Complex Dental Implant Cases

Algorithms, Subjectivity, and Patient Cases Along the Complexity Continuum

Mark Durham, DMD[a,*], Marco Brindis, DDS[b],
Nicholas Egbert, DDS, MSD[a],
Leslie R. Halpern, DDS, MD, PhD, MPH[c]

KEYWORDS

• Algorithms • Complex implant restorations • Interdisciplinary collaboration
• Maxillary and mandibular ridge classification • Provider subjectivity

KEY POINTS

- Complex dental implant cases involve a multiplicity of presurgical and postsurgical considerations that are agreed upon by both patient and practitioner.
- Implant-supported reconstruction in the complex dental implant patient is predicated upon a surgical foundation that promotes both long-term function and esthetics.
- Prosthodontic algorithms are elucidated through a list of the generic operations for providing patients with basic dental implant prosthetics.
- Provider subjectivity is an essential component of complex cases, and specific complex cases are provided to convey the strong subjective component in such cases.

INTRODUCTION

Advances in the discipline of dental implant placement have created choices to enhance the expectations of the dental practitioner and his or her patients with respect to oral rehabilitation. There are more realistic options for restoration of function and esthetics regardless of age, and in most cases, medical disabilities. The latter can improve both better oral health and health-related quality of life in patients who were once considered hopeless "dental cripples." In addition, the bioactivity of implant surface design as well as use of hard and soft tissue augmentation provides a greater enhancement of surgical sites in both the edentulous and the partially edentulous jaw. This millennium has especially provided an increased demand by patients for dental implants, which has cascaded into economic competition by companies that market full mouth rehabilitation whereby the patient regains their teeth regardless of how they lost them. The implant placement, however, although well reported in the literature, can still result in implant failures due to poor patient selection, prior history of oral disease, that is, periodontitis, compliance with oral hygiene instructions, and professional maintenance protocols. These morbidities, whether cause or effect, have their basis in poor treatment planning

Disclosure Statement: The authors have nothing to disclose.
[a] Prosthodontist, University of Utah, School of Dentistry, 530 South Wakara Way, Salt Lake City, UT 84108, USA; [b] Louisiana State University, School of Dentistry, 1100 Florida Avenue, New Orleans, LA 70119, USA; [c] Oral and Maxillofacial Surgery, University of Utah, School of Dentistry, 530 South Wakara Way, Salt Lake City, UT 84108, USA
* Corresponding author.
E-mail address: Mark.durham@hsc.utah.edu

Oral Maxillofacial Surg Clin N Am 31 (2019) 219–249
https://doi.org/10.1016/j.coms.2018.12.003

strategies.[1–4] As such, a systematic approach to patient assessment must be the number one priority for complex dental implant treatment planning in order to avoid a less than optimized outcome.

With respect to the complex implant case, the doctor must determine whether implants are the best option, especially within a framework of a partially or fully edentulous jaw. In many instances, hard and soft tissue foundations are inadequate for implant placement and must, therefore, be augmented before placing implant fixtures. A promise of a fixed prosthesis may be broken if the treatment turns into a removable appliance, especially when implant placement has resulted in improper positioning to handle the biomechanical stressors during function. **Box 1** lists the most common types of complex cases seen in the oral and maxillofacial surgical practice. These complex cases not only will often require a combination of tissue choices but also will require prosthetic and periodontal reformations for total rehabilitation in the partially and fully edentulous maxilla and mandible.[5] An interdisciplinary approach to restore function and esthetics is most often necessary to offer treatment choices that will be agreeable by both the practitioner and their patient population. The disclosure of the case's complexity is a nonnegotiable need in the management of patient-provider relationship.

This article shares subjective claims regarding the restoration of simple to complex cases, because sharing cases is an important activity in the disambiguation of case complexity for providers. Ultimately disclosing the subjective perception of case complexity aids patients in their need for emotional management and helps meet patient expectations. A series of algorithms for approaching complex dental implant restorations in the partially edentulous and fully edentulous patient is presented. A review of the current literature is used to apply a well-tested systematic assessment followed by criteria in a checklist format that will determine whether a removable or fixed implant prosthesis is the best option for the patient. Several cases have been chosen to illustrate the algorithms the authors use in order to provide an optimized prognosis for surgical/restorative success.

Box 1
Common complex cases of dental implant restorations (All cases may need soft and hard tissue augmentation)

- Multi-unit fixed restorations in the esthetic zone
- Full-arch restorations that are completely implant supported
- Single-unit fixed restorations in the esthetic zone
- Full-arch restorations that are implant and tissue assisted
- Fixed restorations outside the esthetic zone

PATIENT WORKUP

An evidence-based approach was applied to determine patient assessment strategies for complex case rehabilitation that were well tested in other studies.[1,6] A literature search was undertaken using Medline within the PubMed Portal to choose articles within the last 15 years. Only articles in English were chosen for inclusion. Each article's bibliography was further evaluated by hand for relevant publications and reviewed by the authors for inclusion. The keywords chosen included "patient assessment," "complex implant cases and patient selection," "complex planning for dental implants," and "complex restoration of the jaw with dental implants." The level of evidence chosen was based on Sackett's hierarchy of evidence and were predominantly level 1A, 2A, 3A, 4, and 5 (**Box 2**).[6] The following sections describe several algorithms used in the workup of the patient beginning with a medical history and physical examination followed by a series of checklists of hard and soft tissue criteria, radiologic imaging, and prosthetic strategies that the surgeon, prosthodontist, and periodontist can apply to complex implant cases in the maxilla and mandible.

Box 2
Criteria for inclusion of articles chosen from PubMed literature search according to Sackett's hierarchy

Level of Evidence	Description
1A	Systematic review/randomized trials (RCT)
1B	RCTs with narrow confidence limit
1C	All or none case series
2A	Systematic cohort
2B	Cohort study/low-quality RCT
3A	Systematic review of case controlled
3B	Case-controlled study
4	Case series/poor cohort case controlled
5	Expert opinion

From Sadowsky SJ, Fitzpatrick B, Curtis DA. Evidence-based criteria for different treatment planning of implant restorations for the maxillary edentulous patient. J Prosthodont 2015;433–46; with permission.

Medical History/Physical Examination

Much debate has centered on whether dental implants are a preferred restorative solution in medically compromised patients, who most often are candidates for complex restorative rehabilitation.[3,4,7] The challenges faced include increased risk of peri-implantitis, recurrence of mucosal disease, and/or development of osteonecrosis due to pharmacotherapy, that is, the use of certain drugs for osteoporosis/bone cancers, and patients who have been exposed to radiation therapy. Diz and colleagues[4] have suggested that risk/morbidity of dental implant placement in medically compromised patients should be predicated upon careful patient workup because new evidence supports successful survival in these patients.[7] Kotsakis and colleagues[3] in a systematic review evaluating implant placement in the maxilla of medically compromised patients conclude that implant survival is acceptable based on disease type and appears more predictable in the mandible than maxilla. Vissink and colleagues[7] in a recent review differentiated between absolute and relative contraindications for dental implant therapy. **Table 1** lists these considerations with measures to allow the feasibility of dental implant placement in patients who are medically challenged.[4,7] Immediate and long-term follow-up of all patients are essential regardless of relative or absolute considerations to complex implant case restorations.

Clinical Examination of Extraoral and Intraoral Hard and Soft Tissues

A systematic approach requires an "interbiologic algorithm" comprising both hard and soft tissue extraoral and intraoral evaluation regardless of whether the practitioner is restoring a single tooth, partial edentulous, or fully edentulous jaw. Factors that influence the ideal restoration must begin with a "checklist approach" across the vertical, transverse, and coronal dimensions of the patient's hard and soft tissue profile.[8,9] In addition, patient concerns of phonation problems and gag reflexes often require a consideration of whether a fixed appliance may be indicated. These criteria are crucial to the design of the restoration because it will ultimately determine the "ideal" position for implant placement. **Table 2** describes the authors' general algorithm for patient treatment planning that sets the stage for the specific criteria to follow based on the patient's treatment preferences.

Extraoral and intraoral hard and soft tissue parameters

The facial appearance provides a foundation for how the hard and soft tissues interact to provide phonation, function, and esthetics. The following provides an in-depth evaluation of these parameters.

Extraoral hard and soft tissue **Table 3** characterizes the extraoral examination based on whether the patient is dentate or edentulous.[8] Skeletal profile, facial contours, soft tissue drape, facial symmetry, lip and cheek support, smile line, and relation of the upper and lower lip provide a guide to optimal placement of the final restoration. These criteria are addressed with and without existing prostheses in order to determine the anatomic limitations precluding stability and retention for a complete denture as well as tolerance for palatal coverage in patients who are refractory gaggers. Regardless of design, facial support becomes critical because dentofacial imbalances also need to be addressed to determine a balance between the esthetic plane and functional occlusion. The balance between upper and low lip esthetics is determined by the convexity or concavity of the patient's profile because prosthetic design can compensate for dentofacial deficiencies. A dentate maxilla provides lip support off the alveolar ridge. In the edentulous upper jaw, lip support is lost due to resorption patterns, and anterior teeth must be placed anterior to the ridge in order to provide lip esthetics and phalange design that compensate for lip length and projection. Maxillary lip length will determine the position of the anterior teeth and therefore short versus long lip length will determine exposure of teeth in repose. All measurements must be calibrated to the age and gender of the patient.[8–10]

Intraoral hard and soft tissue **Table 4** shows an algorithm for intraoral examination based on either a fixed or a removable implant prosthesis.[8,9] The intraoral examination includes quantity and quality of bony and mucosal draping. The tissue biotype will set the stage for clinical crown emergence profiles and accompanying abutment angulation of the implants. Alveolar ridge geometry can influence patterns of resorption, which influence the location of implant positioning. Three-dimensional Bony foundations are of primary importance in the reconstruction of the edentulous ridge (see later discussion). Crown inclination, bone relationship, and tooth size will supply adequate lip support and phonation during smiling and speech.

Diagnostic Wax-up Modeling for Treatment Planning

Diagnostic wax-ups are paramount in designing a prosthesis regardless of whether a fixed or removable treatment option is offered. Impressions and study casts are mounted on semiadjustable

Table 1
Type of medical condition and survival of dental-implant placements

Condition	(Relative) Contraindication	Implant Survival Rate	Precautions/Recommendations
Alcoholism	No	Similar	Assure that patients will keep adequate oral health maintenance.
Bleeding disorder	No	Similar	Check coagulation status before placement of implants
Bone disease			
Osteoporosis	No	Similar	Be aware of a slightly higher risk on MRONJ in patients on oral antiresorptive drugs; bone augmentation surgery is allowed
Bisphosphonate use	Yes	Similar/ reduced	Antibiotic prophylaxis; risk of MRONJ is high in patients treated for bone metastasis. When implants in latter patients are indicated, do it early after start of antiresorptive therapy. Also, no augmentation surgery in patients on IV administration unless early after start of usage
Other antiresorptive drugs, for example, denosumab	Yes	Similar/ reduced	Antibiotic prophylaxis; risk of MRONJ is high in patients treated for bone metastasis. When implants in latter patients are indicated, do it early after start of antiresorptive therapy. Also, no augmentation surgery in patients on IV administration unless early after start of usage
Cardiac disease	No	Similar	Assure that patient will keep adequate oral health maintenance, also with regard to control of cardiac disease
Diabetes mellitus			
Uncontrolled	No	Similar/ reduced	Antibiotic prophylaxis; assure that patient will keep adequate oral health maintenance, also with regard to control of diabetes
Controlled	No	Similar	Assure that patient will keep adequate oral health maintenance, also with regard to control of diabetes
Drugs			
Anticoagulants	No	Similar	See bleeding disorder
Antiresorptive drugs	No	Similar/ reduced	See bone disease
Biologicals	No	Similar	See Immunocompromised patients
Chemotherapy	No	Similar	See head neck cancer
Immunotherapy	Yes	Unknown	Implant treatment often can be postponed until end of therapy
Xerostomic drugs	No	Similar	See hyposalivation
Head and neck cancer			
Chemotherapy	No	Similar	Assure that patient will keep adequate oral health maintenance during the course of chemotherapy. After completion, the risk of developing peri-implant health problems is comparable to healthy subjects

(*continued on next page*)

Table 1
(*continued*)

Condition	(Relative) Contraindication	Implant Survival Rate	Precautions/Recommendations
Radiotherapy	Yes	Reduced	Preferably place dental implants during ablative surgery. When placed after completion of radiotherapy, implant should be placed under antibiotic coverage (eg, amoxicillin 500 mg tid for 2 wk, starting 1 d before placement of the implants). If cumulative radiation dose in the implant area is >40 Gy, it is recommended to apply hyperbaric oxygen therapy preimplant and postimplant placement
Hypersalivation	No	Similar	
Hyposalivation	No	Similar	Higher risk of per-implant health problems, assure that patient will keep adequate oral health maintenance
Immunocompromised patients			
Biologicals	No	Similar	Discuss with physician whether administration of biologicals has to be adjusted or specific precautions are needed
Crohn disease	No	Similar/ reduced	Antibiotic prophylaxis; older studies mention that implant survival is decreased compared with controls; Recent studies indicate that survival is similar
Mixed connective tissue disease	No	Similar	Antibiotic prophylaxis; higher risk of per-implant health problems, antibiotic prophylaxis
Rheumatoid arthritis	No	Similar	Higher risk of peri-implant health problems, assure that patient will keep adequate oral health maintenance
Scleroderma	No	Similar	Antibiotic prophylaxis; higher risk of peri-implant health problems, assure that patient will keep adequate oral health maintenance
Sjögren syndrome	No	Similar	Antibiotic prophylaxis; higher risk of per-implant health problems, assure that patient will keep adequate oral health maintenance
Systemic lupus erythematosus	No	Similar	Antibiotic prophylaxis; higher risk of per-implant health problems, assure that patient will keep adequate oral health maintenance
Mucosal disease			
Epidermolysis bullosa	No	Similar	Antibiotic prophylaxis; careful treatment if oral mucosa. Slightly higher risk of peri-implant health problems. Assure that patient will keep adequate oral health maintenance
Lichen planus	No	Similar	Antibiotic prophylaxis; slightly higher risk of peri-implant health problems. Assure that patient will keep adequate oral health maintenance. Place implants when mucosal disease is in control
Others (Crohn, SLE)	No	Similar	Antibiotic prophylaxis; slightly higher risk of peri-implant health problems. Assure that patient will keep adequate oral health maintenance. Place implants when mucosal disease is in control

(*continued on next page*)

Table 1
(*continued*)

Condition	(Relative) Contraindication	Implant Survival Rate	Precautions/Recommendations
Pemphigoid	No	Similar	Antibiotic prophylaxis; slightly higher risk of peri-implant health problems. Assure that patient will keep adequate oral health maintenance. Place implants when mucosal disease is in control
Pemphigus	No	Similar	Antibiotic prophylaxis; slightly higher risk of peri-implant health problems. Assure that patient will keep adequate oral health maintenance. Place implants when mucosal disease is in control
Smoking	Yes	Similar/ reduced	Implant survival is reduced, in particular for the maxilla, in heavy smokers. Increased risk of per-implantitis
Titanium allergy	Yes	Reduced	Use alternative implant material, for example, zirconium

Abbreviation: MRONJ, medicine related osteonecrosis of the jaw.
From Vissink A, Spijkervet FKL, Raghoebar GM. The medically compromised patient: are dental implants a feasible option? Oral Dis 2018;24:257–8; with permission.

