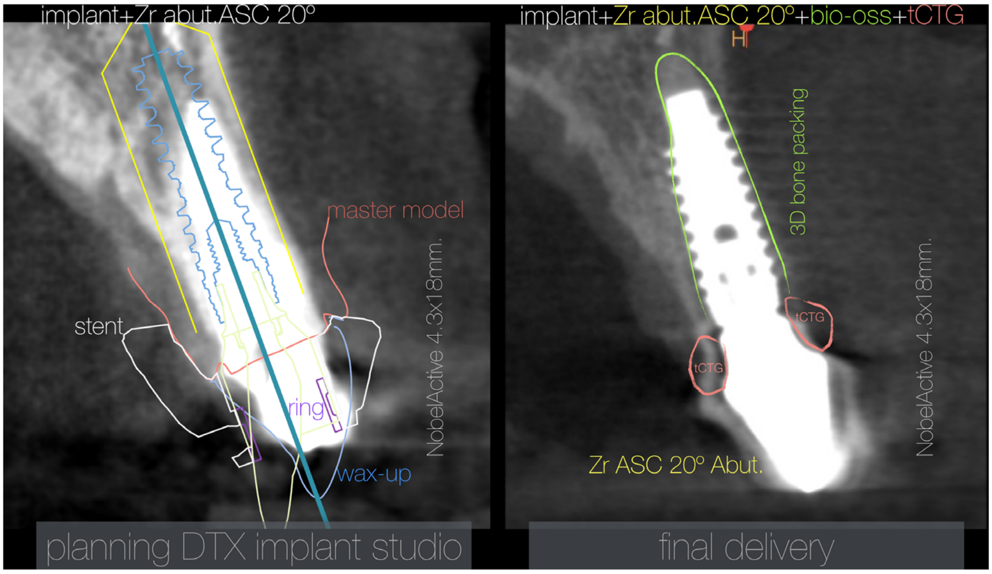

FIGURE 38 CBCTs of virtual implant plan and implant 2 years after placement

are done, the more challenging they become due to the increase in less vascularized scar tissues. And then there are the compromising effects of continuous maxillary growth can have on the long-term stability of the esthetic result.[53,54] These effects include movements and further eruption of teeth next to the implant, causing asymmetries that are often difficult to correct, some severe cases even requiring implant removal. Such cases have become more prevalent in recent years due to the greater number of implants placed and longer available follow up times. As a result, the minimal age recommendations for implant therapy trend to go up.

To increase predictability and limit the occurrence of detrimental events, several new immediate implant protocols, such as the socket-shield technique, have been introduced more recently.[55-57] However, there are two important factors to consider before implementing new concept into the daily practice. First, many of the suggested techniques are highly technique sensitive and there is evidence that implant success is directly correlated to the surgeon's technique, skill, and judgment.[58] It is, therefore, recommended to become well familiarized with any newly adapted technique and, ideally, practice it on a model before using it for the first time in a patient. Second, a single technique should not be applied without being integrated in a complete and comprehensive concept. There are numerous alternative techniques to the ones described and illustrated in this article. However, the proposed concept incorporates a sequence of consecutive techniques, which build on one another. While adaptations to each individual patient situation are always necessary, major aberrations or changes in sequence may compromise the desired outcomes.

The suggested techniques and materials were discussed based on the existing scientific evidence. As technologies are constantly evolving and further clinical research becomes available, the proposed immediate implant concept is expected to be revised and updated in the future to best serve the needs and expectations of our patients.

4 | CONCLUSIONS

Immediate implant placement and restoration in the esthetic zone requires thorough planning and meticulous execution in the proper sequence. Each one of the critical steps discussed in this article has its own importance and challenges, which are critically assessed based on the current scientific evidence to achieve the desired clinical outcomes on a predictable and consistent basis.

DISCLOSURE

The authors do not have any financial interest in the companies whose materials are included in this article.

