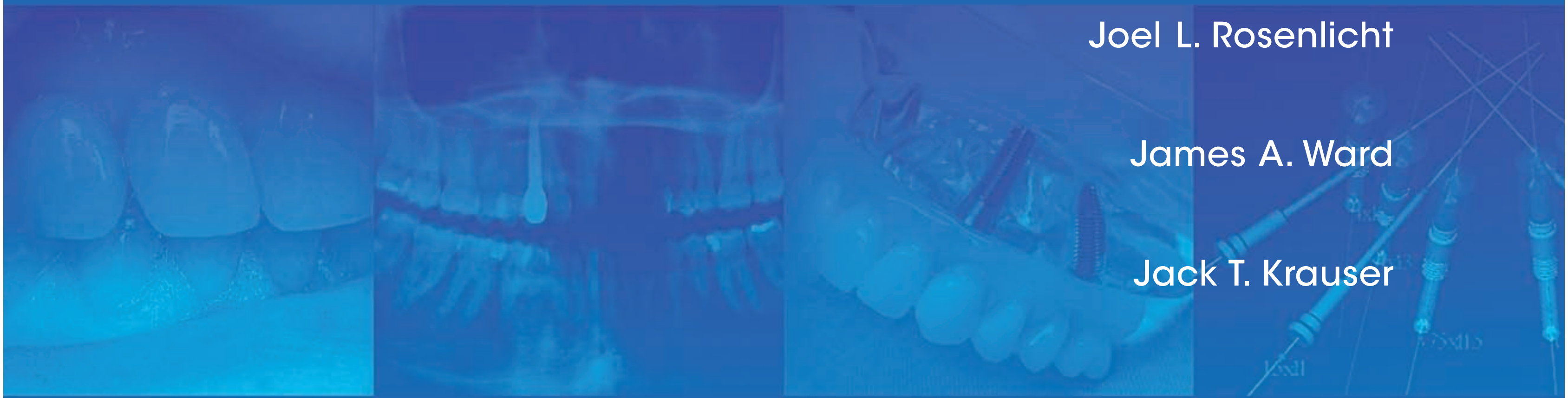

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CHAPTER 21

# IMMEDIATE LOADING OF DENTAL IMPLANTS

The earliest possible restoration to achieve proper form and function is a hallmark of all surgical specialties. This principle underlies the concept for immediate loading of dental implants. The concept of immediate loading was applied in the very early stages of dental implants.[1] The failure rate of the earliest trials of dental implants was high and often occurred shortly after attempts at functional loading. In some cases the complications arising from the early loading of dental implants were more severe than the indication for treatment.[2] Despite these setbacks, many of the early attempts at implant placement were functional for long periods and provided the support for functional prostheses. Several factors contributed to the high early failure rates: metallurgic properties of implants had not yet been improved; the dental materials utilized, although proven compatible, lacked the necessary strength to support a prosthesis in function; and there was not yet a thorough understanding or the proper surgical and prosthetic techniques necessary for success.[3-5]

It was not until the 1940s that Bothe et al.[6] experimented with the biocompatibility of titanium. Its use was not widely accepted until the 1950s, when documented support from Gottlieb and Leventhal[7] and Clarke and Hickman[8] showed the corrosion resistance and inert nature of titanium.[9-11] Brånemark et al.[12] in the 1960s demonstrated the ability of natural bone to accept implanted titanium during its remodeling stages, leading to the concept of osseointegration. This concept was initially conceived as a two-stage system in which the titanium implant was given a length of time to osseointegrate into the native bone without the stress of function.

Dr. Alvin Strock,[13] a Boston oral and maxillofacial surgeon, placed an orthopedic bone screw into an immediate extraction socket of a periodontally involved tooth in the late 1930s. The placement of this implant became the foundation for the placement and restoration of a similar bone screw with the head prepared to receive a prosthetic crown in the following year.[13] The implant and restoration survived for 18 years (Figure 21-1). Implants placed in the subsequent years varied in their sizes, shapes, materials, and placement techniques. One commonality they shared was the concept of immediate loading. These implants were placed and restored according to a one-stage surgical technique allowing for impressioning and rigid splinting of the implants at the time of initial surgery[14-18] (Figure 21-2). After the documented success rates of two-stage surgical techniques in the 1960s the industry began to turn away from immediate loading. However, as the materials and science of dental implants progressed, a return to the restoration of immediate form and function was seen. Documentation of high success rates with immediately loaded dental implants then followed in the mid 1980s.[19-24]

## What Is Immediate Loading?

The scientific literature is rife with definitions of *immediate loading* of dental implants. Misch et al., in 2004,[25] offered several classifications of implant loading:

- *Immediate occlusal loading* refers to full functional occlusal loading of an implant within 2 weeks of placement.
- *Early occlusal loading* refers to functional loading between 2 weeks and 3 months of implant placement.
- *Nonfunctional immediate restoration* refers to implant prostheses placed within 2 weeks of implant placement with no direct functional occlusal loading.


**Figure 21-1. A,** The first extraction and placement of endosseous bone screw followed by dental restoration. Periapical x-rays taken at 8 years **(B)** and 9 years **(C)** postrestoration. (From Rosenlicht JL, Ward J, Krauser JT: Impressions at surgical placement and provisionalization of implants. In Fonseca RJ, et al, editors: Oral and maxillofacial surgery, vol 1, St Louis, 2009, Elsevier.)

- *Nonfunctional early restoration* refers to implant prostheses delivered between 2 weeks and 3 months from implant placement.
- *Delayed occlusal loading* refers to the restoration of an implant more than 3 months after placement.

These categories help to describe the timeframe of the restorative phase of implant surgery. In 2006, Wang et al.[26] provided a definition based on a consensus from the International Congress of Oral Implantologists (Upper Montclair, NJ) in which immediate loading was described as a technique in which the implant supported restoration is placed into functional occlusal loading within 48 hours of implant insertion. Furthermore, a distinction was made between the immediate restoration for aesthetic purposes, in which the restoration was placed out of occlusal contacts, and true immediate loading (Figure 21-3).