Table 2
General algorithm for all implant cases

Stage	Item Number	Mental Checklist	Material Checklist
Evaluation and treatment planning	1	Evaluate chief complaint, history of present illness, past dental and surgical history, medications, allergies, social history, and review of systems	Written records made
Evaluation and treatment planning	2	Extra-oral and intra-oral examination of soft and hard tissues, not limited to radiograph, dental charting, periodontal probing, diagnostic models, esthetic review, current prosthesis review	Radiographs, models, photographs, and charting complete
Evaluation and treatment planning	3	Deliberation of background information and the generation of potential options	Tentative treatment plan(s) written
Evaluation and treatment planning	4	Referral for consultation to surgical specialist	Narrative for specialist with tentative plan(s) mailed
Evaluation and treatment planning	5	Discussion with specialist about background information and the generation of potential options	Team-based treatment plan(s) created
Restorative phase	6	See specific algorithms (Tables 6, 7, 9 and 10)	See specific algorithms (Tables 6, 7, 9 and 10)
Maintenance phase	7	Well maintained implant and prosthetic(s)	Home care instructions annotated in notes, and 3- to 6-mo recall visit scheduled, and keratinized tissue band always examined for sufficiency

Table 3
Flow chart for implant treatment: extra-oral variables

Structures	Fixed Implant Prostheses	Removable Overdenture
Facial support	Unnecessary	Evaluate with (out) prosthesis
Esthetic plane	Convex profile	Concave profile
Maxillomandibular relationship (angle class)	Class I/II	Class III (needs compensation)
Lip support	Entire lip thickness display	Thin upper lip
Smile line during function	Low	Average/high during speech
Vestibular space	Little	Increased during smile
Horizontal tooth display	6–10 teeth	10–14 teeth
Length upper lip	Long (26–30 mm) 2.2-mm upper central view	Short (16–20 mm) 3.4 upper central view

From Zitzmann NU, Marinello CP. Treatment plan for restoring the edentulous maxilla with implant-supported restorations: removable overdenture versus fixed partial denture design. J Prosthet Dent 1999;82(2):189; with permission.

articulators with face bow transfer and reproducible Centric Relation, occlusion, and maximum intercuspation. These three-dimensional benchmarks will give the practitioner a position of occlusal function, tooth alignment, and the ability to correct occlusal discrepancies if required. The esthetic zone can be mapped out in order for proper implant placement in relation to the hard and soft tissue of the alveolar ridge. An achievement will allow an achievement of facial form and function that the patient can both comment on and critique so that their perception of the prosthesis is considered as well.[1,8] Most significant is the aid of diagnostic casts in determining the vertical distance of the crown to bone based on the severity of ridge resorption. The distance can provide a "template "for the oral surgeon to build on using bone augmentation strategies.[1] Study casts can also provide a template for surgical guides' radiologic imaging utilizing volumetric.[11]

Bone and Soft Tissue Augmentation Strategies

Surgical-prosthetic reconstruction complexity is increased because this procedure is carried out on a wide variety of patients whose unique alveolar bone positions and facial references require patient-specific surgical-prosthetic customization. Customization almost always increases

Table 4
Flow chart for implant treatment: intraoral variables

Structures	Fixed Complete Denture	Removable Overdenture
Mucosal quality	Keratinized; nonmovable	Nonkeratinized/movable/ grafting?
Mucosal quantity	Thick	Thin
Bone quantity		
Ridge palpation buccal/crest	Buccal (convex); crest (round/ wide)	Buccal (concave) crest; thin/ sharp Bone grafting?
Incisal papilla position	Palatal	Crest/buccal
Crown/bone/interarch space		
Clinical crown length: 10.5 mm	Optimal	Too long (large vertical space)
Tooth size/arch discrepancy	No	Yes
Speech disruption: phonetic	No	Yes
Bone quality	Type I Type II	Type III Type IV

From Zitzmann NU, Marinello CP. Treatment plan for restoring the edentulous maxilla with implant-supported restorations: removable overdenture versus fixed partial denture design. J Prosthet Dent 1999;82(2):190; with permission.

complexity. If the patient has an ideal amount and position of bone on the maxilla and the mandible, and if an ideal amount of prosthetic space is available, then the case is relatively simple. However, as more of these variables that fall outside of ideal, more customization is required. When bone is insufficient, customized bone grafting increases the case complexity. If a patient has insufficient bone in the maxilla or mandible in the vertical or horizontal dimension, bone augmentation is needed, and complexity naturally increases. Vertical augmentation procedures range from the very complex, like distraction osteogenesis, block graft, and interpositional bone grafting, to the moderate sinus augmentation, and to the mild use of particulate grafting.[12] Horizontal bone augmentation is generally mild to moderate in complexity.[12]

There is a wealth of material describing various techniques for bone augmentation, which provides a foundation that either "matures" over a period of months or allows for immediate function by biomechanical loading of implants.[12–16] Classification systems such as the schematic of Lekholm and Zarb[13] allows the surgeon an algorithm to craft the volume and density of bone required for a single unit, partially edentulous and edentulous arch restorations when planning the foundation for complex cases. Most patients who present with complex deficiencies request an "immediate surgical approach" to provide esthetics and function without the removal of an appliance. Jensen[14–16] has published numerous evidence-based studies that measured an "ideal" vertical and horizontal volume required for immediate loading of dental implants in complex cases. Immediate function is ideally the goal for prosthetic rehabilitation and depends on mechanical fixation of the implant and not how much bone is present or required by augmentation to function. Jensen[17] has developed a complete arch site classification for immediate function using an all-on-4 design in the maxilla and mandible. **Tables 5 and 6** describes the classification system based on length, width, and angulation within the cortical bone in the maxilla and mandible. Jensen's data on 100 consecutive all-on-4 treatment cases, 54 in the maxilla and 46 in the mandible, provided greater than 95% success for immediate function.[17] These results suggest that grafting may not be required as long as there is enough cortical bone that provides a foundation for implant fixation and function. The choice of whether to use an immediate or delayed approach must be based on a discussion by the surgeon with the patient regarding risks and benefits of each method.

Radiologic Imaging

Three-dimensional computed tomography (CT) is the standard of choice to provide a "roadmap" of available bone for dental implant placement, and the introduction of cone-beam computed tomography (CBCT) with virtual reconstruction has provided a new "dimension" for precision of treatment planning.[18] The combination of implant software and imaging allows the surgeon to carefully avoid anatomic barriers, that is, pneumatized

Table 5
Complete arch classification for all-on-4 immediate function

Class of Cortex	Maxilla	Mandible
A		Sufficient vertical bone in posterior; anterior implants placed into canine region; 4 vertical implants placed 20 mm apart, interarch span 60 mm; cantilevered prosthesis not necessary
B		Several millimeter vertical bone above canal; angled implant to avoid mental foramen; implants can be placed in second premolar region and cantilevered; 2 anterior implants can be placed perpendicular to ridge; 4 implants are spaced 15 mm apart with interimplant arch between 40 and 345 mm; 5 mm vertical bone above the nerve
C		Little or no vertical above the foramen; angled implant forward in the first premolar region;10-mm cantilever and no first molar; anterior implants spread equally angled 30° to midline and extending apically in a V formation; anterior/posterior spread between 10 and 12 mm; interimplant distance of 4 implants between 30 and 40 mm. Can have an all-on-3 to increase A/P spread
D		<10 mm vertical height; 3 implants with posterior angled toward midline. IAN visible; implant perforate inferior border; 1 single central implant A/P spread 8 and 12 mm with interimplant span 25–35 mm; 3 implants adequate for immediate function

Table 6
Complete maxillary arch classification for All-On-4 immediate function

Class of Cortex	Maxilla
A	This class has a thick palatal wall of bone. Anterior implants are placed 20 mm or > forward. And angled back to create an M shape at 30°. A; engage at the M for maximum bone mass which is mostly seen in men
B	Class B has moderate bone atrophy with a relatively thin palatal wall. Posterior implants are placed at the 2nd premolar area and angled 30° forward to form an M. Anterior implants are placed in the canine area and angled back towards the M point
C	Class C maxilla alveolar bone is absent, and trans-sinus implant placement is required. Second premolar location is an alternative. The M point is reduced in volume and anterior implants engage the midline bone referred to as the V point. Anterior implants are angled at 30° forward from canine into the nasal crest; vomer implants. All converge toward the Midline; 2 of which were grafted in sinus and 2 at vomer area. A/P spread is 10–15 mm with 45 mm inter-arch span.
D	Has no M point but has V point. Good for zygomatic implant Placement. BMP needed if no sinus grafting Pterygoid implants are a choice. A V-4 approach can be used but 2 anterior implants must have a high torque value but if not available then zygomatic implants are recommended with delayed loading.

Data from Jensen OT. Complete arch site classification for all – on – 4 immediate function. J Prosth Dent. 2014;112:741–51.

sinuses and resorbed nerve canals, and can also aid in fabrication of surgical guides, which reproduce mutual landmarks improving accuracy between virtually planned and "real-life" insertion of implants.[19] A systematic review by Tahmaseb and colleagues[19] characterized greater accuracy with implants, CT, and the final surgical guide for immediate loading of mini-implants. Although these approaches have significant benefits, caution is indicated. Intraoperative mishaps can occur, such as movement of the guide during placement of implants. Another frequent complication is the fracture of the surgical guide, which must be considered before so that an alternative surgical plan can be implemented in order to avoid early loss of implants due to lack of primary stability.[19] An impaired surgical guide is of great concern in complex cases where a "domino effect" can occur, resulting in both early and late complications with irreparable damage to anatomically vital structures and future rescue restorations. Future studies measuring template stability are being tested, especially in fully edentulous patients who are devoid of reference markings when compared with partially dentate ridges that provide greater accuracy due to surrounding supporting hard tissue. (The reader is referred to the references for further information.)

COMPLEX CASE PRESENTATIONS

Why is the perception of a case's simplicity/complexity necessary, when the steps to completing a case can be rationally arranged and then carried out according to the logical order of operations?

If patients did not require the emotional management of expectations, executing this rationale of arranged steps would be the only activity necessary, and grading the case's complexity would be valueless. Patients with complex restorative issues require a tremendous amount of emotional management of expectations, and the disclosure of the provider's subjective perception, including the case's perceived level of complexity, is imperative.[20,21] The following represents 4 basic categories of implant restoration that can be considered complex: (a) implant-supported single crown; (b) implant-supported fixed-partial denture; (c) implant-supported/attachment-retained removable overdentures; (d) implant-supported fixed dentures (hybrid).

Implant-Supported Single Crowns

Table 7 depicts the algorithm applied to a single-unit fixed implant treatment plan. If the bone and soft tissue are in the ideal place, then the single-unit fixed implant case can be considered simple. Generally speaking, however, a single, anterior, edentulous space rarely has the bone and soft tissue at an ideal position and therefore is not likely to be considered simple. To verify if the case is simple or complex before extraction of an apparently ideal looking site, bone around the mesial, facial, and distal surfaces are measured to see if the patient has less than or equal to 3 mm, 5 mm, and

Table 7
Specific algorithms for the implant-supported fixed single crowns and partial denture cases

Stage	Item Number	Mental Checklist	Material Checklist
Evaluation and treatment planning	1	Smile height for esthetic cases	Photograph of high smile and document prosthetic-tissue interface's position relative to the lips
Evaluation and treatment planning	2	Bone considerations for implant placement	CBCT reviewed
Evaluation and treatment planning	3	Interarch and intra-arch spacing considerations	Measure distances on mounted models and CBCT
Evaluation and treatment planning	4	Evaluation of the surrounding dentition's color and translucency	Evaluate the patient
Evaluation and treatment planning	5	Evaluation of the potential esthetic prognosis	Bone sounding and visual examination of smile
Presurgical work	6	Optimize the surgical experience	Fabricate surgical template and temporary
Surgical phase	7	Idealized implant placement is communicated	Surgical template is used by surgeon
Surgical phase	8	Patient has reasonable temporization	Temporary is delivered to surgeon and surgeon delivers temporary
Surgical phase	9	Patient is healed and approved by surgeon for restoration	Approval letter with implant size(s) and brand(s)
Restorative phase	10	Soft tissue site is idealized with temporary	Photograph or view of site approved by patient
Restorative phase	11	Impression coping(s) seating position is verified by radiograph	Radiograph of seated impression coping(s), opposing model, bite record, shade, photographs
Restorative phase	12	High-quality impression of implant(s) and relevant dental anatomy	Elastomeric impression with impression coping seated with implant replica
Restorative phase	13	High-quality prosthetic(s) fit on laboratory cast	Master models with implant replica and prosthetic(s)
Restorative phase	14	High-quality single-unit prosthetic(s) delivered to patient	Radiograph of prosthetic(s) torqued to manufacturer's recommendation, and any excess cement removed and patient satisfaction are documented
Restorative phase	15	Patient aware of oral hygiene and maintenance needs	Oral hygiene and maintenance instructions documented, including need to keep implant clean
Maintenance phase	16	Well-maintained implant and prosthetic(s)	Home care instructions annotated in notes, and 3- to 6-mo recall visit scheduled

3 mm, respectively, from the mesial to distal of the contact point and free-gingival margin to the bone. If the space does not exceed these distances, and there is adequate width and height of bone, then the case will be relatively simple. Whereas, a case whose bone sounding measures depths beyond those shown in **Fig. 1**, like in **Fig. 2**, will be moderate to very difficult, as the tissue will relapse to positions that are not in accordance with the ideal. The complexity will then be based on the provider's competence in using technology, interpersonal effectiveness within a multidisciplinary team, and knowledge of justified true-beliefs for the development of the insufficient tissues.