ORCID

Markus B. Blatz https://orcid.org/0000-0001-6341-7047

REFERENCES

1. Moraschini V, Poubel LA, Ferreira VF, Barboza ES. Evaluation of survival and success rates of dental implants reported in longitudinal studies with a follow-up period of at least 10 years: a systematic review. *Int J Oral Maxillofac Surg*. 2015;44(3):377-388.
2. Tomasi C, Wennstroem JL, Berglundh T. Longevity of teeth and implants - a systematic review. *J Oral Rehabil*. 2008;35:23-32.
3. Blatz MB, Chiche G, Bahat O, Roblee R, Coachman C, Heymann HO. Evolution of aesthetic dentistry. *J Dent Res*. 2019;98(12):1294-1304.
4. Quirynen M, Van Assche N, Botticelli D, Berglundh T. How does the timing of implant placement to extraction affect outcome? *Int J Oral Maxillofac Implants*. 2007;22(Suppl):203-223.
5. Esposito MA, Koukoulopoulou A, Coulthard P, Worthington HV. Interventions for replacing missing teeth: dental implants in fresh extraction sockets (immediate, immediate-delayed and delayed implants). *Cochrane Database Syst Rev*. 2006;18:CD005968.
6. Del Fabbro M, Testori T, Kekovic V, et al. A systematic review of survival rates of Osseointegrated implants in fully and partially