## Patient Selection

Several factors determine whether a patient is a candidate for immediate loading of his or her dental implants. These factors can be divided into four categories:

1. Surgery-related factors
2. Host-related factors
3. Implant-related factors
4. Occlusion-related factors

The surgical factors pertain primarily to implant stability and surgical technique. Host factors include not only bone quality and density but also proper healing environment. Implant factors are based on the structure and design of the implant system utilized, and occlusal factors relate to the importance of proper prosthetic design under occlusal forces.[27]

Of the factors related to surgical technique, the establishment of primary stability has been described as the single most important variable for success of immediately loaded implants.[28-30] The transmission of micromotion to an implant body after placement can result in crestal bone loss and failure of osseointegration. It has been shown that micromotion must be limited to less than 100 nm to achieve implant-to-bone contact.[31] Clinically, the torque during implant placement is a good predictor of implant stability. Studies have reported that implants placed with an insertion torque greater than 30-35 Ncm resulted in higher success rates for immediate loading.[32-34] Additionally, to ensure adequate bone health and stability, proper implant placement technique includes copious irrigation both internally and externally to maintain temperatures less than 47° C for prevention of necrosis of the surrounding bone.

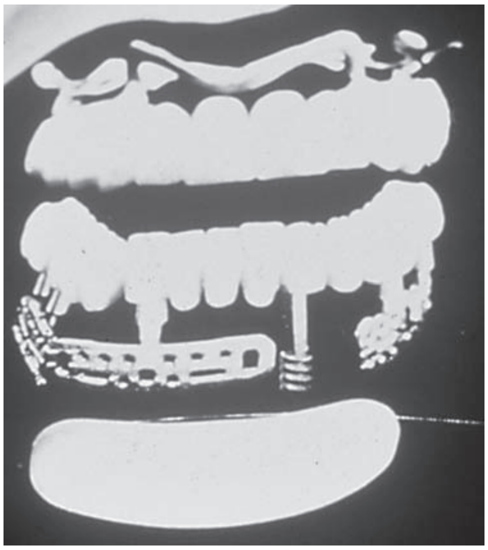

**Figure 21-2.** Early examples of dental implants routinely loaded after implant placement.

Host factors also contribute to the decision-making process for immediate loading of dental implants. The practitioner must take into account the patient's medical history in evaluating candidacy for immediate loading, including tobacco use, oral hygiene, medications, and systemic diseases such as human immunodeficiency virus (HIV)/acquired immunodeficiency syndrome (AIDS), diabetes mellitus, and osteoporosis. The clinical history of the tooth to be replaced at the time of extraction should also be considered. Teeth associated with a history of trauma, infection, or periodontal disease with active inflammatory response may not be candidates for immediate implant placement or immediate loading. Radiographic and physical examination are also necessary for evaluation of bone quality and quantity.

The quality of bone often controls the prosthetic choices when immediate loading is considered. The need for bone grafting at the time of implant surgery may be necessary, depending on the anatomical variances of the patient's bony

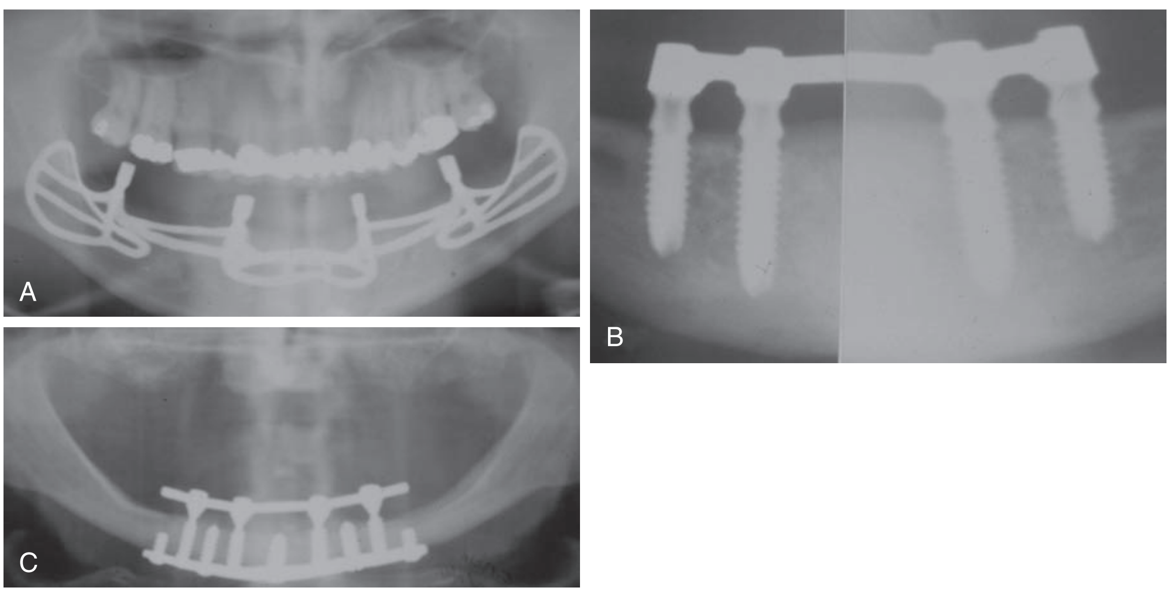


**Figure 21-3.** **A,** Subperiosteal implant traditionally loaded after placement with fixed or removable prosthesis. **B,** TPS (titanium plasma sprayed) screw loaded within 12 to 24 hours after a bar is placed to rigidly connect implants. **C,** Transosseous implant inserted extraorally and loaded within 12 to 48 hours or allowed to integrate 3 to 6 weeks. (**A** and **B,** From Rosenlicht JL, Ward J, Krauser JT: Impressions at surgical placement and provisionalization of implants. In Fonseca RJ, et al, editors: Oral and maxillofacial surgery, vol 1, St Louis, 2009, Elsevier.)

anatomy. Bone quality can be described in many ways. The system proposed by Lekholm and Zarb[35] places bone into four classifications based on the relative amounts of cortical and trabecular bone. In the first classification almost the entirety of bone is composed of compact cortical bone. In the second classification, compact trabecular bone is surrounded by a thick layer of cortical bone. The third classification is described as a thin layer of cortical bone encompassing high-density trabecular bone with favorable strength properties. Finally, in the fourth and least desirable bone type, a thin layer of compact bone surrounds loosely arranged trabecular bone. Higher failure rates have been reported in type IV bone for immediate loading of implants.[36]

With the growing marketplace for dental implants and the advent of new technologies, implant design principles can affect success of immediately loaded implants. The screw design type has been shown to have higher mechanical retention and greater ability to transfer compressive forces.[37,38] Implant length and diameter—critical values for immediate loading—have yet to be defined; however, early reports have suggested that lengths greater than 10 mm provide dramatically higher success rates.[39] Another factor of implant design that may contribute to success of immediate loading is surface texture. A variety of surface coatings and treatments are available and a multitude of studies have proven high success rates. A roughened implant surface clearly has shown improved success rates over its machined counterpart. Success rates on average of 91% were found when comparing the studies.[40]