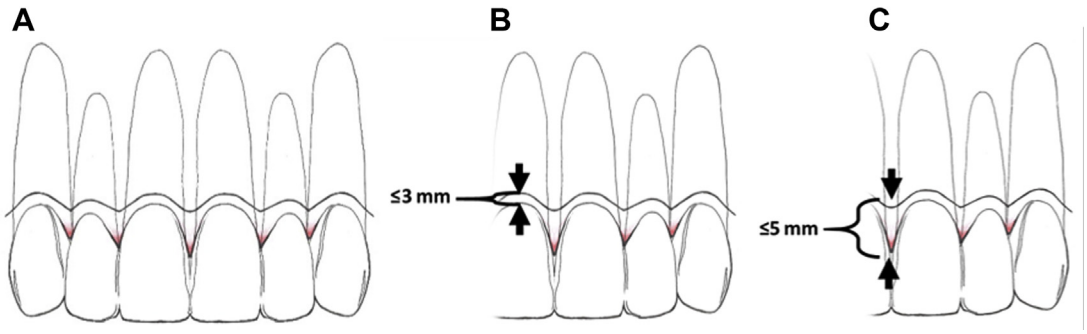

Fig. 1. (*A*) The ideal free-gingival margins and the ideal alveolar bone crests. (*B*, *C*) The ideal space between the contact point and free-gingival margins and the alveolar bone crests. Note that the distance at the buccal surface on (*B*) is 3 mm from the contact point and free-gingival margin to bone, and on (*C*) it is 5 mm on the mesial and distal surfaces.

Anterior maxillary single teeth

Single-tooth replacement in the anterior maxilla should include gingival position, bone levels at the alveolar crest, dimensional proportions of teeth adjacent to the replacement region, and bone quality; that is, apical levels, canine eminence, and prior periapical disease.[22] Surgical methods for socket preservation and/or bony augmentation of ridges vary, as well as timing of implant placement and loading.[14,23] The latter are predicated upon previous invasive surgery as well as whether an immediate implant is scheduled for placement. Grafting of the extraction site, however, does not guarantee anatomic resolution of the gingival margins. Adjunctive soft tissue grafting and crown lengthening have been used with good success. In a retrospective study by Axiotis and colleagues,[23] the one-piece implant with a smooth concave neck preserved marginal bone levels as well as increased space for soft tissue maturation and the establishment of a biologic width.[24,25]

If the position of the ideal free-gingival margins of the papilla and zenith point is located away from the alveolar bone crest, and the contact point is in the ideal esthetic position, then one can assign the complexity as simple. Ideally, the tissue would look like the illustration in Fig. 1 and will have adequate bone height and width. If the alveolar bone and attached/free-gingival tissues are not in the ideal positions, like in Fig. 2, then the case moves away from the simple side of a complexity continuum. For instance, if before extraction, in a pending implant site, the free-gingival margin extends from the ideal position of the papilla to the interproximal bone in less than 5 mm, then the case is likely simple (see Fig. 1). If in the same case, the ideal free-gingival margin extends from the zenith point in a distance greater than 3 to 4 mm, then the case is likely going to be complex. In Fig. 3, vertical aspects of the natural tissue were missing at the time of placement of the implant, and this led to the often times overlooked complexity of delivering an ideal-looking outcome, despite the fact that the supporting tissues are not present. When aspects of the natural tissue are not in the ideal position, then competence in using technology, interpersonal effectiveness within a multidisciplinary team, and knowledge of justified

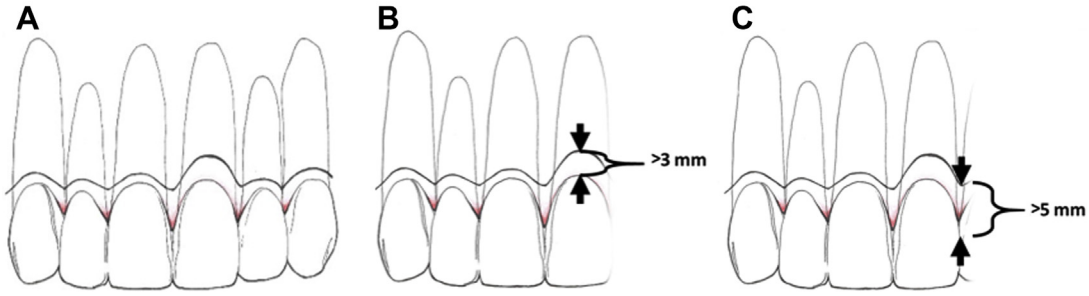

Fig. 2. (*A*) The nonideal gingival margins and the nonideal alveolar bone crests. (*B*, *C*) The nonideal space between the contact point and free-gingival margins and the alveolar bone crests. Note in (*A*) that the distance at the buccal surface is greater than 3 mm from contact point and free-gingival margin to bone. Note in (*B*) that the space is greater than 5 mm on the mesial and distal surfaces. These illustrations are models of complex cases.

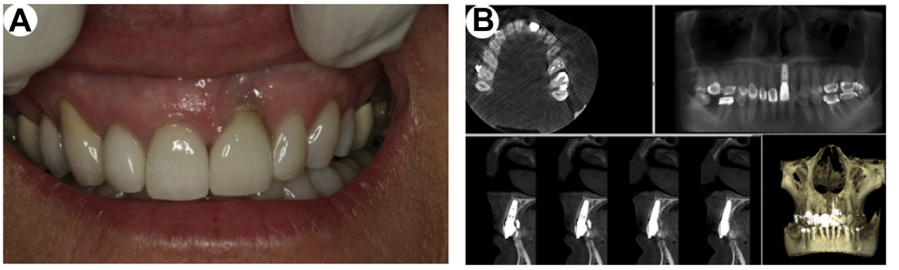

Fig. 3. The definitive effect of an implant placed in a site where the presurgical relationship of the nonideal free-gingival margin and the nonideal alveolar bone crest were greater than the ideal distances. (*A*) Facial photograph showing the nonideal tissue appearance. (*B*) CBCT scan showing the high apical positioning of the implant platform. (*Courtesy of* Nicholas Egbert, DDS, MSD, Salt Lake City, UT.)

true-beliefs, will be challenged as the provider subjectively determines the complexity of a case. Fig. 4 portrays a case where the mesiodistal bone width was limited, due to congenitally missing lateral incisors. Although the surgeon might have opted to exercise a multidisciplinary team and widen the space with an orthodontist, the use of a smaller-diameter implant technology simplified the case and allowed for the outcome shown in the radiograph. The latter supports how subjectivity of complexity depends on the provider's innovative ability with technology in creating a successful prosthetic foundation.

Following the surgical preparation of this case, the restorative dentist's capacity for using material technology, interpersonal effectiveness with a laboratory team, and knowledge of justified true-beliefs regarding restorative materials are used to resolve the complexity of the case. In the case described, the restorative options pictured in Fig. 5 could be considered. The breadth of options underlines the potential complexity due to material options in restoring single units. This case is in the esthetic zone so the complexity is inherently greater than one in the nonesthetic zone, but because the implants were one-piece implants and therefore the abutments could not be altered for position or color, the case became more complex. Although it would seem that if by using a one-piece implant and not adding more material abutments to the situation this would simplify the process, why is it more complex? The complexity comes from the absolute necessity of knowing the justified true-beliefs requisite to mask the silver one-piece implant abutment. The case becomes more complex, when, in addition to masking, the ceramic must also be translucent enough to match the surrounding dentition's translucency. Finally, there is the issue of interpersonal effectiveness of working with a laboratory team that can also add to the complexity. In this case, the implant company no longer made components to impress this case after the patient experienced trauma that compromised the anterior crowns, following years of successful integration. The creative workflow for restoring the one-piece implants is shown in Fig. 6, which the laboratory and the restorative dentist underwent to fabricate the proper laboratory materials, and the final restorative image is shown in Fig. 7 on the day of delivery.

Horizontal biologic issues like the aforementioned case are challenging; however, the vertical biologic issues are usually more difficult. Fig. 8 shows a case whereby the vertical bone was compromised and the CBCT scan confirmed the vertical buccal bone problems. The management of this issue starts at the diagnostic appointment. If the scan cannot be obtained, then bone sounding can be used to help with the diagnosis and prognosis. The bone

Fig. 4. A patient with minimal space between the central incisors and the canines. (Images were made at least 5 years after the implant placement.) (*A*) Facial photograph showing the final placement of one-piece implants in sites 7 and 10. (*B*) Periapical image of number 10 showing the very narrow space between teeth 9 and 11. (*Courtesy of* [*A*] Juan Olivier, CDT, MDT, FACE, Draper, UT.)

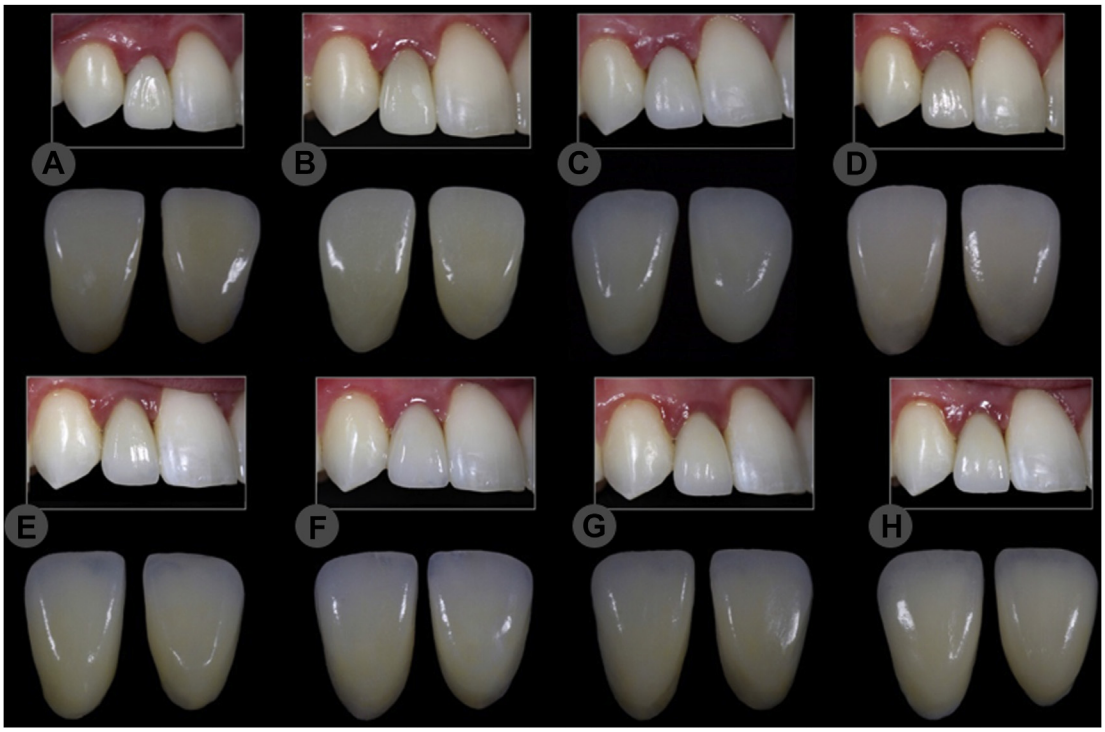

Fig. 5. Clinical images of a small sampling of potential restorative options available to restorative dentists. Notice the translucency differences. (These crowns were fabricated to fit the patient shown previously in Fig. 4, but were fabricated and photographed for educational purposes only by Juan Olivier.) (*A*) Multilayered, full-contour (moderate-strength), zirconia crown with glaze/stain. (*B*) Monochromatic, full-contour (high-strength), zirconia crown with glaze/stain. (*C*) Zirconia substructure (high-strength) with porcelain on the entire substructure. (*D*) Full-contour, high-translucency, lithium-disilicate crown with glaze/stain. (*E*) Low-translucency, lithium-disilicate substructure with porcelain stacked/layered on the entire substructure. (*F*) Medium-translucency, lithium-disilicate substructure with porcelain stacked/layered on the entire substructure. (*G*) Medium-opacity, lithium-disilicate substructure with porcelain stacked/layered on the entire substructure. (*H*) High-opacity, lithium disilicate substructure with porcelain stacked/layered on the entire substructure. (Courtesy of Juan Olivier, CDT, MDT, FACE, Draper, UT.)

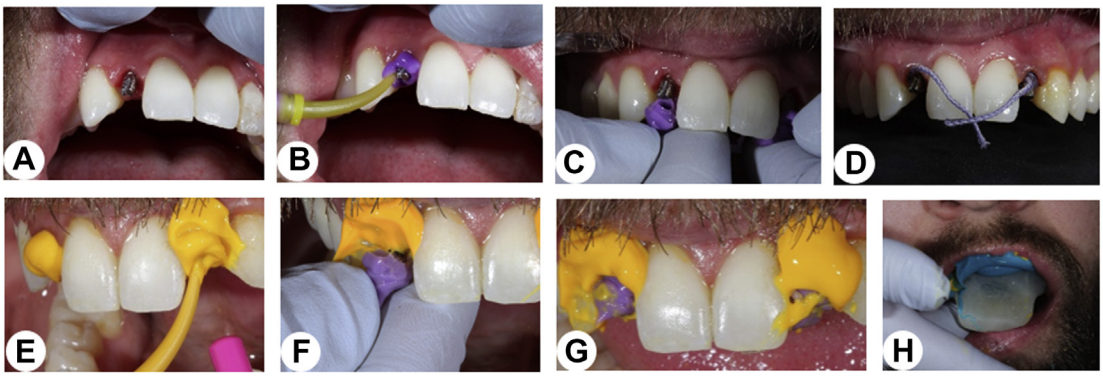

Fig. 6. Clinical image showing a patient with minimal space between the central incisors and the canines, who is going through the steps to restore two single-piece implant body implants. Because the Implant is no longer manufactured, the appropriate parts for impressing are not available. (*A*) Shows the implant site to be impressed. (*B*) Shows the use of bite registration replica to capture the emergence profile. (*C*) Shows the captured emergence profile. (*D*) Shows gingival retraction. (*E*) Shows a light viscosity elastomeric impression. (*F*) Shows the emergence profile replica to be used to ensure a better capture of the emergence profile. (*G*) Shows the use of the bite-registration replica to retract the gingival tissues. (*H*) Shows the elastomeric impression material within a custom tray for the final impression. (Courtesy of Juan Olivier, Draper, UT.)