edentulous patients following immediate loading. *J Clin Med*. 2019;8(12):2142.
7. Gamborena I, Sasaki Y, Blatz MB. Updated clinical and technical protocols for predictable immediate implant placement. *J Cosmet Dent*. 2020;35(4):36-51.
8. Al-Sawai AA, Labib H. Success of immediate loading implants compared to conventionally-loaded implants: a literature review. *J Investig Clin Dent*. 2016;7(3):217-224.
9. Covani U, Cornelini R, Calvo-Guirado JL, Tonelli P, Barone A. Bone remodeling around implants placed in fresh extraction sockets. *Int J Periodontics Restorative Dent*. 2010;30(6):601-607.
10. Kolerman R, Tal H, Guirado JLC, Barnea E. Aesthetics and survival of immediately restored implants in partially edentulous anterior maxillary patients. *Appl Sci*. 2018;8(3):377.
11. Gamborena I, Blatz MB. *EVOLUTION - Contemporary Protocols for Anterior Single-Tooth Implants*. Hanover Park, IL, USA: Quintessence Publishing, Inc.; 2015.
12. Crespi R, Capparé P, Crespi G, Gastaldi G, Romanos G, Gherlone E. Tissue remodeling in immediate versus delayed prosthetic restoration in fresh socket implants in the esthetic zone: four-year follow-up. *Int J Periodontics Restorative Dent*. 2018;38(Suppl):s97-s103.
13. Rungcharassaeng K, Kan JY, Yoshino S, Morimoto T, Zimmerman G. Immediate implant placement and provisionalization with and without a connective tissue graft: an analysis of facial gingival tissue thickness. *Int J Periodontics Restorative Dent*. 2012;32(6):657-663.
14. Iyer SS, Haribabu PK. Minimizing alveolar bone loss during and after extractions (part I)- -review of techniques: atraumatic extraction, root retention. *Alpha Omegan*. 2013;106(3–4):67-72.
15. Dietrich T, Schmid I, Locher M, Addison O. Extraction force and its determinants for minimally invasive vertical tooth extraction. *J Mech Behav Biomed Mater*. 2020;105:103711.
16. Douglas de Oliveira DW, Lages FS, Lanza LA, Gomes AM, Queiroz TP, Costa FO. Dental implants with immediate loading using insertion torque of 30 Ncm: a systematic review. *Implant Dent*. 2016;25(5):675-683.
17. Kan JY, Roe P, Rungcharassaeng K, et al. Classification of sagittal root position in relation to the anterior maxillary osseous housing for immediate implant placement: a cone beam computed tomography study. *Int J Oral Maxillofac Implants*. 2011;26(4):873-876.
18. Vignoletti F, Sanz M. Immediate implants at fresh extraction sockets: from myth to reality. *Periodontol*. 2014;66(1):132-152.
19. Morimoto T, Tsukiyama Y, Morimoto K, Koyano K. Facial bone alterations on maxillary anterior single implants for immediate placement and provisionalization following tooth extraction: a superimposed cone beam computed tomography study. *Clin Oral Implants Res*. 2015;26(12):1383-1389.
20. Seyssens L, Eghbali A, Cosyn J. A 10-year prospective study on single immediate implants. *J Clin Periodontol*. 2020;47(10):1248-1258.
21. Al Qabbani A, Al Kawas S, Enezei H, et al. Biomechanical and radiological assessment of immediate implants for alveolar ridge preservation. *Dent Res J*. 2018;15(6):420-429.
22. Al Qabbani A, Al Kawas S, Razak NH, et al. Three-dimensional radiological assessment of alveolar bone volume preservation using bovine bone Xenograft. *J Craniofac Surg*. 2018;29(2):e203-e209.
23. Buser D, Martin W, Belser UC. Optimizing esthetics for implant restorations in the anterior maxilla: anatomic and surgical considerations. *Int J Oral Maxillofac Implants*. 2004;19:43-61.
24. Belser U, Buser D, Higginbottom F. Consensus statements and recommended clinical procedures regarding esthetics in implant dentistry. *Int J Oral Maxillofac Implants*. 2004;19:73-74.
25. Higginbottom F, Belser U, Jones JD, Keith SE. Prosthetic management of implants in the esthetic zone. *Int J Oral Maxillofac Implants*. 2004;19:62-72.
26. Belser UC, Schmid B, Higginbottom F, Buser D. Outcome analysis of implant restorations located in the anterior maxilla: a review of the recent literature. *Int J Oral Maxillofac Implants*. 2004;19:30-42.
27. Garber DA. The esthetic dental implant: letting the restoration be the guide. *J Am Dent Assoc*. 1995;126:319-325.
28. Wismeijer D, Brägger U, Evans C, et al. Consensus statements and recommended clinical procedures regarding restorative materials and techniques for implant dentistry. *Int J Oral Maxillofac Implants*. 2014;29(Suppl):137-140.
29. Morton D, Chen ST, Martin WC, et al. Consensus statements and recommended clinical procedures regarding optimizing esthetic outcomes in implant dentistry. *Int J Oral Maxillofac Implants*. 2014;29(Suppl):216-220.
30. Sailer I, Mühlemann S, Zwahlen M, Hämmerle CHF, Schneider D. Cemented and screw-retained implant reconstructions: a systematic review of the survival and complication rates. *Clin Oral Implants Res*. 2012;23(Suppl 6):163-201.
31. Chaar MS, Att W, Strub JR. Prosthetic outcome of cement-retained implant-supported fixed dental restorations: a systematic review. *J Oral Rehabil*. 2011;38:697-711.
32. Nissan J, Narobai D, Gross O, Ghelfan O, Chaushu G. Long-term outcome of cemented versus screw-retained implant-supported partial restorations. *Int J Oral Maxillofac Implants*. 2011;26:1102-1107.
33. de Carvalho Barbara JG, Luz D, Vianna K, Porto Barboza E. The influence of abutment disconnections on peri-implant marginal bone: a systematic review. *Int J Oral Implantol*. 2019;12(3):283-296.
34. Grunder U. Crestal ridge width changes when placing implants at the time of tooth extraction with and without soft tissue augmentation after a healing period of 6 months: report of 24 consecutive cases. *Int J Periodontics Restorative Dent*. 2011;31:9-17.
35. Atieh MA, Alsabeeha NHM. Soft tissue changes after connective tissue grafts around immediately placed and restored dental implants in the esthetic zone: a systematic review and meta-analysis. *J Esthet Restor Dent*. 2020;32(3):280-290.
36. Linkevicius T, Apse P, Grybauskas S, Puisys A. The influence of soft tissue thickness on crestal bone changes around implants: a 1-year prospective controlled clinical trial. *Int J Oral Maxillofac Implants*. 2009;24:712-719.
37. Wiesner G, Esposito M, Worthington H, Schlee M. Connective tissue grafts for thickening peri-implant tissues at implant placement. One-year results from an explanatory split-mouth randomised controlled clinical trial. *Eur J Oral Implantol*. 2010;3:27-35.
38. Burkhardt R, Joss A, Lang NP. Soft tissue dehiscence coverage around endosseous implants: a prospective cohort study. *Clin Oral Implants Res*. 2008;19:451-457.
39. Zucchelli G, Mazzotti C, Mounssif I, Mele M, Stefanini M, Montebugnoli L. A novel surgical-prosthetic approach for soft tissue dehiscence coverage around single implant. *Clin Oral Implants Res*. 2013;24:957-962.
40. Reiser GM, Bruno JF, Mahan PE, Larkin LH. The subepithelial connective tissue graft palatal donor site: anatomic considerations for surgeons. *Int J Periodontics Restorative Dent*. 1996;16:130-137.
41. Studer SP, Allen EP, Rees TC, Kouba A. The thickness of masticatory mucosa in the human hard palate and tuberosity as potential donor sites for ridge augmentation procedures. *J Periodontol*. 1997;68:145-151.
42. Muller HP, Schaller N, Eger T, Heinecke A. Thickness of masticatory mucosa. *J Clin Periodontol*. 2000;27:431-436.
43. Stipetić J, Hrala Z, Celebić A. Thickness of masticatory mucosa in the human hard palate and tuberosity dependent on gender and body mass index. *Coll Antropol*. 2005;29:243-247.
44. Song JE, Um YJ, Kim CS, et al. Thickness of posterior palatal masticatory mucosa: the use of computerized tomography. *J Periodontol*. 2008;79:406-412.
45. Hurzeler M, Weng D. A single incision technique to harvest subepithelial connective tissue from the palate. *Int J Periodontics Restorative Dent*. 1999;19:279-287.

