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The Immediate Loading of Dental Implants

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Abstract

The aim of this article is to identify current opportunities for the immediate loading of endosseous dental implants. A biologic basis for the clinical parameters associated with success and failure of immediately loaded implants is presented, and select clinical situations where immediate loading is presently advocated will be illustrated. The wide-ranging applications of the immediate-loading concept for endosseous dental implants will be introduced; however, further experimental validation is necessary before incorporating all of these various expedited therapeutic approaches into practice.

Learning Objectives

After reading this article, the reader should be able to:

- discuss the wide-ranging applications of the immediate-loading concept for endosseous dental implants.
- explain current opportunities for the immediate loading of endosseous dental implants.
- describe clinical parameters associated with success and failure of immediately loaded implants.

Evolving Patient Care

Individuals perceive the complete dentition as a state of good health, and edentulous patients perceive themselves in a better light when a functional dentition is established with endosseous dental implants.[1] This contrasts with the aversion reported for the use of removable partial dentures or the frustration reported for the use of complete dentures for mandibular edentulism.[2,3] Implant success rates for single-tooth replacement rival or exceed the clinical performance of fixed partial dentures.[4,5] Implant-supported dental prostheses offer multiple advantages for patients.

The conventional process of implant-based dental rehabilitation was founded on prospective clinical cohort studies that demonstrated the long-term success of root form titanium dental implants.[6,7] High success rates of dental implant therapy have been repeatedly reported. The reports were reviewed by Fiorellini and colleagues, performed according to the established staged protocols with a 3- to 6-month healing period that avoided direct masticatory loading from the prosthesis to the implant.[8] However, the complexities and long duration of implant therapy may discourage some patients and clinicians from electing an implant-based strategy for dental rehabilitation.[9]

Nearly a decade ago, some coalescence of opinion regarding surgical approaches to implant therapy was attained in light of emerging clinical evidence that 1-stage and 2-stage procedures performed using a diverse array of dental implant products resulted in high survival rates for endosseous dental implants.[10-13] Osseointegration was reproducibly achieved using both 1- and 2-stage approaches, and transmu-