Fig. 7. The final patient case restored on 2 one-piece dental implants. Medium-translucency, lithium-disilicate crowns, with porcelain layered on the entire substructure for teeth 7 and 10. The objective was to copy the adjacent shade and translucencies, while still masking out the silver abutments that were positioned facially, relative to the ideal, due to the natural trajectory of one-piece implants following the natural pitch of the maxilla (see Fig. 4). These competing variables make the restoration more complex. Laboratory attribution to/photography from Juan Olivier. (Courtesy of Juan Olivier, CDT, MDT, FACE, Draper, UT.)

sounding will allow the provider to find large vertical discrepancies and determine if additional considerations might be needed. For instance, if a provider bone sounded an ideal looking free-gingival margin to discover bone loss like that pictured in Fig. 9, then additional esoteric understanding of biologic nuances would be needed to reconstitute an ideal-looking periodontal architecture. Fig. 8 shows how the provider managed the vertical defect using a host of carefully executed biologic processes to obtain an ideal outcome.

Posterior maxillary/mandibular single tooth

The placement of a posterior implant and subsequent loading has been debated due to forces on the site restored. It is advantageous to graft in the hopes of restoring ideal width and height to withstand the biting forces. Careful designing of flaps to avoid vascular compromise as well as watertight closure for graft maturation is the primary goal in implant surgery of the posterior jaw.[12,17,22,24]

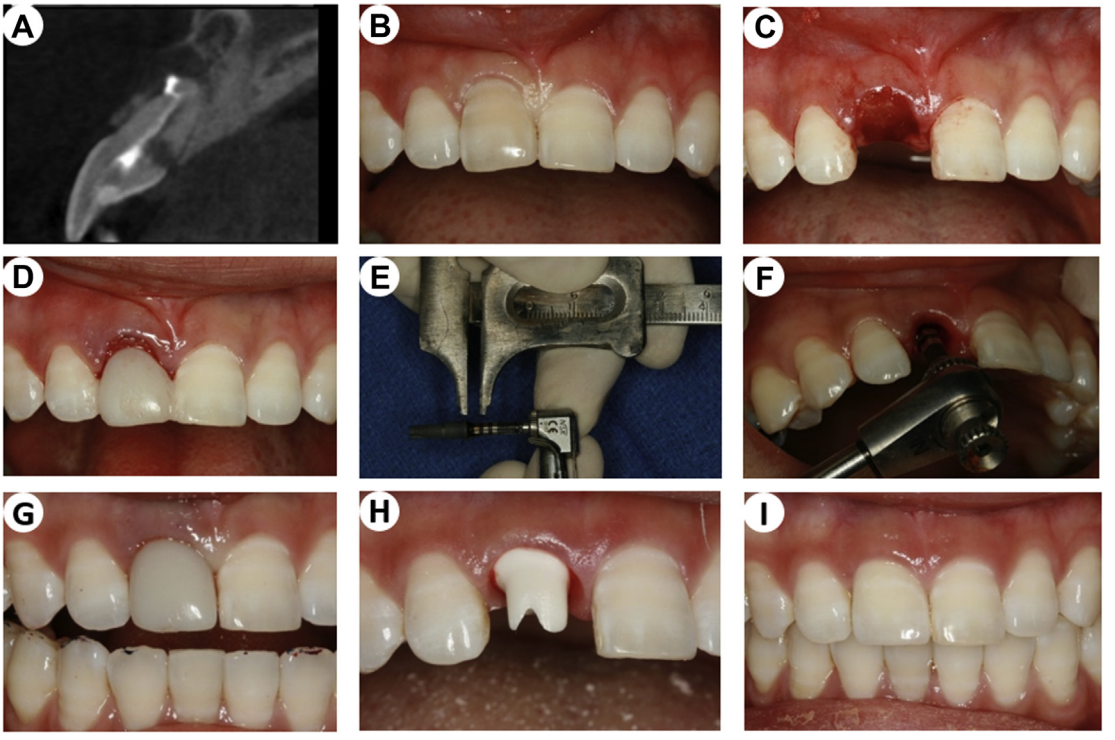

Fig. 8. These clinical photographs show socket preservation with a temporary, fixed-partial denture, using an ovate provisional occluding the graft, because buccal plate was present. If the buccal plate was not present, more aggressive GBR with a membrane would be necessary. After 4 months of healing, an immediate fixed "tissue-molding" screw-retained provisional, out of occlusion, was delivered and properly managed. Case attribution to/photographs from Dr Nicholas Egbert. (*A*) Diagnostic CBCT imaging of tooth number 8. (*B*) Presurgical photograph. (*C*) The extraction site and socket preservation. (*D*) Temporary, fixed-partial denture, with an ovate pontic occluding the grafted site. (*E*) Measuring to obtain a 3-mm distance to the ideal contact point and free-gingival facial margin. (*F*) The implant placement. (*G*) The implant-supported provisional to immediately temporize the implant. (*H*) High-strength zirconia abutment to optimize the crown and gingival colors. (*I*) The final restoration with ideal free-gingival margins. (Courtesy of Nicholas Egbert, DDS, MSD, Salt Lake City, UT.)

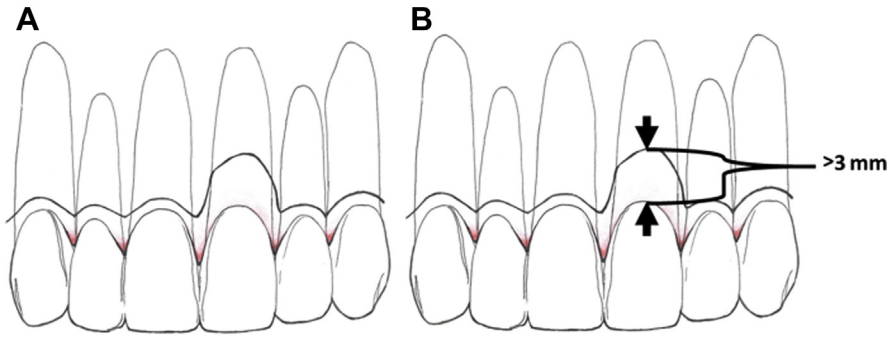

Fig. 9. (*A*) The nonideal gingival margins and the nonideal alveolar bone crests. (*B*) The nonideal space between the free-gingival margins and the alveolar bone crests. Note that the distance at the buccal surface is greater than 3 mm from free-gingival margin to bone. This is a complex case.

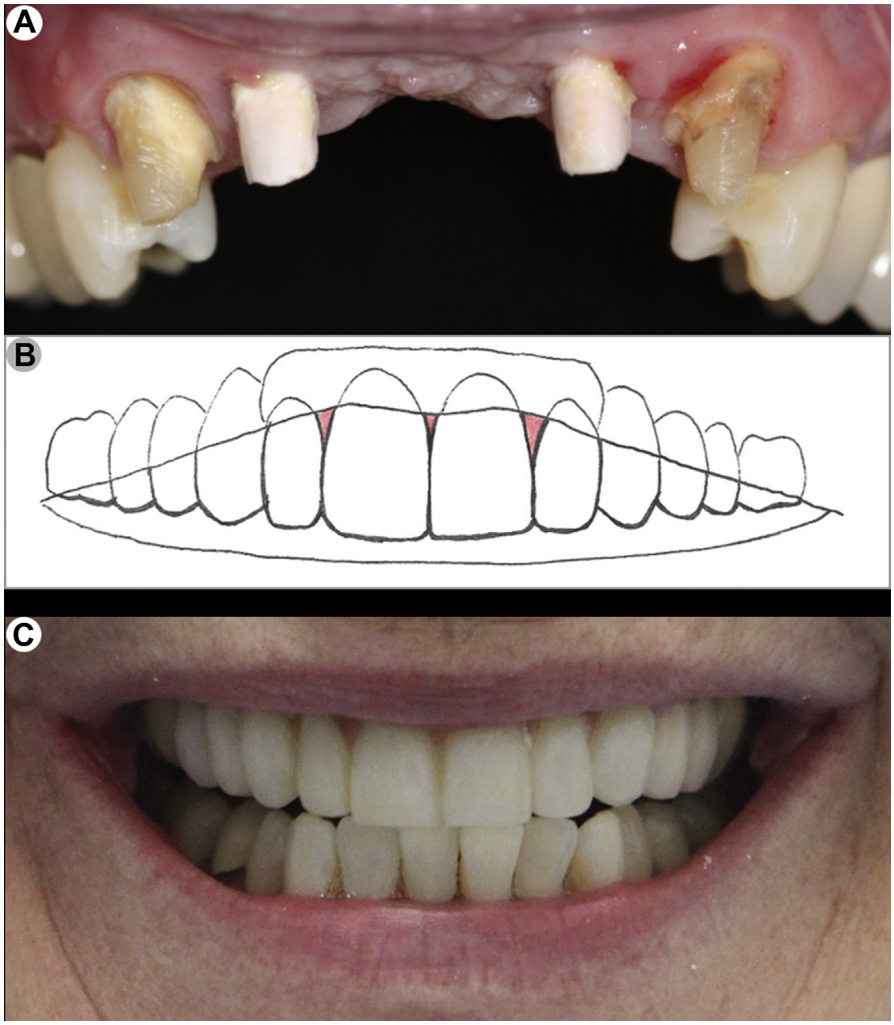

Fig. 10. (*A–C*) A case where the prosthetic's interface to the tissue is covered by the lip. (*A*) The edentulous site when the lip is fully retracted. (*B*) Why the lip is so useful in simplifying these cases. (*C*) A restorative image of the case showing the benefit of hiding the prosthetic-tissue interface.

Successful outcomes of 95% have been reported with regard to long-term predictability of immediate function in the posterior jaw. A retrospective 5-year follow-up study by Mura[24] demonstrated a less than 0.56-mm marginal bone loss in posterior implant placement. Esposito and colleagues[25,26] using the *Cochrane Database of Systematic Review* randomized clinical trials (RCT) concluded advantages in immediate posterior implant placement/functioning by patient esthetics and satisfaction. Although these results are encouraging, care must be taken in interpreting their generalizability. Practitioner protocols exist with respect to preservation of alveolar bone, overall oral health of the patient, type of bone substitutes, and timing of follow-up of patients postoperatively. (The reader is referred to the list of references.)

Implant-Supported Fixed-Partial Denture

All multiunit implant cases that will support fixed-partial dentures, in the subjective assessment of these authors, are worthy of complex status. However, there is a continuum of complexity in multiunit cases that can help assign complexity more distinctly. Generally speaking, a multiunit case whose tissue-prosthetic interface (**Fig. 10**) hides behind the lip is considered relatively simple on a multiunit complexity continuum. A multiunit case whose tissue-prosthetic interface is visible below the maxillary lip is notably more complex on a multiunit complexity continuum (**Fig. 11**). The case shown in **Fig. 10** only required adequate bone and connective tissue to support the dental implants; then prosthetic replica tissues were simulated to manage the existing defects below

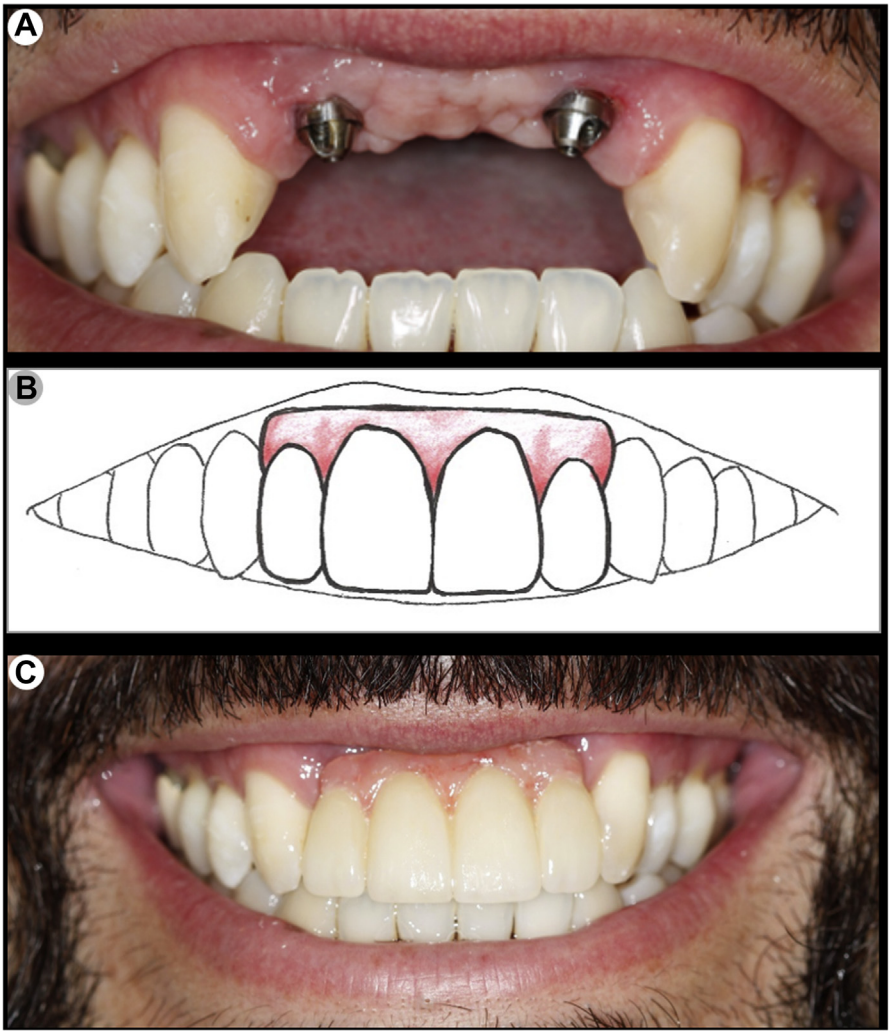

Fig. 11. A case where the prosthetic's interface to the tissue is visible. (*A*) The edentulous site. (*B*) Why the harsh borders of the prosthesis are so hard to disguise when visibly placed below the lip. (*C*) A restorative image of the case showing the entire tissue-prosthetic interface.

the lip. Although this case is admittedly complex, these cases are far simpler than when the interface is visible. So the case in Fig. 11 is more challenging than the one pictured in Fig. 10, because it requires the margin of the replica gingival tissue that sits against the periodontium to be both hygienic and esthetic. Because it is the case that ideal hygiene can exist only when esthetics are deprioritized, the margin interface usually has a very artificial appearance, because this interface,