The recommended occlusal scheme for immediately loaded implants is one of maximal interocclusal contacts without lateral contacts.[26] Patients with parafunctional habits or compromised occlusion should not receive immediate loading options. Studies by Balshi and Wolfinger demonstrated that approximately 75% of failures with immediate loading occurred in patients with parafunctional habits. Additional studies have supported these results and suggest that these patients, if not excluded from immediate loading, must be strongly cautioned of the high risk for failure.[41-43]

## Immediate Loading for Single-Tooth Restoration

Studies of single-tooth restoration and immediate loading have shown good success rates.[44-46] Various studies have been done on these single-tooth restorations placed into immediate occlusion via provisionalization with success rates similar to those implants restored with light or no occlusal forces.[44,47-51] Other studies of these single-tooth restorations have shown lower success rates when placed into immediate functional occlusion.[52-55] Clearly, more detailed studies are needed to assess the role of occlusion in these restorations.

Studies of implants placed in type IV bone with varying degrees of success.[52,56] The soft tissue response was very favorable in these studies owing to the presence of a provisional crown throughout the healing phase,[55] which allowed the sculpting of the interdental papilla and the attached gingiva. Comparable bone loss was seen with immediate loading versus the traditional two-stage surgeries.[48,51] Some studies even showed a net gain of bone over a 5-year follow-up period.[57] Given the recent advances and research in this area, long-term follow-up data are not yet available; however, the immediate loading of a single-tooth restoration is clearly a viable option for select patients.

Figure 21-4 shows the placement of an immediate screw-retained temporary provisional restoration at the time of implant placement and Figure 21-5 shows a presurgical guided placement of implant with final zirconia abutment and temporary crown at time of implant placement.

## Immediate Loading of the Fixed Prostheses

Research in the area of fixed or multiple-tooth replacement with immediate loading has been divided into prostheses placed in the mandible and those placed in the maxilla. In the early studies of mandibular multi-tooth restorations with immediate loading, one technique placed additional or interim implants to initially support the prosthesis while the remaining implants underwent the healing phase. The thinking behind this technique was based on the suspected high failure rates of these immediately loaded implants.[41,58,59] This was further investigated to reduce treatment costs to the patient and determine the minimum number of implants necessary to support an immediately loaded prosthesis. When the three-implant model was tested, several drawbacks were noticed. Several systems were not flexible in their surgical technique and the failure of a single implant resulted in a 15% prosthetic failure rate.[60] This led to the determination that a minimum of four implants should be placed in the edentulous mandible to support an immediately loaded fixed prosthesis. This method requires the implants to be a minimum of 10 mm in length.

In the edentulous or partially edentulous maxilla, significantly more implants must be placed to obtain primary stability of an immediately loaded prosthesis. Although many studies have suggested a requirement of 8 to 12 implants, several studies have shown similar success rates with 5 to 8 implants.[43,61,62] The literature debates, with varying results, the surface morphology of implants best suited to placement in the decreased bone density of the maxilla. No standardized protocol exists to justify the selection of one implant morphology over another.[63] Selection criteria also are more difficult to meet in the maxilla because of the anatomical presence of the maxillary sinus and its effect on residual bone heights. However, immediate loading in both the edentulous or partially edentulous maxilla and mandible is a viable treatment option if the selection criteria are met.

Figure 21-6 shows a 38-year-old patient, edentulous in the regions of 4 through 6, who had been wearing a partial maxillary prosthesis. The patient wished to have an immediate restoration of an implant-supported fixed bridge. Radiographic presurgical planning was carried out with cone beam x-ray and model-based surgery.


**Figure 21-4.** **A,** Edentulous site (tooth #5) 8 weeks following extraction and socket preservation. **B,** Placement of implant (Zimmer Dental Corp., Carlsbad, CA) with figure mount transfer pin (note the mark on transfer pin to precisely place implant at level of bone). **C,** An immediate impression taken for future final abutment and restoration. **D,** Custom chair-side fabrication of composite provisional on temporary plastic abutment. **E,** Contours established for emergence profile and soft tissue support. **F,** Temporary provisional in place (screw retained) immediately after implant placement. (**B-D** and **F,** From Rosenlicht JL, Ward J, Krauser JT: Impressions at surgical placement and provisionalization of implants. In Fonseca RJ, et al, editors: Oral and maxillofacial surgery, vol 1, St Louis, 2009, Elsevier.)