Table 1—Examples of Immediate or Early Loading Experience

Author	Number of patients	Time of Loading	Location	Number of Implants and Prosthesis type	Implant Survival
Lorenzoni[15]	12	At extraction	Anterior maxilla	Single tooth	100%
Buchs[16]	93	At extraction	Maxilla and mandible	Single tooth	93.7%
Proussaefs[17]	10	At surgery	Anterior maxilla	Single tooth	100%
Kan[18]	35	At extraction	Anterior maxilla	Single tooth	100%
Rahman[19]	30	At extraction	Maxilla	Single tooth	100%
Anderssen[20]	8	7 days	Anterior maxilla	Single tooth	100%
Jo[21]	75	At surgery/at extraction	Maxilla and mandible	Single tooth	94.8-96%
Cooper[22]	48	3 weeks	Anterior maxilla	Single tooth	96.2%
Rocci[23]	46	At surgery	Maxilla	1 or 2/crown or FPD	91%
Degidi[24]	152 patients	At surgery	Maxilla and mandible	Single tooth, FPD, FD	>98%
Hui[25]	13 patients	At extraction	Anterior maxilla	Single tooth	100%
Glauser[26]	38 patients	At surgery	All locations	Single tooth, FPD, 1 FD	97.1%
Glauser[27]	41 patients	At surgery (up to 11 days)	All locations	FPDs, single tooth	82.7%
Malo[28]	73 patients	At extraction; 1-3 days	All locations	Single tooth, FPD, FD	95.7%
Cornelini[29]	20 patients	At surgery	Posterior mandible	FPD	97.5%
Grunder[30]	10 jaws	1 day	Maxilla and mandible	8-10/FD	92.1%
Cooper[31]	60 patients	At surgery	Edentulous mandible	2/OD	96.7%
Roynesdal[32]	21 patients	3 weeks vs. 3 months	Edentulous mandible	2/OD	100%
Twase-Smith[33]	24 patients	At surgery	Edentulous mandible	2/OD	95.8%/ 100%
Gatti[34]	21 patients	0-20days	Edentulous mandible	4/OD	96%
Chiapasco[35]	226 patients	0-20 days	Edentulous mandible	4/OD	96.9%
Colomina[36]	13 patients	2 weeks	Edentulous mandible	5/FD	96.7%
Van Steenberghe et al[37]	8 patients	At surgery	Maxilla Computer Aided Design	FD	>99%
Brånemark[38]	50 patients	At surgery	Edentulous mandible	3/FD	98%
Horiuchi[39]	17 patients	At surgery	12 mandible/5 maxillae	8-10/FD	97.2%
Jaffin[40]	27 patients	At surgery	21 mandible/6 maxilla	5-6/FD	97% (excluding machined)
Ibanez[41]	11 patients	2-3 days	Maxilla and mandible	FD	100%
Randow**[42]	16 patients	20 days	Edentulous mandible	5-6/FD	100%
Collart&deBruyn[43]	25 patients	30 days	Edentulous mandible	5 FD	
Tarnow[44]	10 patients	At surgery	6 mandible/4 maxilla	5 of 10 loaded/FD	97.1%
Balshi[45]	10 patients	At surgery	Edentulous mandible	3 of 8 loaded/FD	84.7%
Wolfinger[46]	24 patients	At surgery	Edentulous mandible	5-6/FD	97%
Schnitman[47]	10 patients	At surgery	Edentulous mandible	4 of 7 loaded/FD	96%
Salama[48]	2 patients	At surgery	Edentulous mandible	5	95%
De Kok[49]	28 patients	At surgery	Anterior maxilla	43/single tooth	90.6%

cosal healing was disregarded as a potential risk factor for most dental implants.[14]

More recently, several clinical investigations reported similarly high survival rates for endosseous dental implants placed in the mandibular parasymphysis and loaded either immediately after implant placement or within weeks after implant placement (Table 1).[15-49] First offered as expendable or transitional fixtures, these reports of immediate loading dental implants provided new insight into the biological capacity of the mandibular parasymphysis to support the process of osseointegration under diverse clinical conditions. Also, these successful initiatives suggested that immediate loading of endosseous dental implants was, in fact, a feasible clinical enterprise.

As the experience of immediate loading of endosseous dental implants has expanded throughout several centers worldwide, activities have grown to include maxillary complete arch prostheses, single-tooth implants, and even posterior fixed partial dentures and single unit molar crowns. It remains to be demonstrated if all of these procedures will achieve high success over long periods of time.

Defining Immediate Loading

Immediate loading is variably defined, depending on the restorative protocol used at various investigating centers. The interval between the implant placement and the restoration has varied between 0 and 20 days. However, from a patient's perspective, immediate loading should refer to the placement and restoration of an endosseous dental implant during the same clinical visit.

Because this procedure often involves the placement of a provisional restoration, the term "immediate provisionalization" also was proposed. The speculation that immediate provisionalization by virtue of provisional materials represented a reduced loading environment is not fully supported by existing literature.[50] Immediate provisionalization of implants also describes the placement of a provisional restoration that is designed to lack centric and eccentric contacts to avoid potential risks of loading by function (thus alternatively termed nonfunctional immediate loading). Despite this confusion, it is possible to define immediate loading in terms that contrast other loading strategies (Table 2).