46. Jung UW, Um YJ, Choi SH. Histologic observation of soft tissue acquired from maxillary tuberosity area for root coverage. *J Periodontol*. 2008;79:934-940.
47. Roccuzzo M, Gaudioso L, Bunino M, Dalmasso P. Surgical treatment of buccal soft tissue recessions around single implants: 1-year results from a prospective pilot study. *Clin Oral Implants Res*. 2014;25:641-646.
48. Sanz-Martín I, Rojo E, Maldonado E, Stroppa G, Nart J, Sanz M. Structural and histological differences between connective tissue grafts harvested from the lateral palatal mucosa or from the tuberosity area. *Clin Oral Investig*. 2019;23(2):957-964.
49. Zuhr O, Baumer D, Hurzeler M. The addition of soft tissue replacement grafts in plastic periodontal and implant surgery: critical elements in design and execution. *J Clin Periodontol*. 2014;41(Suppl):123-142.
50. Dellavia C, Ricci G, Pettinari L, Allievi C, Grizzi F, Gagliano N. Human palatal and tuberosity mucosa as donor sites for ridge augmentation. *Int J Periodontics Restorative Dent*. 2014;34:179-186.
51. Blatz MB, Vonderheide M, Conejo J. The effect of resin bonding on long-term success of high-strength ceramics. *J Dent Res*. 2018;97(2):132-139.
52. Yeung CA. Effect of implant rehabilitation on oral health-related quality of life with three different implant strategies. *Evid Based Dent*. 2020;21(3):92-93.
53. Heij DG, Opdebeeck H, van Steenberghe D, Kokich VG, Belser U, Quirynen M. Facial development, continuous tooth eruption, and mesial drift as compromising factors for implant placement. *Int J Oral Maxillofac Implants*. 2006;21(6):867-878.
54. Andersson B, Bergenblock S, Fürst B, Jemt T. Long-term function of single-implant restorations: a 17- to 19-year follow-up study on implant infraposition related to the shape of the face and patients' satisfaction. *Clin Implant Dent Relat Res*. 2013;15(4):471-480.
55. Staehler P, Abraha SM, Bastos J, Zuhr O, Hürzeler M. The socket-shield technique: a step-by-step protocol after 12 years of experience. *Int J Esthet Dent*. 2020;15(3):288-305.
56. Gluckman H, Salama M, Du Toit J. A retrospective evaluation of 128 socket-shield cases in the esthetic zone and posterior sites: partial extraction therapy with up to 4 years follow-up. *Clin Implant Dent Relat Res*. 2018;20(2):122-129.
57. Kan JYK, Rungcharassaeng K, Deflorian M, et al. Immediate implant placement and provisionalization of maxillary anterior single implants. *Periodontol*. 2018;77(1):197-212.
58. Chrcanovic BR, Kisch J, Albrektsson T, Wennerberg A. Impact of different surgeons on dental implant failure. *Int J Prosthodont*. 2017;30(5):445-454.

How to cite this article: Gamborena I, Sasaki Y, Blatz MB. Predictable immediate implant placement and restoration in the esthetic zone. *J Esthet Restor Dent*. 2021;33:158–172. https://doi.org/10.1111/jerd.12716