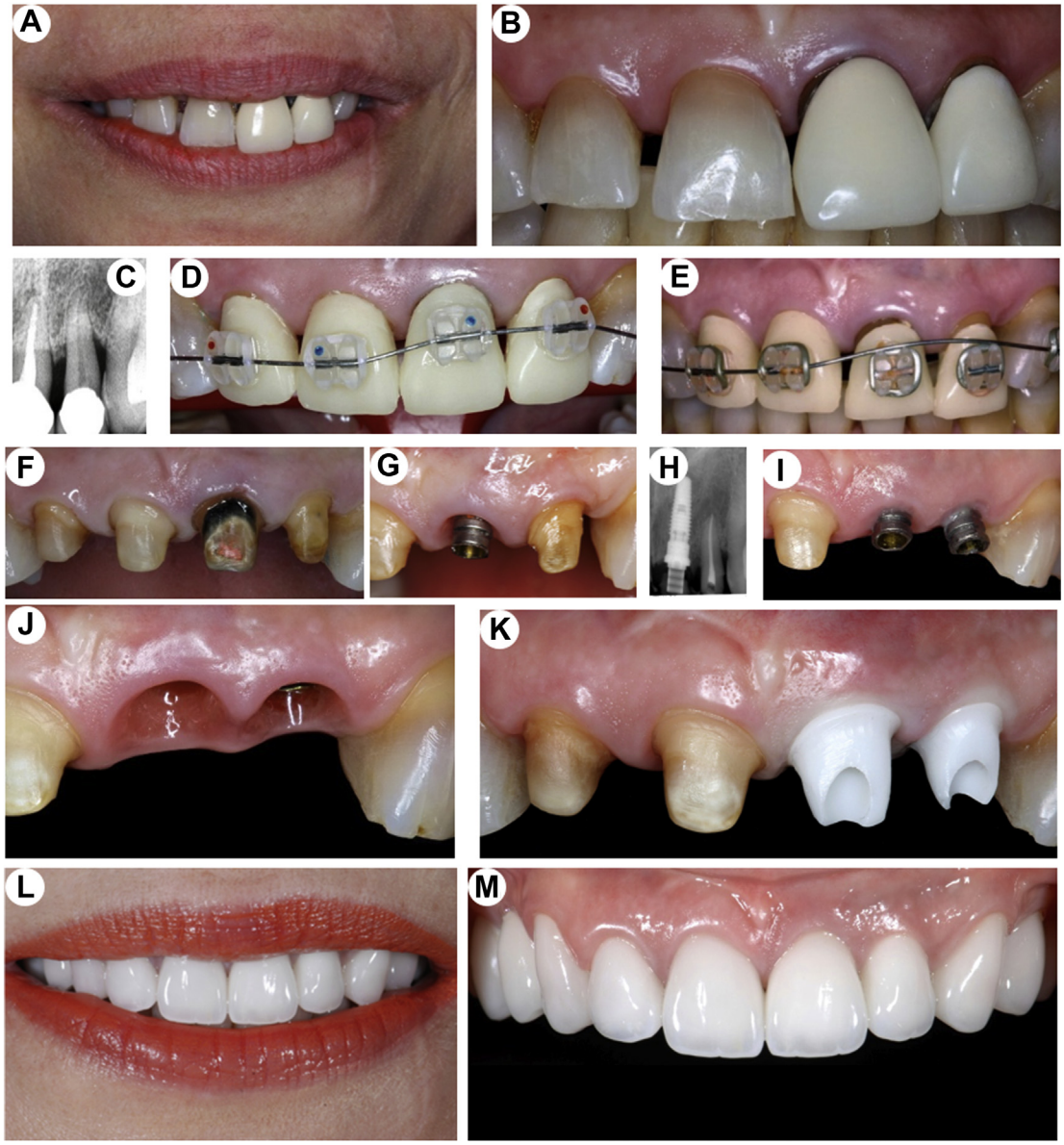

Fig. 12. (*A–M*) A case where the biologic environment surrounding the potential implant sites is compromised in a multitooth space. (*A*) Preoperative smile photograph. (*B*) Preoperative intraoral photograph. (*C*) Preorthodontic periapical film showing extent of bone loss. (*D*) Photograph of preorthodontic starting position with patient in provisionals. (*E*) Outcome of the extrusion of teeth 9 and 10 to improve biologic architecture. (*F*) Postorthodontic photograph. (*G*) One tooth extracted with immediate implant placement, followed by healing; then, the next tooth was extracted with immediate implant placement, for interimplant papilla preservation. (*H*) Radiographic view of bone levels during interimplant papilla preservation. (*I*) Preparing for site-sculpting using temporary abutments that will hold acrylic temporaries. (*J*) After site-sculpting from acrylic temporaries, with optimized emergence profile and well-matured ideal biologic architecture. (*K*) Zirconia abutments in sites 9 and 10. (*L*) Postoperative smile photograph. (*M*) Final intraoral photograph of the idealized multiunit implant sites. (*Courtesy of* Marco Brindis, DDS, New Orleans, LA.)

Table 8
Specific algorithms for the implant/attachment-supported removable dentures for edentulous cases

Stage	Item Number	Mental Checklist	Material Checklist
Evaluation and treatment planning	1	Need to know the ideal amount of prosthetic space needed and how much bone needs to be removed to obtain the ideal space	Boley gauge measurement of prosthetic space of current denture entered into the notes, and the amount of bone reduction needed
Evaluation and treatment planning	2	Define the current status of the existing prosthesis or determine if a new prosthesis is warranted	Document whether the current denture will have a prosthesis modification or a new overdenture prosthetic will be made
Evaluation and treatment planning	3	Bone considerations for implant placement	CBCT reviewed
Presurgical work	4	Optimize the surgical experience	Fabricate surgical template, bone reduction guide, and temporary
Surgical phase	5	Idealized bone position is communicated	Surgical bone reduction template is used by surgeon
Surgical phase	6	Idealized implant placement is communicated	Surgical implant placement template is used by surgeon
Surgical phase	7	Patient has reasonable temporization (most temporary solutions will require a reline)	Temporary is delivered to surgeon and surgeon delivers temporary
Surgical phase	8	Patient is healed and approved by surgeon for restoration	Approval letter with implant size(s) and brand(s)
Restorative phase	9	Definitive prosthetic fabrication is arranged	Patient is scheduled for attachment pick up if the old prosthetic will be modified, or, if a new prosthetic is to be made, the patient is scheduled for the fabrication of an attachment overdenture
Restorative phase	10	Patient is satisfied with attachment overdenture	Abutments torqued to manufacturer's recommendation, resilient liners placed with documented instructions, and patient satisfaction is documented

(*continued on next page*)

Table 8
(*continued*)

Stage	Item Number	Mental Checklist	Material Checklist
Restorative phase	11	Patient is aware of oral hygiene and maintenance needs	Oral hygiene and maintenance instructions documented, including need to keep implants clean
Maintenance phase	12	Well-maintained implant and prosthetic(s)	Home care instructions annotated in notes, and 3- to 6-mo recall visit scheduled

unlike natural tissue, must be separated from the tissue for access of hygienic instrumentation.

Both of the cases in Figs. 10 and 11 are simpler than cases whereby the tissue-prosthetic interface shows, and biologic tissue must be used to replace missing natural tissue. Prosthetic gingiva is more predictably manipulated to the ideal positions than the biologic tissues. If a practitioner desires to bring deficient tissues down to the ideal positions using biologic materials and not use prosthetic gingiva, despite a low lip line, the case would be more complex than if prosthetic gingiva was used. Prosthetic gingiva under a low lip line allows for a less complex scenario.

Some of the more challenging cases occur when multiple adjacent teeth have to be removed, because extraction of adjacent teeth leads to a cascade of massive periodontal tissue loss. Even though much of the periodontal tissue loss has occurred before the implant placement, the removal of the teeth with the implant placement really can exasperate the appearance of this tissue loss. Diagnosing and treating these situations is extremely complex and regularly requires the use of a multispecialty team. Fig. 12 shows an example of a ridge with periodontal disease that has caused severe bone loss in the esthetic zone, and the culmination of this loss manifests itself with 2 adjacent teeth, whose dual extraction would lead to even greater periodontal tissue loss.[27] However, the provider manages a multiplicity of biologic variables with a multidisciplinary team to deliver ideal outcomes. Table 7 provides the algorithms for implant-supported fixed single crowns and fixed partial dentures.

Implant-Supported/Attachment-Retained Removable Overdentures

Maxillary and mandibular attachment-retained, implant-supported, removable "overdentures" for edentulous arches are relatively simple, as long as the necessary prosthetic space is accounted for and the implant health is maintained. Table 8 shows the specific algorithms for executing the treatment involved in providing implant-supported removable dentures to patients. Complete dentures that do not need to incorporate

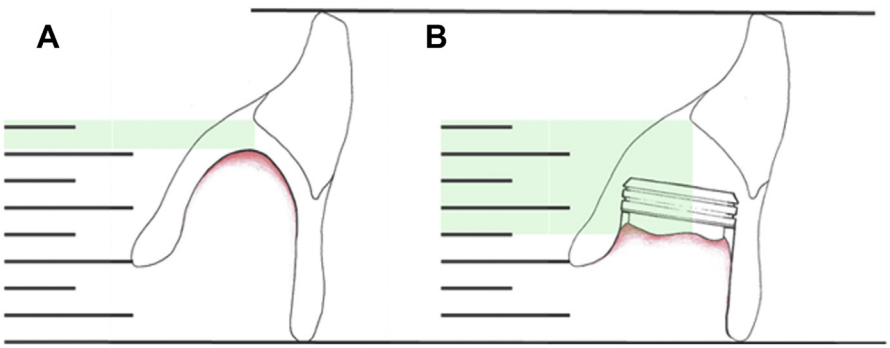

Fig. 13. (*A*, *B*) Sagittal section illustrations of prosthetics for an edentulous mandible. (*A*) A complete denture. Note the thin space from ridge crest to denture tooth. (*B*) An implant/abutment-supported removable denture for the edentulous arch (implant overdenture). Note the displacement of the ridge away from the denture tooth to provide space for the acrylic denture and the attachments.

Fig. 14. A denture is measured from the incisal/occlusal surface to the intaglio surface opposite that tooth. This is the entire distance energy will be absorbed by the materials before reaching the attachment. If the amount of material within the distance measured is less than ideal, the denture will break. Table 8 shares minimum distances from incisal/occlusal surfaces to the residual ridge to help provide sufficient material bulk to avoid prosthetic breakage.

attachments for implants can be far thinner than overdentures, because they do not need space for retaining the attachment or additional energy absorbing acrylic. Energy absorption is not necessary in conventional complete dentures because complete dentures do not have weak points caused by the cavitation into the acrylic that houses the attachment (Fig. 13), and because forces on complete dentures are far less than forces on implant-supported removable dentures. Because overdentures must incorporate attachments and be thick enough to withstand the weak points surrounding the attachment cavity, additional prosthetic space is necessary. Figs. 14 and 15 depict how to determine the minimal amount of prosthetic space between the occlusal/incisal surface to the opposite intaglio surface, to avoid the common breakages accompanying overdentures with insufficient space. Table 9 provides the minimal amount of space necessary for edentulous prosthetic solutions.

The use of implants as a restorative alternative in patients with severely resorbed ridges is commonly chosen in cases of limited prosthetic space. Complications due to deficiencies of soft tissue foundation, that is, keratinized gingiva, soft tissue hypertrophy, shallow vestibular depth, and elevated floor of the mouth, gingival hyperplasia, and mucosal irritation, will impede long-term success of implant structure and function. When bone has to be removed to accommodate for the lack of prosthetic space, or when attached tissue has to be added around mucosal-surrounded implants, cases become somewhat more complex. Traditional preprosthetic surgery, originally conceived as the only therapeutic option for complete dentures, provides a stable foundation for implant overdentures. Fig. 16 depicts a combined "lip switch" and free palatal gingival graft surgical treatment that both increased the vestibular depth and width of keratinized gingiva that "embraces" the transmucosal components of the implant without increasing tension on the mentalis muscle. As a result, the prosthesis becomes periodontally stable for long-term function. The timing of surgery has been debated with respect to simultaneous preprosthetic surgery and implant placement versus implant placement 2 to 3 months after preprosthetic augmentation before loading.[28,29]

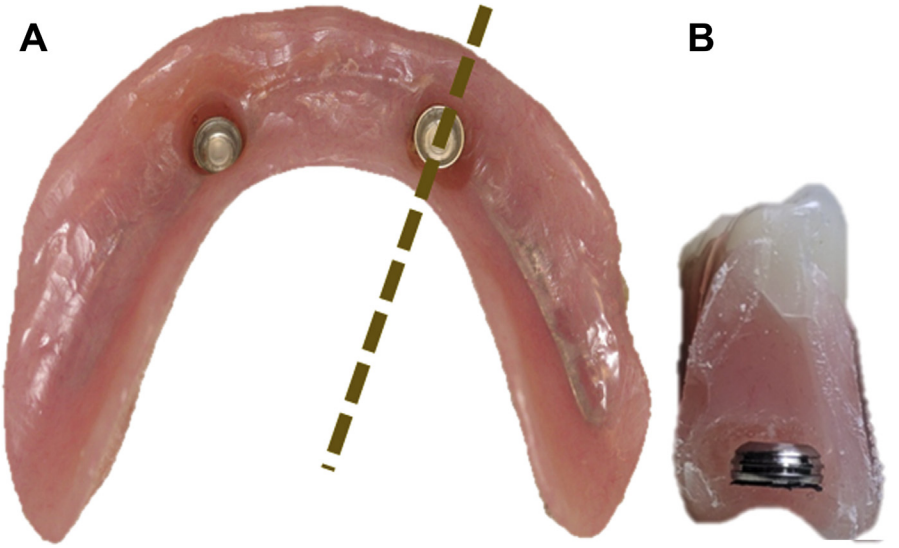

Fig. 15. (*A*) The most probable location for attachment overdenture breakages. (*B*) The overdenture from the sagittal section allows the viewer to make a visual inference as to why the breakage regularly occurs at this specific location.