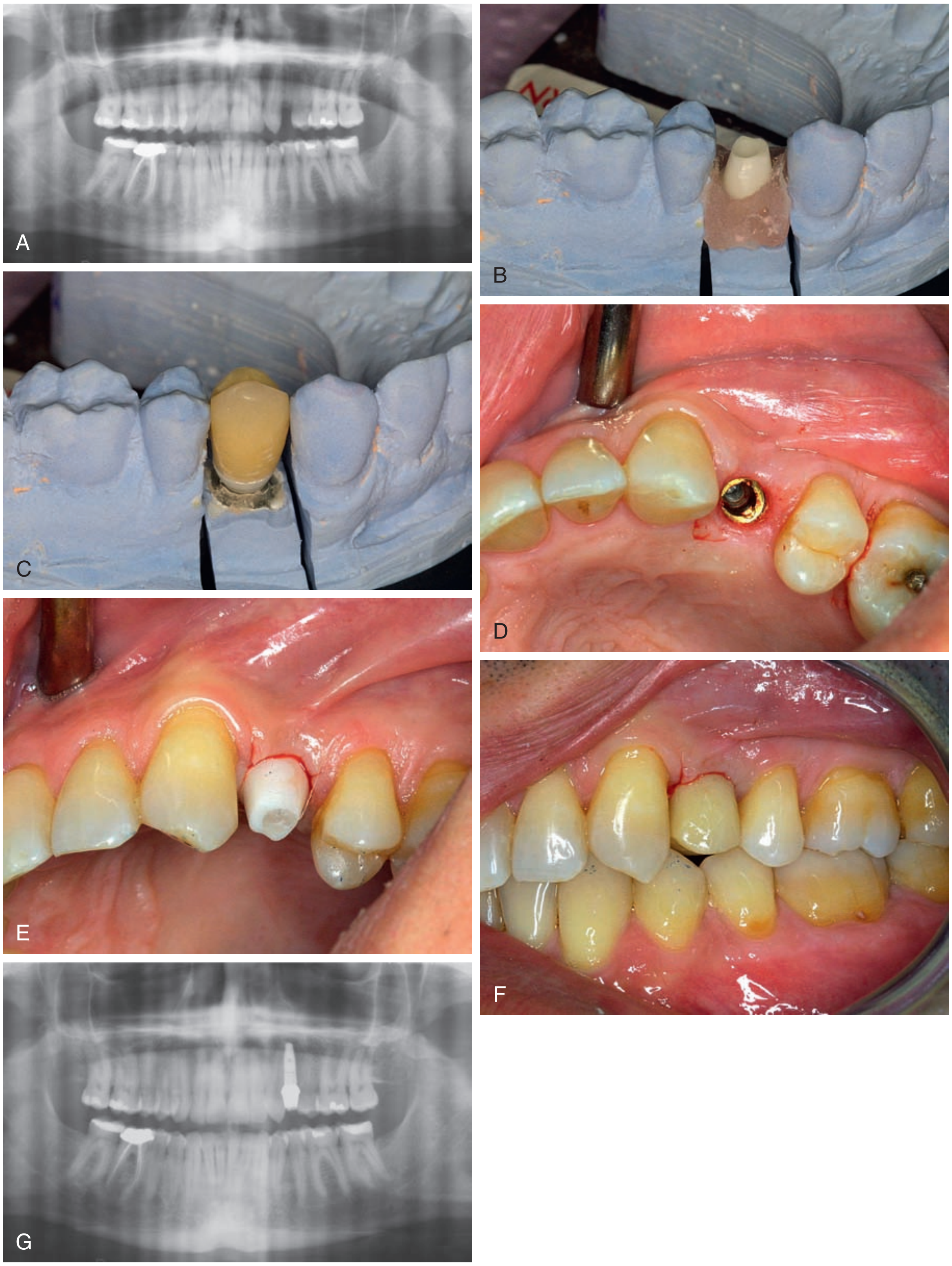


**Figure 21-5.** **A,** Panoramic radiograph of edentulous site (tooth #12). Note adequate bone height and density. **B,** Laboratory model with implant analog plated and fabricated final zirconia abutment. **C,** Laboratory fabricated provisional crown on final abutment. **D,** Guided surgical placement of implant (Noble Biocare, Yorba Linda, CA) based from presurgical model planning. **E,** Placement of the final zirconia abutment at the time of implant placement (torqued to 35 Ncm). **F,** Provisional restoration adjusted to modify occlusal load. **G,** Immediate postoperative panoramic x-ray. (**B, C,** and **E-G,** From Rosenlicht JL, Ward J, Krauser JT: Impressions at surgical placement and provisionalization of implants. In Fonseca RJ, et al, editors: Oral and maxillofacial surgery, vol 1, St Louis, 2009, Elsevier.)