Table 9
Prosthetic space considerations

Vertical	Maxillary Anterior	Maxillary Posterior	Mandibular Anterior	Mandibular Posterior	Horizontal
Attachment overdenture					
S Person	10	8	11	8	Mx. 12 mm, Md. 10 mm
M Person	12	9	13	9	
L Person	14	10	14	10	
Bar/attachment-overdenture					
S Person	12.5	10.5	13.5	10.5	Mx. 13 mm, Md. 11 mm
M Person	15	12	16	12	
L Person	17.5	13.5	17.5	13.5	
Acrylic hybrid					
S Person	11.5	9.5	12.5	9.5	Mx. 13 mm, Md. 11 mm
M Person	14.5	11.5	15.5	11.5	
L Person	17	13	17	13	
Hybrid with porcelain stacked to metal bar					
S Person (height of clinical crown)	9	6	8	6	Maxillary anterior 9 mm Maxillary posterior 10 mm
M Person (height of clinical crown)	10	7	9	7	Mandibular anterior 8 mm Mandibular posterior 10 mm
L Person (height of clinical crown)	11	8	10	8	
Hybrid with crowns cemented to metal bar					
S Person	10	10	10	10	Maxillary anterior 10 mm
M Person	10	10	10	10	Maxillary posterior 12 mm
L Person	11	10	10	10	Mandibular anterior 9 mm Mandibular posterior 12 mm

*Note these numbers are all minimum, and clinical judgment is necessary.

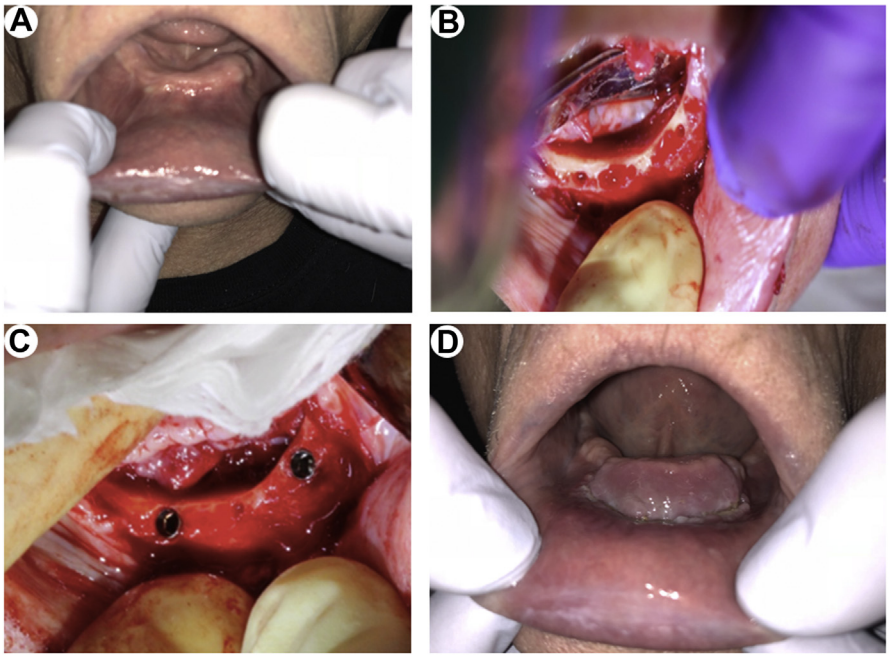

Fig. 16. (*A*) The presurgical vestibule on the mandible. (*B*) Exposure of the site. (*C*) Implants in situ. (*D*) Two-week postoperative deepened vestibule with covered implants for subsequent loading. (Courtesy of David Adams, Salt Lake City, UT.)

Table 10
Specific algorithms for the implant/attachment-supported removable denture for dentate cases

Stage	Item Number	Mental Checklist	Material Checklist
Evaluation and treatment planning	1	Dental labial and overjet:overbite ratio determined	Ideal length of teeth documented, including overbite changes
Evaluation and treatment planning	2	Need to know the ideal amount of prosthetic space needed and how much bone needs to be removed to obtain the ideal space	CBCT reviewed
Evaluation and treatment planning	3	Get ideal position of teeth to plan case	Mounted models of ideal positions of teeth
Presurgical work	4	Optimize the surgical experience	Fabricate surgical template, bone reduction guide, and temporary
Surgical phase	5	Idealized bone position is communicated	Surgical bone reduction template is used by surgeon
Surgical phase	6	Idealized implant placement is communicated	Surgical implant placement template is used by surgeon
Surgical phase	7	Patient has reasonable temporization (most temporary solutions will require a reline and immediates will require additional restorative follow-up)	Temporary is delivered to surgeon and surgeon delivers temporary (appointment(s) with restorative dentist will be needed for the immediate denture)
Surgical phase	8	Patient is healed and approved by surgeon for restoration	Approval letter with implant size(s) and brand(s)
Restorative phase	9	Definitive prosthetic fabrication is arranged	Patient is scheduled for attachment pick up if the immediate will be modified, or, if a new prosthetic is to be made, the patient is scheduled for the fabrication of an attachment overdenture
Restorative phase	10	Patient is satisfied with attachment overdenture and instruction provided	Abutments torqued to manufacturer's recommendation, resilient liners placed with use instructions, and patient satisfaction is documented
Restorative phase	11	Patient aware of oral hygiene and maintenance needs	Oral hygiene and maintenance instructions documented, including need to keep implants clean
Maintenance phase	12	Well-maintained implant and prosthetic(s)	Home care instructions annotated in notes, and 3- to 6-mo recall visit scheduled

Procedures for patients who want to convert their natural teeth to overdentures are more complicated than those for patients who are converting an edentulous ridge with a complete denture to an overdenture. **Table 10** shows the specific algorithms for converting compromised dentitions to implant-supported removable dentures. Patients with natural teeth who will convert to an overdenture have the following 3 additional factors that add complexity to the case. First, natural overbite and overjet relationships in natural teeth are rarely ideal to transfer to the immediate denture, because the excessive overbite/overjet ratio of natural teeth would be destabilizing in overdenture occlusion (**Fig. 17**). Because of a need to correctly engineer a smaller overjet/overbite ratio for overdentures, additional complexity is added. Second, patients without teeth have never worn a complete denture, an overdenture, or an immediate denture, and the abrupt change

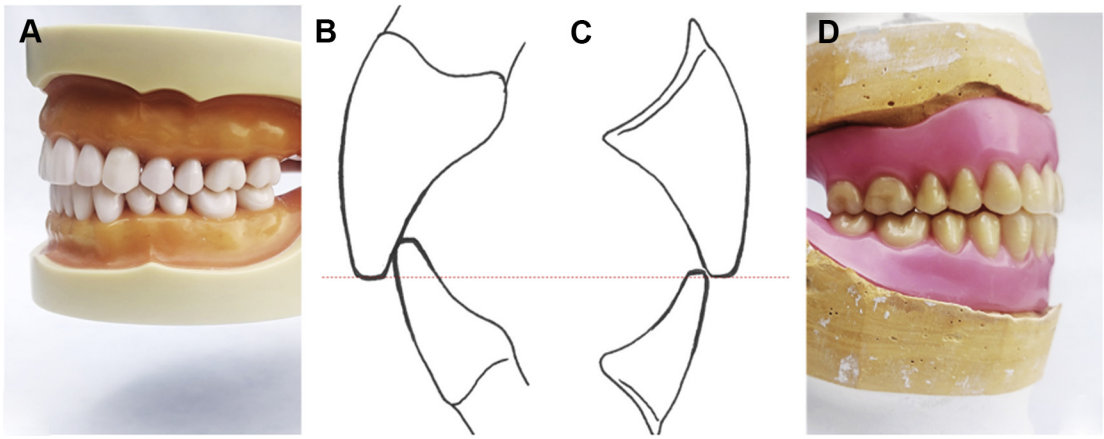

Fig. 17. (*A*) A typodont showing an ideal overbite to overjet ratio of about 3:3 mm. (*B*) The ideal dental overbite. (*C*) The reality of the overjet to overbite ratio with complete denture prosthetics, needed to minimize overbite's destabilizing force made from protrusive movements. (*D*) A complete denture with the classic shallow overbite used to avoid complete denture dislodgement.

from natural teeth to removable teeth can be functionally and psychologically distressing for a couple of months, while they await osseointegration to use the implants to stabilize the overdenture. Third, patients converting from natural teeth may have infections within the bone or other reasons with the extraction sockets that prevent the immediate placement of implants,

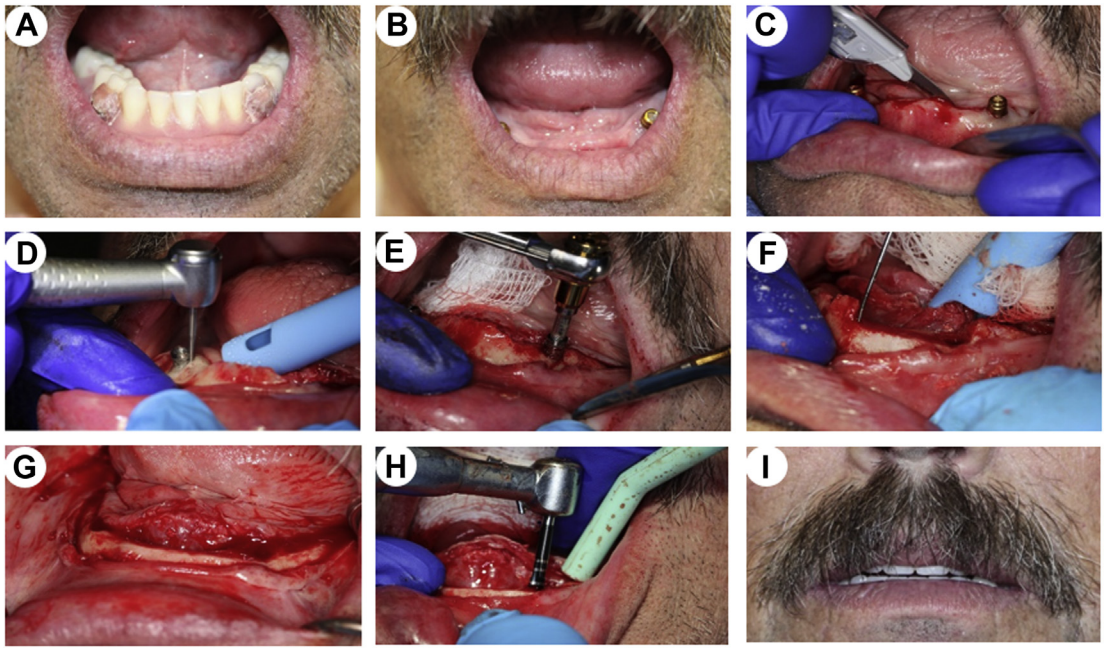

Fig. 18. A patient who likely had a deep bite in his dentition and was likely converted to an immediate without the ideal repositioning of the bone to account for the ideal position of the incisal edge nor the ideal prosthetic space. The patient underwent revision surgery to redo the implant placement and have the implants and bone placed at the ideal positions. Redoing cases can add complexity. (*A*) A significant amount of incisor display, and insufficient acrylic showing through with noticeable pink acrylic on the facial of the premolars. (*B*) Attachments are visible without retraction of the patient's lips. (*C*) Preparing the flap for surgery. (*D*) Trephining out the implants. (*E*) Removing the implants from the jaw. (*F*) Bone reduction to afford a more ideal amount of space between the attachments and the incisal/occlusal surfaces. (*G*) The leveled alveolar bone. (*H*) Placement of the implants at a more apical position. (*I*) The final restoration with a more ideal dentolabial position of the lower incisors.

Table 11
Specific algorithms for the implant-supported fixed denture (hybrid) cases

Stage	Item Number	Mental Checklist	Material Checklist
Evaluation and treatment planning	1	Smile height for esthetic cases	Photograph of high smile and document prosthetic-tissue interface's position relative to the lips
Evaluation and treatment planning	2	Bone considerations for implant placement	CBCT reviewed
Evaluation and treatment planning	3	Inter-arch and intra-arch spacing considerations	Measure distances on casts or CBCT
Evaluation and treatment planning	4	Dental labial and overjet/overbite ratio determined	Ideal length of teeth documented, including overbite changes
Evaluation and treatment planning	5	Get ideal position of teeth to plan case	Mounted models of ideal positions of teeth, and the prosthetic-tissue interface's position relative to the lips
Evaluation and treatment planning	6	Need to know the ideal amount of prosthetic space needed and how much bone needs to be removed behind the lip to obtain the ideal prosthetic space and prosthetic-tissue interface position	CBCT measurement of necessary prosthetic space combined with mounted model measurements, determine the amount of bone reduction needed
Presurgical work	7	Optimize the surgical experience	Fabricate surgical template, bone reduction guide, and temporary
Surgical phase	8	Idealized bone position is communicated	Surgical bone reduction template is used by surgeon
Surgical phase	9	Idealized implant placement is communicated	Surgical implant placement template is used by surgeon
Surgical phase	10	Patient has reasonable temporization (interim temporary solutions will require additional restorative follow-up)	Temporary is delivered to surgeon and surgeon delivers temporary (appointment(s) with restorative dentist will be needed for the interim hybrid)
Surgical phase	11	Patient is healed and approved by surgeon for restoration	Approval letter with implant size(s) and brand(s)
Restorative phase	12	Improvement of the interim hybrid	Reline, repair, and polish the interim
Restorative phase	13	Impression coping(s) seating position is verified by radiograph	Radiograph of seated impression coping(s), opposing model, bite record, shade, photographs
Restorative phase	14	High-quality impression of implant(s) and relevant dental anatomy	Elastomeric impression with impression coping seated with implant replica
Restorative phase	15	Cast's implant positions and mouth's implant positions are precisely the same positions	Verification jig is able to fit precisely on the implants on the cast and in the mouth, and

(*continued on next page*)

Table 11
(*continued*)

Stage	Item Number	Mental Checklist	Material Checklist
			radiographs are made and documented
Restorative phase	16	Wax try in on fixed appliance is approved	Photograph and/or documentation of patient's acceptance of the appearance obtained
Restorative phase	17	Coordination with laboratory for the substructure completed	Computer-aided design files approved for fabrication of milled bar
Restorative phase	18	High-quality prosthetic(s) fit on laboratory cast	Master models with implant replica and prosthetic(s)
Restorative phase	19	High-quality single-unit prosthetic(s) delivered to patient and patient is satisfied	Radiograph of prosthetic(s) torqued to manufacturer's recommendation and photographs and documentation of patient's satisfaction obtained
Restorative phase	20	Patient aware of oral hygiene and maintenance needs	Oral hygiene and maintenance instructions documented and include cleaning in-between prosthesis and the tissue for optimal implant and tissue health, and the need to report any problems immediately
Maintenance phase	21	Well-maintained implant and prosthetic(s)	Home care instructions annotated in notes, and 3-mo recall visit scheduled

thereby adding additional wait time for socket healing before initiating the subsequent osseointegration of the implants. Delaying the utility of the overdenture adds more psychological distress to the patient, which has to be managed by the provider.