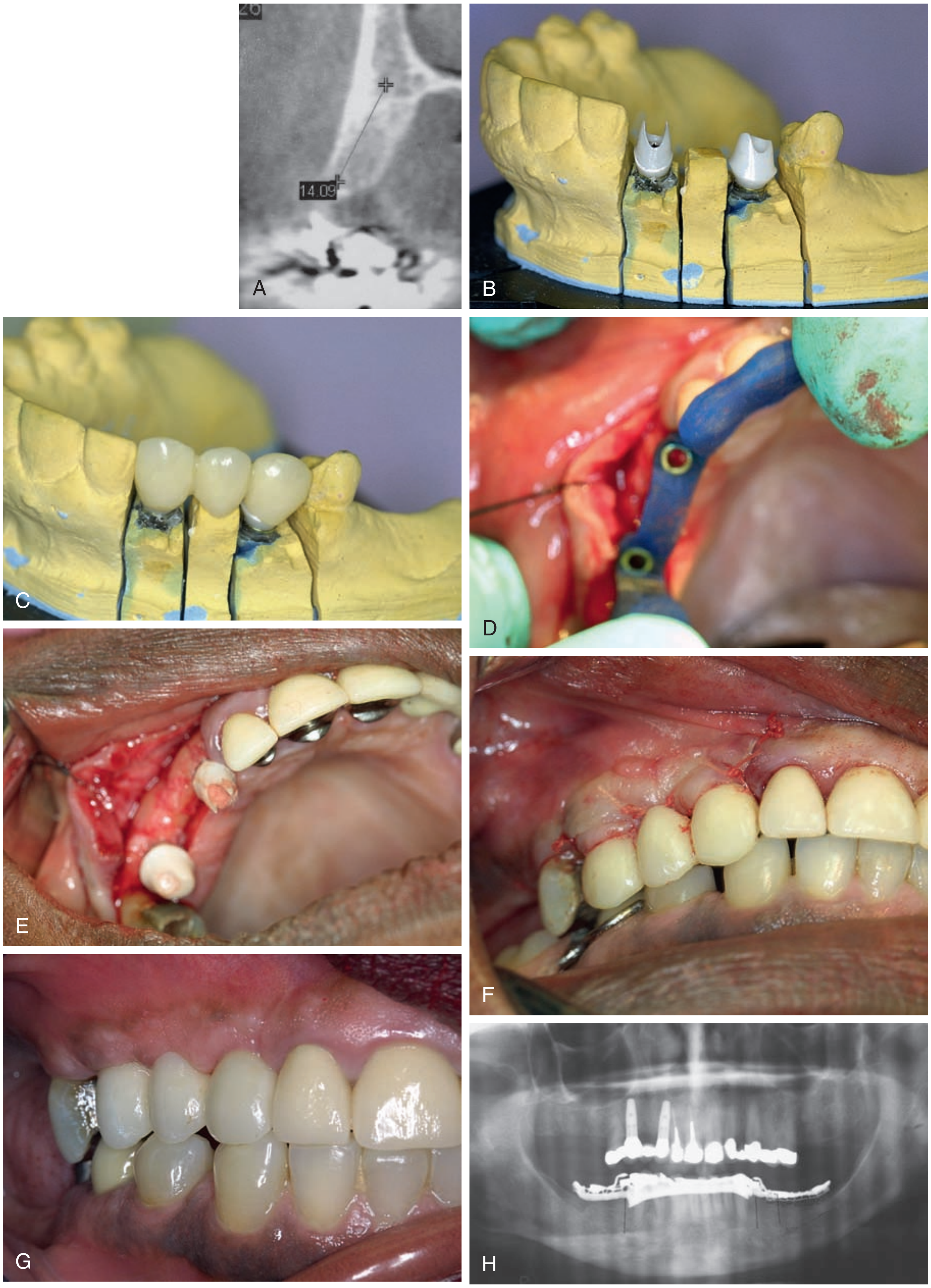


**Figure 21-6.** **A,** Cone beam CT scan (Imaging Science International, Inc., Hatfield, PA) showing buccal-palatal and vertical dimensions of implant site. **B,** Prefabricated final zirconia abutments for two implants and a three-unit bridge. **C,** Acrylic temporary bridge used after implant placement. **D,** Prefabricated surgical guide replication model-based planning. **E,** Implants placed with final zirconia abutments torqued onto implants. **F,** Temporary bridge placed and soft tissue positioned and sutured to establish emergence profile of teeth and provide soft tissue support. **G,** Final bridge cemented at 2 months. **H,** Postoperative panoramic radiograph at 1 year. (**B-H,** From Rosenlicht JL, Ward J, Krauser JT: Impressions at surgical placement and provisionalization of implants. In Fonseca RJ, et al, editors: Oral and maxillofacial surgery, vol 1, St Louis, 2009, Elsevier.)

## Immediate Loading of Over-Denture Prostheses

No studies exist that display true immediate loading protocols for over-denture prostheses as defined earlier. However, there is support for early occlusal loading with over-dentures. True immediate loading in these cases may not be possible due to the need for prosthetic development of bar attachments in many instances. A recent study placing over-dentures into occlusal loading at 4 days supported by a bar system showed high success rates.[64] Several studies have shown success rates with early occlusal loading of over-dentures with implants placed in the mandibular interforaminal area.[65-71] The loading protocols in these studies were described as progressive loading, which prohibited denture wear for 2 weeks, or allowed wear of a denture that was completely relieved from abutment contact. Early functional loading in these studies referred to a protocol usually consisting of implant loading at approximately 3 weeks with either a ball attachment or bar-clip assembly. Immediate early functional loading referred to placement of the prosthesis within 5 days. In the studies that attempted the earliest functional loading the bar-clip attachment was the restorative method of choice.

Four studies showcased control patients undergoing two-stage techniques which demonstrated high success rates similar to the patients receiving early loading.[70-74] These studies all support the utilization of over-dentures with early loading as a viable restorative option for many edentulous patients. The majority of the opposing dentitions in these studies were complete dentures and some implant-supported prostheses; there was little difference in success rates between these opposing dentitions. Studies have also suggested that implants for early loading with over-dentures should be splinted with the bar-clip attachment to prevent axial rotation and micromotion.[65,67,74] However, given the success rates with early loading of ball attachment implants it cannot be factually stated that splinting these implants is a requirement for success. Again, further research is necessary.

Figure 21-7 presents an early example of an edentulous patient with adequate bone height, width, and quality. A flapless procedure was done with the placement of six one-piece, single-stage implants from which an immediate impression was taken for a bar constructed that day, passively placed to support a clip-retained full lower denture. Two years later this very successful case was converted to a fixed bridge, which had survived over 10 years at the patient's death.

## Immediate Placement and Loading of Implants in Extraction Sites

The literature describing the placement and immediate loading of implants placed into fresh extraction sockets does not provide an adequate basis for strong conclusions. Good supporting evidence can be found for a variety of techniques and implant types. The literature is very case specific and, because the extraction process and surgical sites are never identical for any given tooth, it falls to the practitioner to make sound judgments based on circumstantial evidence. The overall reasoning behind immediate restoration of these implants is to aid in restoration of soft tissue aesthetics by gingival contouring as well as removing the need for temporary removable prostheses. Conclusions reached by these studies are inherently unreliable due to variance in extraction site morphology and treatment, grafting techniques, implant morphology, and follow-up.[41,43,53,56] One common theme in these studies, however, is that success rates were not compromised by placement in extraction sites if adequate primary stability was obtainable.

Similar problems exist in the literature on placement and immediate loading of implants placed simultaneously with bone augmentation techniques. Most studies of this technique recommend a waiting period prior to implant loading to allow full maturation of the planned implant site's bone morphology.[75,76] Simultaneous bone grafting and immediate loading have been shown to have success in other studies.[77,78] It is apparent that, once again, the driving factor for success of immediate loading is primary stability. Even in cases of sinus augmentation, immediate loading of dental implants can have success rates above 80%.[79]

Figure 21-8 shows a 34-year-old female patient who demonstrated both internal and external resorption on tooth #11. She did not want to wear a removable prosthesis or have

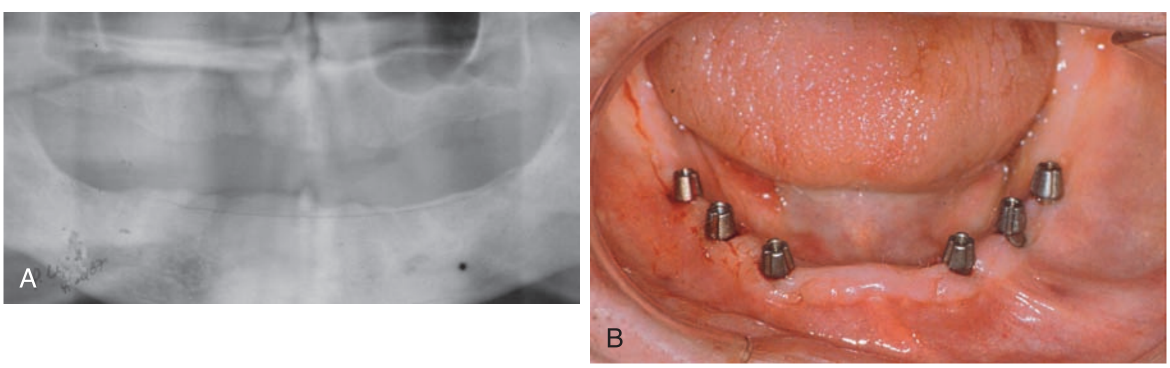


**Figure 21-7. A,** Panoramic radiograph of edentulous mandible well suited for immediate load over denture. **B,** Flapless procedure for placement of six one-piece, single-stage implants.