Fig. 18 depicts a case whereby the complexity of a patient converting to an overdenture from natural teeth was misperceived, and the case had to be redone. This case did not account for the ideal placement of the prosthetic teeth nor did it account for prosthetic space needs with accompanying bone reduction, before the delivery of the overdenture. Redoing any case requires careful management of trust with the patient, and conservative preservation of the effected tissues during the reparative transformation.

Mandibular overdentures are far simpler than maxillary overdentures. Maxillary overdentures are built in bone that has a historically higher failure rate for implants, and more uncertainty surrounds the maxillary overdenture because it has far less research available to inform providers about its essentials. Once the overdentures are in use, as long as the implant health is maintained, both the maxillary and the mandibular maintenance are about the same. However, if an implant's health becomes problematic from an ailing or failing implant in either of these arches, both these arches become complex; because the maxillary arch uses more implants and has poorer-quality bone, the maxillary overdenture is more at risk for higher complexity. Both arches are usually designed with just enough implant support, and not extra implant support in terms of the number of implants. Therefore, when one implant ails or fails, the entire overdenture system is weakened and uncertainty arises regarding the prognosis of the remaining implants that now have to carry more load than originally designed, which adds complexity to the case.

Implant-Supported Fixed Dentures (Hybrid)

Among the available implant options patients consider, the implant- and bar-supported fixed denture (a hybrid) is generally the most complex. Table 11 shares the specific algorithms for the workflow necessary to provide patients with

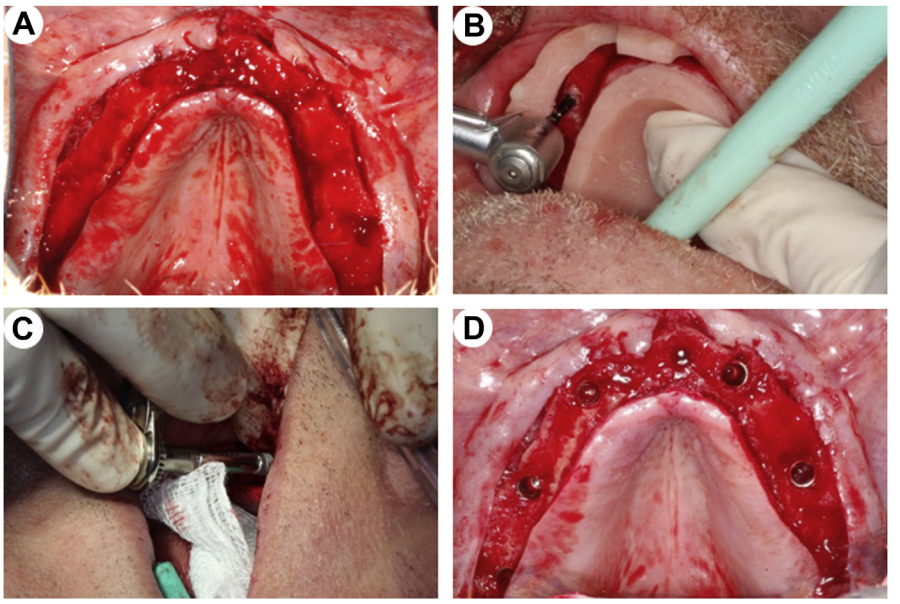

Fig. 19. The hybrid generally is supported by 4 or more maxillary implants. These photographs give a very simplified generic outline of the process of the surgical work leading up to the hybrid prosthetic protocols. (*A*) Incision and flap. (*B*) Osteotomies. (*C*) Implant delivery. (*D*) Implants placed.

implant-supported fixed dentures (hybrids). Only the multiunit fixed partial dentures on patients with visible transition lines that are managed with biologic site development rival these complex cases. These cases often present the most complexity because the technology is extremely esoteric; interpersonal effectiveness within a multidisciplinary team is paramount, and knowledge of justified true-beliefs is very specialized. Figs. 19 and 20 provide a brief overview of the surgical steps to deliver implants to support hybrids and the prosthetic protocols to immediately load

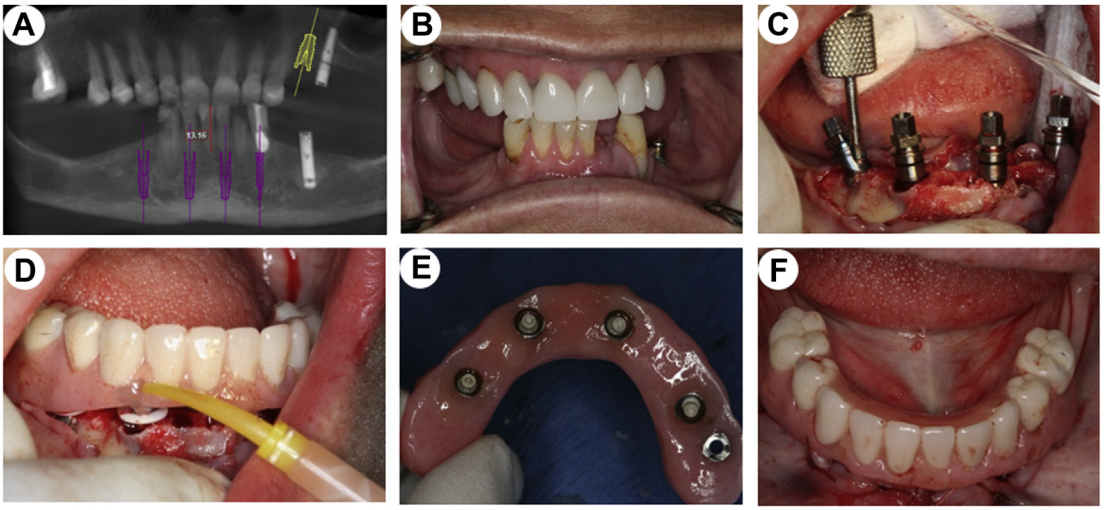

Fig. 20. The conversion process undertaken to replace mandibular dentition with an immediately loaded implant-supported fixed denture. Case attribution to/photography from Dr Nicholas Egbert. (*A*) Presurgical CBCT for planning the placement of implant bodies. (*B*) Preoperative photograph of mandibular dentition. (*C*) Placement of implants into the mandible. (*D*) Preparing for the bonding stage wherein the prosthesis is connected to the implants abutments. (*E*) The intaglio surface showing the cured acrylic or resin surface integrating with the attachments or abutments. (*F*) The completed immediate prosthesis. (Courtesy of Nicholas Egbert, DDS, MSD, Salt Lake City, UT.)

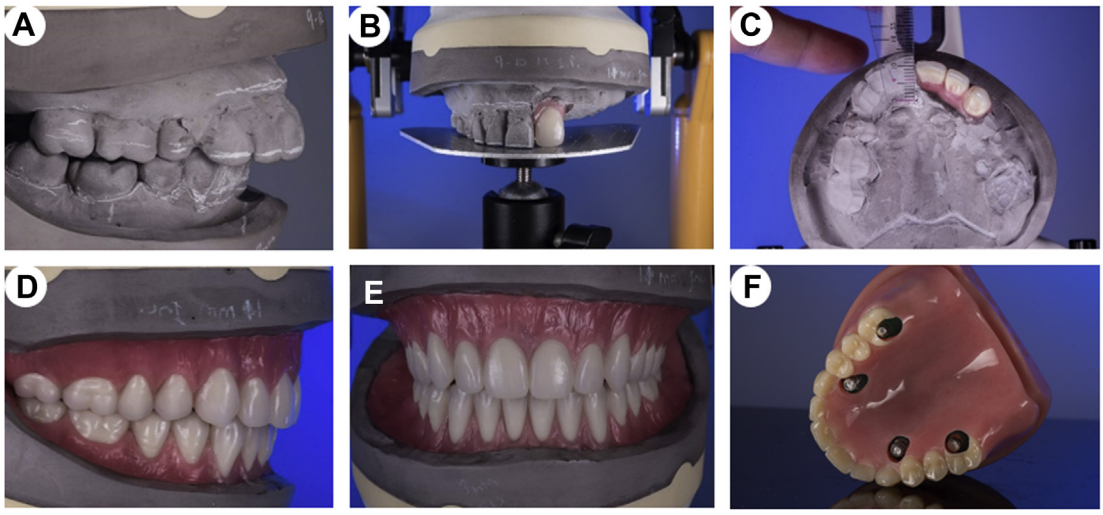

Fig. 21. The workflow to prepare an immediate denture to be used for the transition to an immediate implant-supported hybrid prosthesis. Laboratory attribution to/photography from Eugene Royzengurt. (*A*) White lines on the dental casts signify the references the dentist gave to the laboratory technician to idealize the prescriptive positions of the teeth. (*B*, *C*) The laboratory technician placing the acrylic teeth in the ideal positions. (*D*) Relative to (*A*), the laboratory technician has optimized the positions of the teeth. (*E*). An immediate denture processed in acrylic from the laboratory technician's wax-up seen in (*F*) This immediate denture will be converted into a temporary hybrid at the day of surgery and used during the healing of the implants. (Courtesy of Eugene Royzengurt, laboratory technician, Sandy, UT.)

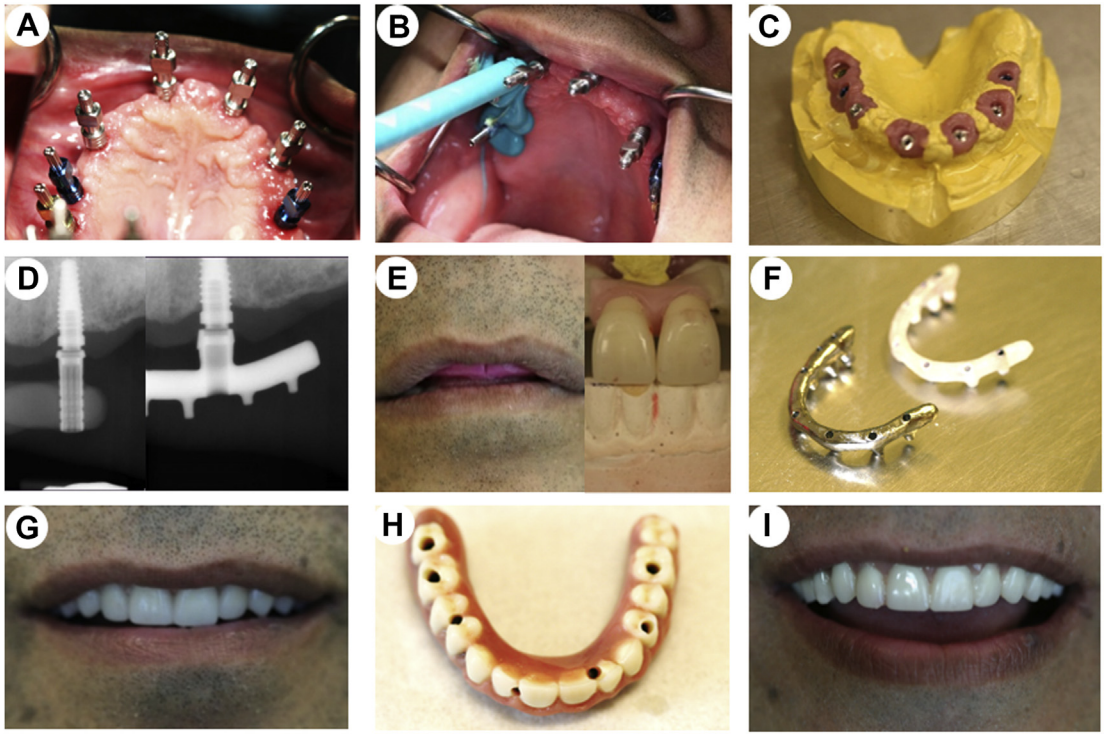

Fig. 22. A patient having an implant-supported fixed denture (hybrid) fabricated. (*A*) An implant impression using open tray impression copings is prepared. (*B*) An elastomeric impression material captures the positions of the copings. (*C*) A dental model is made using implant replicas in the same relative positions as the implants, so indirect dentistry can be performed in the laboratory. (*D*) In the left radiograph, a verification jig is used and shows that it is not seating; therefore, the image on the right containing the final titanium bar will also not seat. The verification jig needs to sit passively in order to fabricate a bar that also sits passively. (*E*) Conventional steps in the fabrication of dentures are carried out, like wax rim and wax try-in prescriptions. (*F*) The replica bar is copied or a computer aided design bar is milled to produce a titanium substructure. (*G*) The final try-in with the titanium bar and acrylic teeth set in wax. (*H*) The definitive prosthesis is processed indirectly in the laboratory. (*I*) The final restoration is delivered.

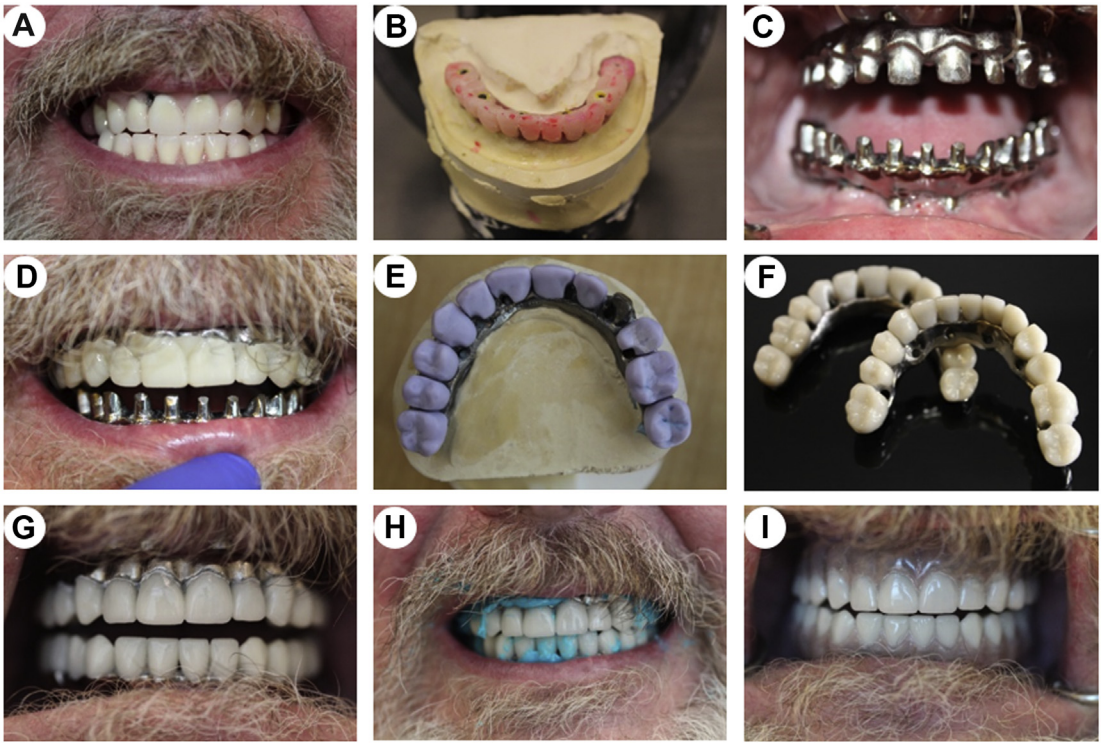

Fig. 23. An implant-supported fixed denture (hybrid) made with ceramic teeth on individual preparations to increase the longevity of the prosthetic. This level of complexity combines the difficulty of hybrid construction with full-mouth crown rehabilitation, but it requires far less bone reduction because the materials are far more effective at managing masticatory forces than acrylic. (*A*) The process begins with the approval from the patient/doctor of the wax try-in. (*B*) The wax try-in is either digitized or acrylized for either digital or mechanical preparing of the denture teeth, similar to how natural teeth are prepared. In the picture shown here, the denture was acrylized, and each acrylic tooth was then prepared for a crown and then sent to a technician to copy and mill. (*C*) The milled titanium bars with individual crown preparations. (*D*) Similar to the full-mouth rehabilitation, temporaries can be used to determine the ideal positions of the teeth and to elucidate the vertical and horizontal bite position. (*E*) The crowns are milled to specification and heated in a furnace. (*F*) The completed prosthetics without the gingival veneering. (*G*) The ceramic try-in and bite verification. (*H*) An up-to-date record of the tissue is desired to provide intimate fit with the ridge, so an impression will be made to replicate these tissue/prosthetic relationships. (*I*) The final porcelain or acrylic pink veneer (acrylic shown here) is finalized and the definitive prosthetic is delivered.

hybrids on the day of surgery. Fig. 21 provides a case overview of the prosthetic laboratory workflow for the interim hybrid. Fig. 22 provides a workflow overview of the definitive prosthetic considerations.

Like the overdentures, these full-arch hybrid prosthetics require enough restorative materials to withstand the forces of mastication without breaking. Table 9 shows the space needed for various prosthetics, including the full-arch hybrid varieties. Again, the space between the lingo-incisal/occlusal surfaces and the gingival tissue made up by restorative materials can be referred to as the prosthetic space and is measured with a Boley gauge (see Fig. 14). Because of the uniqueness of every patient, many times patients present with bone that obstructs the volume needed for the prosthetic space. Although it would be nice to simply open the vertical dimension and gain the necessary prosthetic space by changing the position of the teeth from the ideal length to a longer length, unfortunately, this lengthening often presents its own set of esthetic, functional, and phonetic issues. Therefore, oftentimes, instead of increasing vertical dimension, case customization requires the reduction of bone in order to provide for the necessary prosthetic space. Reducing bone adds complexity to the case because this procedure requires the coordination and execution from the surgical and restorative team of the precise amount of bone that must be removed.

Table 9 shows that the hybrid made of cemented individual crowns on a metal bar, and

Table 12
Subjectivity continuum

Complexity Ranking	Surgical Prosthetic Procedure	Provider Complexity Range
1	Redoing or implant failure with items ranked 2–7 below	Extremely difficult
2	Crowns on metal preparation hybrids (see Fig. 23) with zygomatic implants	Extremely difficult
3	Stacked ceramo-metal hybrid with zygomatic implants	Extremely difficult
4	Crowns on metal preparation hybrids (see Fig. 23) with sinus grafting	Extremely difficult
5	Stacked ceramo-metal hybrid with grafting	Extremely difficult
6	Acrylic/titanium hybrid with zygomatic implants	Extremely difficult
7	Acrylic/titanium hybrid with grafting	Extremely difficult
8	Redoing or implant failure with 9	Extremely difficult
9	Implant-supported fixed multiunit crowns, vertical biologic issues, visible interface (see Figs. 11 and 12)	Extremely difficult
10	Redoing or implant failure with items ranked 11–13 below	Extremely difficult
11	Crowns on metal preparation hybrids (see Fig. 23) with ideal bone	Difficult
12	Stacked ceramo-metal hybrid with ideal bone	Difficult
13	Acrylic/titanium hybrid with ideal bone	Difficult
14	Redoing or implant failure with item ranked 15	Difficult
15	Implant-supported fixed partial dentures, vertical biologic issues, hidden interface (see Fig. 10)	Difficult
16	Redoing or implant failure with item ranked 17	Difficult
17	Implant-supported single crown with visible interface and vertical biologic issues (see Fig. 8)	Difficult
18	Redoing or implant failure with items ranked 19–20	Difficult
19	Maxillary implant/attachment-supported removable overdenture with grafting	Difficult
20	Mandibular implant/attachment-supported removable overdenture with grafting	Difficult
21	Redoing or implant failure with items ranked 22–23	Moderate
22	Maxillary implant/attachment-supported removable overdenture with ideal bone	Moderate
23	Mandibular implant/attachment-supported removable overdenture with ideal bone	Moderate
24	Redoing or implant failure with items ranked 25–26	Moderate
25	Implant-supported single crown with visible interface and ideal periodontium	Moderate
26	Implant-supported single crown with hidden interface and ideal periodontium	Moderate

the hybrid where porcelain is stacked on the metal bar, do not need very much prosthetic space, and therefore, would not be as complex. However, although the surgical work is less complex if bone reduction is not necessary, these prosthetics are highly technical and surpass the acrylic hybrid in restorative complexity. Fig. 23 shows some of the unique steps in fabricating one of these more complex prosthetics. Both the porcelain stacked to the metal bar and the crowns cemented to the metal bar combine elements of full-mouth dental reconstruction with the elements required to provide standard hybrids. If one of the implants ails or fails under the interim or definitive full-arch hybrid, the case can become very complicated if the failing implant is essential for the support of the prosthesis. Because many hybrid prostheses are made with the bare minimum amount of implants to support a hybrid, the failure of one implant can

mean short- and long-term reconsiderations. Many of these patients selected the hybrid because it is fixated to the jaw, and these patients are unwilling to have any removable prosthetic. When a definitive prosthetic, fixed to the patient's jaw, has a supporting implant that is failing, in a patient who will not tolerate short-term removable prosthetics, the case becomes very complex. These patients will need to revert to their interim hybrid, and have another implant placed and heal, before a new definitive prosthetic can be delivered. Although these are again somewhat complex operations, as well as expensive and time-consuming reconstructions, much of the additional complexity comes from managing a potentially tense patient-provider relationship.

SUBJECTIVELY HELPING PATIENTS

Although evidence-based dentistry has done much to improve dental procedures by radically augmenting providers' subjective limitations with objectively demonstrated science, the patient-provider relationship will likely always be enormously grounded in sharing subjective beliefs.[29,30] Patient expectations often are misaligned with reality because he or she does not have the experience to form a strong understanding of the impact complex implant procedures might have on their lives. The more complex the procedure, the more likely the expectations of patients may not be managed well enough to avoid a loss of trust in the patient-provider relationship. To aid expectation management in complex implant cases, **Table 12** provides a subjective ranking of case complexity for providers.[29,30] (The reader is referred to the references for further interest.)

SUMMARY

This article has provided a series of algorithms and checklists in the treatment planning of the complex dental implant patient from both the surgeon and the restorative dentist's perspectives. Cooperation among interdisciplinary fields is paramount in order to both reestablish a functional occlusion and provide a long-term esthetic benefit to the patient. Although more of an art than a science, most experienced oral-health care physician know that effectively relating to patients on a subjective level may prove at times to be just as important to the patient as the providers' knowledge of clinical science. The key to success will always be an honest recommendation based on her or his specialization and experience. Cost, advantages, disadvantages, and treatment alternatives must be predicated upon the hard and soft tissue foundations and how well they can be crafted to create a prosthesis that the surgeon, restorative dentist and patient are satisfied with. Both an algorithmic and a subjective description of complex implant cases have been provided so as to provide the restorative dentists' perceptions and realities involved therein. This form of communication allows dental implant teams to provide higher standards for baseline performance and success in the complex implant patient.

REFERENCES

1. Zitzmann NU, Margolin MD, Filippi A, et al. Patient assessment and diagnosis in implant treatment. Aust Dent J 2008;53(1Suppl):S3–10.
2. Jivraj S, Corrado P, Chee W. An interdisciplinary approach to treatment planning in implant dentistry. Br Dent J 2007;202:11–8.
3. Kotsakis GA, Ioannou AL, Hinrichs JE, et al. A systematic review of observational studies evaluating implant placement in the maxillary jaws of medically compromised patients. Clin Implant Dent Relat Res 2015;17(3):598–608.
4. Diz P, Scully C, Sanz M. Dental implants in the medically compromised patient. J Dent 2013;41(3):195–206.
5. Tucker MR, Narcisi ER, Ochs MW. Implant treatment: advanced concepts and complex cases. In: Hupp JR, Ellis E, Tucker MR, editors. Contemporary oral and maxillofacial surgery. 6th edition. St Louis (MO): Elsevier Mosby Health Sciences; 2014. p. 264–94.
6. Sadowsky SJ, Fitzpatrick B, Curtis DA. Evidence-based criteria for different treatment planning of implant restorations for the maxillary edentulous patient. J Prosthodont 2015;24:433–46.
7. Vissink A, Spijkervet FKL, Raghoebar GM. The medically compromised patient: are dental implants a feasible option? Oral Dis 2018;24:253–60.
8. Zitzmann NU, Marinello CP. Treatment plan for restoring the edentulous maxilla with implant-supported restorations: Removable overdenture versus fixed partial denture design. J Prosthet Dent 1999;82(2):188–96.
9. Pinho T, Neves M, Alves C. Multidisciplinary management including periodontics, orthodontics, implants, and prosthetics for an adult. Am J Orthod Dentofacial Orthop 2012;142:235–45.
10. Mills EJ, Dunson BC, Koch P. Evaluation, diagnosis, and treatment planning of complex implant cases. J Oral Implantol 1996;22(1):12–6.
11. D'Haese J, Ackhurst J, Wismeijer D, et al. Current state of the art of computer-guided implant surgery. Periodontol 2000 2017;73:121–33.
12. Moy PK, Pozzi A, Palacci P, et al. Hard and soft tissue augmentation [Chapter 8]. In: Moy PK, Pozzi A,

John B III, editors. Fundamentals of implant dentistry, vol. 2. Chicago: Quintessence; 2016. p. 205–58.
13. Lekhom U, Zarb GA. Patient selection and preparation. In: Branemark P-I, Zarb GA, Albreksson T, editors. Tissue –integrated prostheses: osseointegration in clinical dentistry. Chicago: Quintesscence; 1985. p. 199–209.
14. Jensen OT. Site classification for the osseointegrated implant. J Prosthet Dent 1989;61:228–34.
15. Jensen OT, Adams MW, Cottam JR, et al. The all-on-four shelf: Maxilla. J Oral Maxillofac Surg 2010;68: 2520–7.
16. Jensen OT, Adams MW, Cottam JR, et al. The all-on-four shelf mandible. J Oral Maxillofac Surg 2011;69: 175–9.
17. Jensen OT. Complete arch site classification for all-on-4 immediate function. J Prosthet Dent 2014;112:741–51.
18. Handelsman M. Surgical guidelines for dental implant placement. Br Dent J 2006;201(3):139–51.
19. Tahmaseb A, De clerck R, Wismeijer D. Computer-guided implant placement: 3D planning software, fixed intraoral reference points, and CAD/CAM technology: a case report. Int J Oral Maxillofac Implants 2009;24:542–6.
20. Emanuel EJ, Emanuel LL. Four models of the physician –patient –relationship. JAMA 1992;267(16):2221–6.
21. Polanyi M. Personal knowledge. Corr. edition. Chicago: University Of Chicago Press; 1974.
22. Block MS, Jackson WC. Techniques for grafting the extraction site I the preparation for dental implant placement. Atlas Oral Maxillofac Surg Clin N Am 2006;14(1):1–25.
23. Axiotis JP, Nuzzolo P, Barausse C, et al. One-Piece implants with smooth concave neck to enhance soft tissue development and preserve marginal bone levels: a retrospective study with 1-6- year follow-up. Biomed Res Int 2018. https://doi.org/10.1155/2018/2908484.
24. Mura P. Immediate loading of tapered implants placed in post extraction sockets: retrospective analysis of the 5-year clinical outcome. Clin Implant Dent Relat Res 2012;14(4):565–74.
25. Esposito MA, Koukoulopoulou A, Coulthard P, et al. Interventions for replacing missing teeth: dental implants in fresh extraction sockets (immediate, immediate-delayed and delayed implants). Cochrane Database Syst Rev 2006;(4):CD005968.
26. Cillo JE, Finn R. reconstruction of the shallow vestibule edentulous mandible with simultaneous split thickness skin graft vestibuloplasty and mandibular endosseous implants for implant- supported overdentures. J Oral Maxillofac Surg 2009;67:381–6.
27. Kan JYK, Rungcharassaeng K. Interimplant papilla preservation in the esthetic zone: a report of six consecutive cases. Int J Periodontics Restorative Dent 2003;23(3):249–59.
28. Cortell-Ballester I, Figuerido R, Gay-Escoda C. Lowering of the mouth floor and vestibuloplasty to support a mandibular overdenture retained by two implants: a case report. J Clin Exp Dent 2014;6(3):310–2.
29. Carlsson G. Review of some dogmas in clinical prosthodontics. J Prosthodont Res 2009;53:3–10.
30. ADA policy statement on evidence-based dentistry. Available at: http://www.ada.org/en/about-the-ada/ada-positions-policies-and-statements/policy-on-evidence-based-dentistry. Accessed January 27, 2019.