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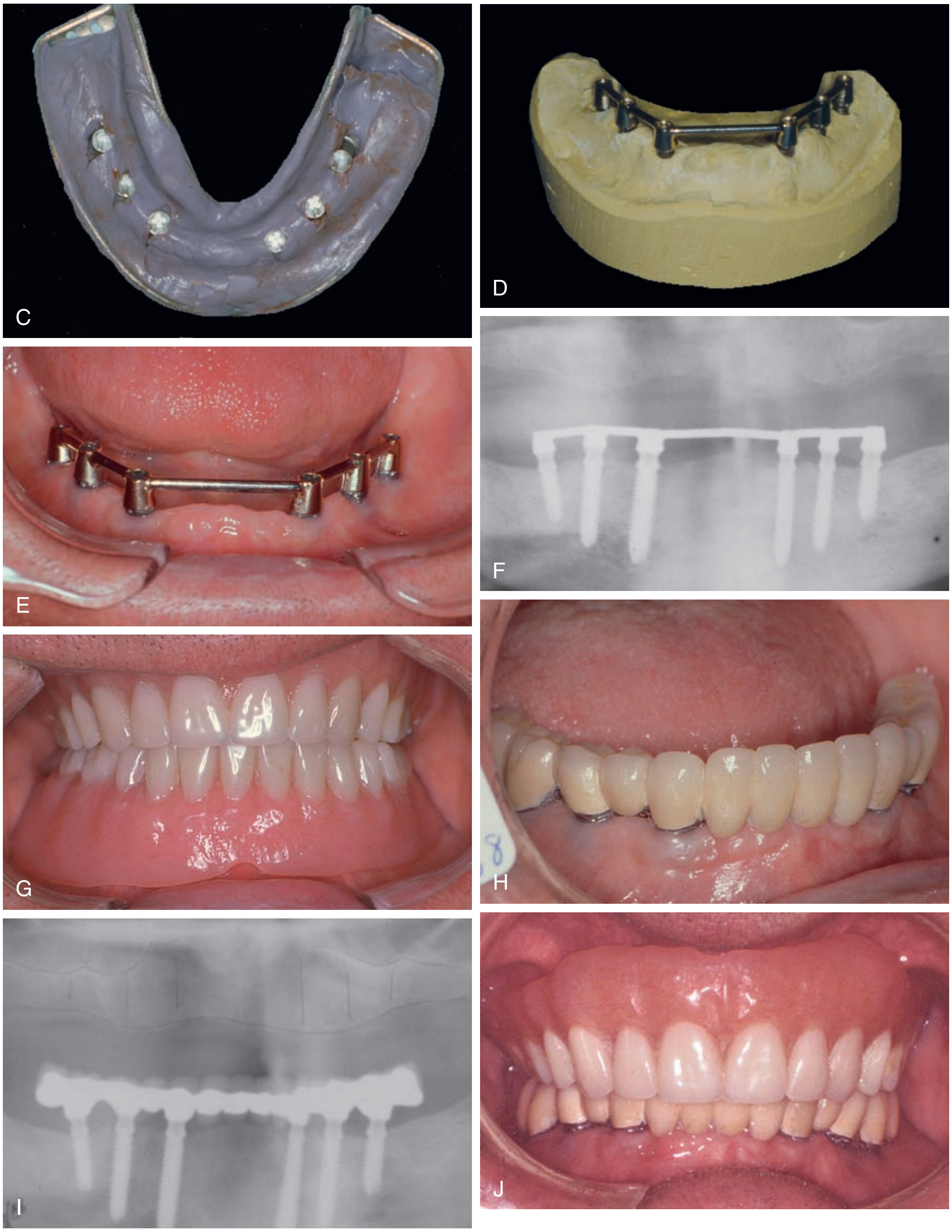


Figure 21-7, cont'd. **C,** Immediate impression taken with impression coping for laboratory model and analogs. **D,** Bar fabricated for placement within 24 hours. **E,** Bar placement passively seated and rigidly connecting all implants. **F,** Panoramic view of integrated implants with passively connecting bar. **G,** Full maxillary denture and mandibular over-denture. **H,** Conversion of bar to fixed mandibular prosthesis. **I,** Panoramic radiograph 2 years after implant placement and insertion of fixed bridge. **J,** Ten-year postoperative clinical photo.

adjacent teeth prepared in any way. She also wanted a very high smile line.

Figure 21-9 shows a 38-year-old female patient with a fractured crown on #10 and a split residual root. The tooth was removed atraumatically and an immediate implant placed. The existing crown was modified and reused as a temporary provisional restoration.

## CAD/CAM Technology in Immediate Loading

There are a number of approach choices to provide optimal, predictable, and timely care to patients. Without question, the use of technology allows practitioners to see into the patient in unprecedented ways. Today's technology provides an under-

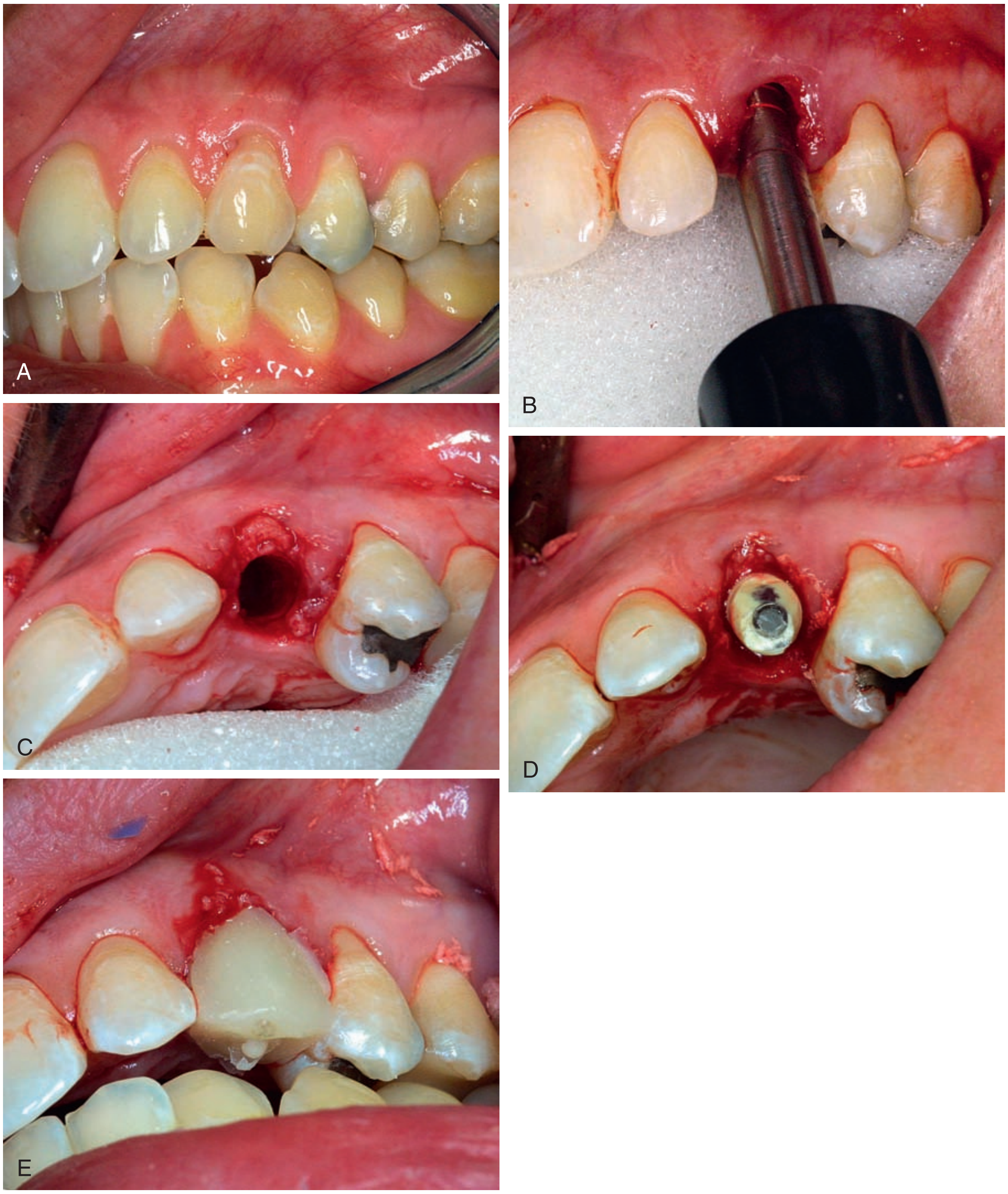

**Figure 21-8.** **A,** Tooth #11 showing significant internal and mesial external resorption. **B,** Atraumatic extraction and careful osteotomy to minimize bone removal and condense surgical site. **C,** Bone graft placed into extraction site to minimize dead space and form osteotomy for implant. **D,** Plastic temporary abutment placed onto implant and prepared for acrylic crown. **E,** Provisional crown adapted to prepped abutment and checked for occlusal interferences.

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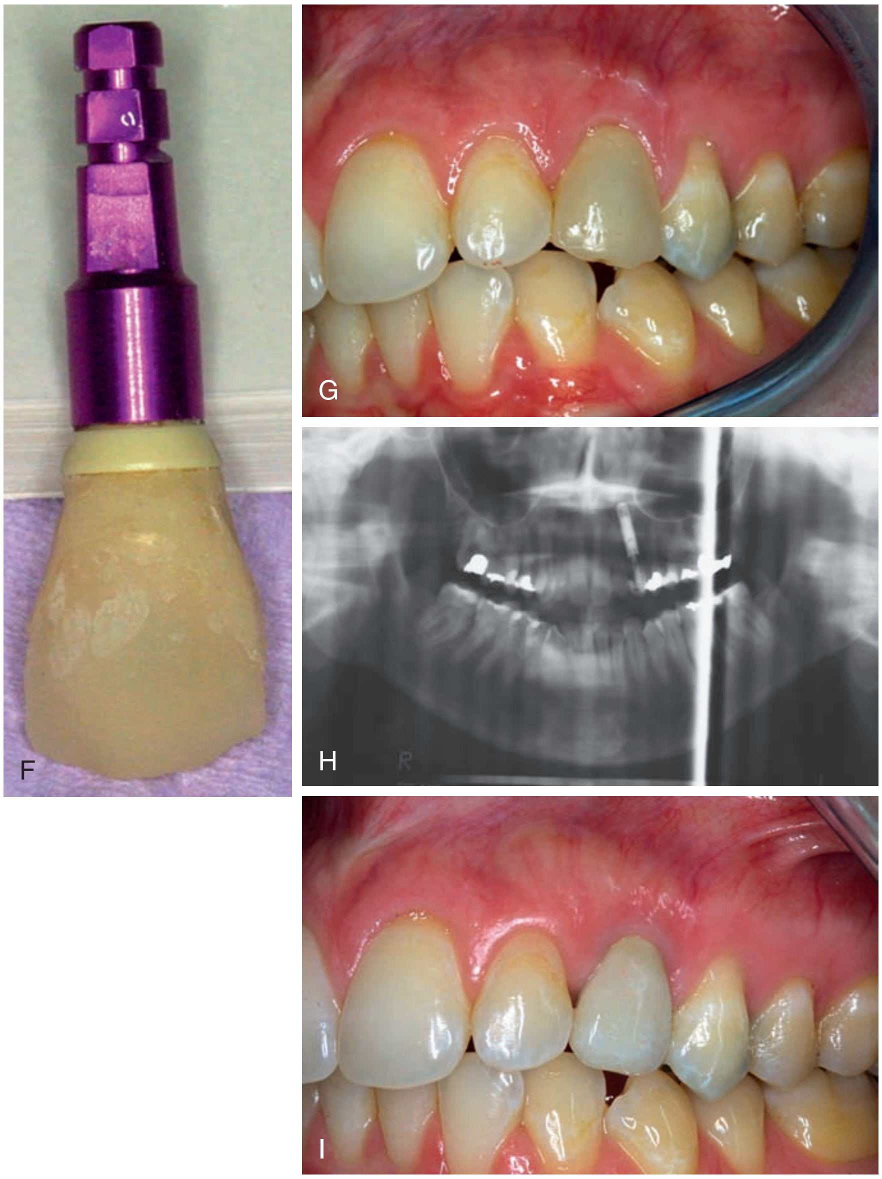


**Figure 21-8, cont'd.** **F,** Temporary crown contoured for proper emergence profile and aesthetics. **G,** Temporary restoration 1 week postoperatively. **H,** Postoperative panoramic radiograph showing implant secured well to apical bone. **I,** Final crown placed at 3 months. (**A, C, D, F, G,** and **I,** From Rosenlicht JL, Ward J, Krauser JT: Impressions at surgical placement and provisionalization of implants. In Fonseca RJ, et al, editors: Oral and maxillofacial surgery, vol 1, St Louis, 2009, Elsevier.)

standing of the risk of failure and what aids in predictable success. When cone beam CT scanning entered the field of implant dentistry it provided the ability to see in advance the surgical challenges that couldn't be easily identified previously. Armed with that advanced information, exact planning of cases can now be carried out. Surgical guides for precise implant placement can be machined and, if so indicated, the prosthesis can be fabricated to whatever degree the practitioner may wish. The chapters in this text that look at cone beam imaging and guided surgery review in great detail these treatment options and their most appropriate applications (see Chapters 8 and 18).

Figure 21-10 shows a 69-year-old male patient who had been edentulous in both the maxilla and mandible for over 40 years. He could no longer wear a maxillary denture comfortably. Cone beam imaging revealed good bone support from which a surgical guide was fabricated, followed by implant planning on computer-based software. With the fabrication of the surgical guide, the dental laboratory fabricated a fixed temporary restoration to be placed at the time of surgery.

## Conclusion

In conclusion, the placement of implants and their immediate restoration, whether provisional or final, can be very advantageous. However, care and appropriate surgical and prosthetic considerations need to be highly contemplated when


**Figure 21-9.** **A,** Loose crown on tooth #10 after fracture of post. **B,** Original crown and residual root after atraumatic removal of tooth. **C,** Implant placement with fixture mount transfer for insertion of implant, registration with impression, and identification of depth of implant. **D,** Prepared plastic temporary abutment. **E,** Original crown adapted to prepared temporary abutment. The emergence profile is established. **F,** Insertion of crown, now being used as a provisional restoration. **G,** Panoramic radiograph of postoperative implant placement. (**C,** From Rosenlicht JL, Ward J, Krauser JT: Impressions at surgical placement and provisionalization of implants. In Fonseca RJ, et al, editors: Oral and maxillofacial surgery, vol 1, St Louis, 2009, Elsevier.)

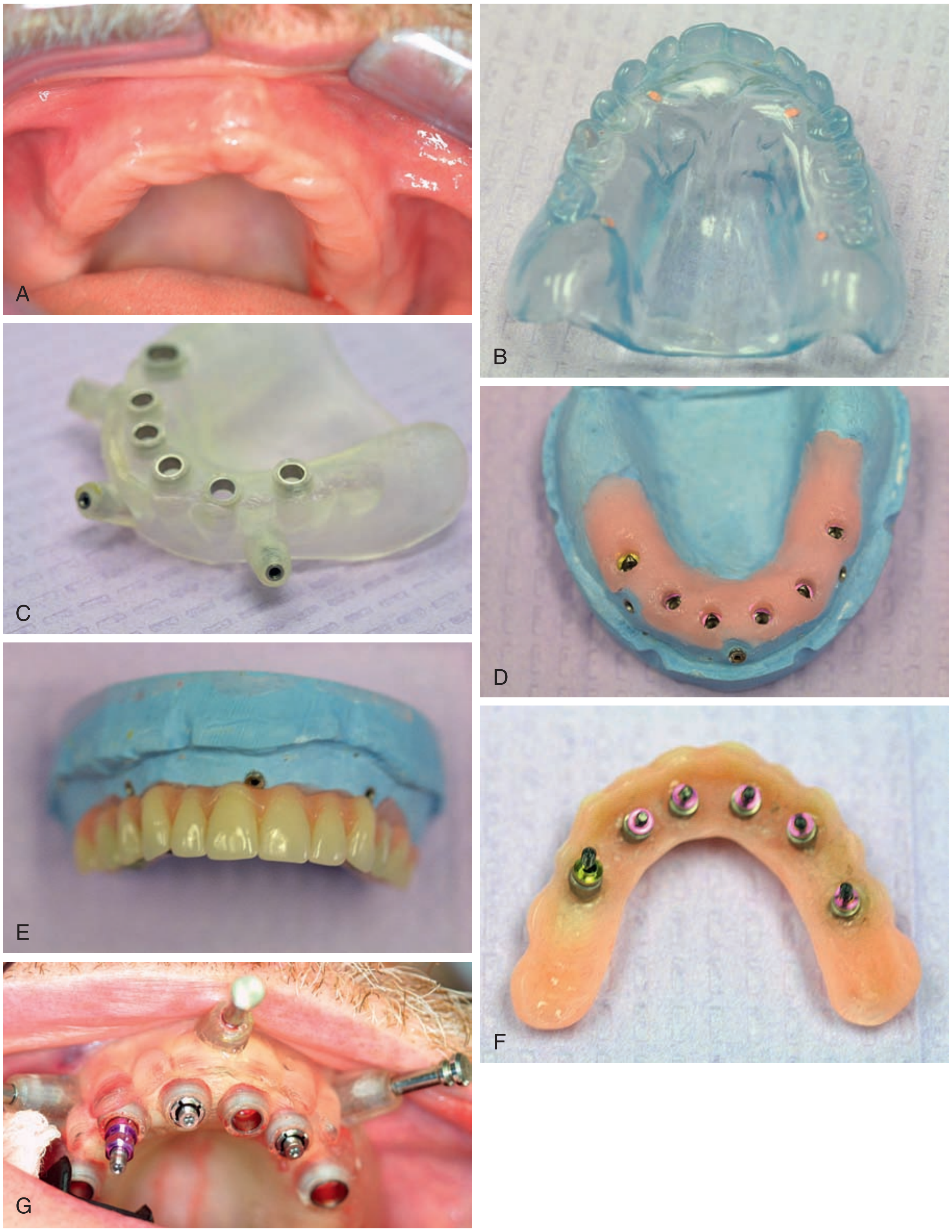

**Figure 21-10.** **A,** Clinical evaluation of maxillary ridge. **B,** Duplicate denture with radiographic markers for cone beam scan. **C,** CAD-generated surgical guide. **D,** Lab-fabricated model. **E,** Presurgical fabrication of a fixed temporary restoration. **F,** Insertion of guided abutments into fixed temporary restoration. **G,** Stabilized and secured surgical guide for implant insertion.


**Figure 21-10, cont'd. H,** Flapless placement of implants in maxilla per the surgical plan. **I,** Full maxillary provisional fixed restoration in place.

performing these procedures. As we perform these procedures, we're increasing the possibility for complications as more aspects of treatments are being rendered. Its success rate may differ slightly from completing procedures in a more conventional way. Of the greatest and most advantageous application of immediate restoration of implants are those cases in which aesthetic needs and soft tissue preservation are most important.

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