Table 2—Definition of Loading Strategies for Dental Implants

Immediate Loading	Enhanced primary stability	Loading is temporally irrelevant with respect to osseointegration	Implant placement with primary stability and prosthetic loading occurs at the same clinical visit;
Early Loading	Primary stability	Loading after onset of osteogenesis, prior to attaining osseointegration	Implant loading occurs 2 -3 weeks* after implant placement
Conventional Loading	Primary stability	Loading after osteogenesis and woven bone remodeling to load-bearing lamellar bone	Implants are loaded 3-6 months after healing in a submerged or nonsubmerged mucosal orientation.
Delayed Loading	Stability limited	Loading after protracted period and process of bone formation involving low-density or augmented bone.	Loading 6-12 months after implants are placed without primary stability, when implants are placed into bone of low density, when implants are placed into extraction sockets or concomitant with bone grafting without significant primary stability

*Rapid loading should not perturb initial healing (blot clot formation, cellular infiltration, onset of epithelialization; approximately 2-3 weeks of healing) provisionalization infers no occlusal contact for restoration of unsplinted implants.

Table 3—Clinical Assessments of Primary Stability

Method	Parameters	References
Tactile Assessment	Sound and visualization	Adell[62]
Reverse Torque[#]	>25 Ncm	Sulllivan[63]
Cutting Resistance	> 40 Ncm	Turkyilmaz[64] Friberg[65]
Insertion Torque*	>30 Ncm >45 Ncm	Malo[28] Horiuchi[39]
PerioTest	-2.5 -3.5	Olive[66] Aparicio[67] Hui[25]
RFA (*at placement*)	ISQ = 57-82 ISQ = 60 (maxilla)	Balleri[68] Meredith[69] Olsson[29]

#-not relevant to the immediate loading scenario

1)* note - evaluation of insertion torque for orthopedic screws suggests damaging effect of high insertion torque and cutting resistance was not related to success or failure of dental implant.[70]

A Biological Basis for Immediate Loading Success

Three predominant biologic factors emerge in consideration of osseointegration and immediate loading They are: (1) factors affecting interfacial bone formation (osteogenesis); (2) periimplant bone resorption (osteolysis); and (3) micromotion effects on periimplant osteogenesis. Because of the time-dependent nature of osteogenesis, success further depends on maintaining implant stability during healing. As depicted, success relies on primary stability and achieving abundant interfacial bone formation to offset cortical bone resorption that results from implant placement.[51] Strategies for improving immediate loading success may be directed at enhancing osteogenesis, limiting functional loads and micromotion, and controlling the resorption that reduces stability during the healing period.

A Role for Bone Formation

Osteogenesis must occur at the implant surface in the immediate loading environment.[52] Both in vitro and in vivo studies demonstrated that surface topography enhancement results in increased osteogenic activity of adherent cells and increased bone-to-implant contact attributable to this increased osteogenic cellular activity.[53] More recent investigations indicate effects of specific surface modifications on osteoblastic gene expression and induction of wound-healing responses. The significance of contact osteogenesis as described by Davies,[54] the role of surface-dependent gene regulation, and the demonstration of surface-dependent increases in bone formation has been reinforced by human clinical histological demonstration that enhanced surface topography supports increases in interfacial bone formation during the first 6 months after implant placement.[55,56] The early increased rate or extent of osseointegration may be a central determinant of immediately loaded implant success.

Primary stability is the clinical means of controlling micromotion between the implant and the new, forming interfacial tissue.[57] This helps to establish the proper mechanical environment for osteogenesis. Immediate provisionalization and immediate loading scenarios superimpose micromotion on interfacial tissue. How much micromotion is permissible or precisely how masticatory function relates to interfacial micromotion has not been fully addressed. When precursor osteoblastic cells are exposed to limited physical deformation that models micromotion in a laboratory setting, differentiation is enhanced in cell culture experiments.[58] Despite limitations of interpretation, some range of microstrain is considered advantageous for osteoblastic differentiation,[59] bone ingrowth,[60] and osseointegration.[61] Current in vivo studies suggest that micromotion greater than 150 µm (direction and frequency remain ill-defined) limits osseointegration.[57]

Clinical guidelines for gaining and enhancing implant primary stability include careful evaluation of the recipient bone site, careful osteotomy preparation, undersized osteotomy, self-tapping implant insertion, osteotome preparation of the site, and use of improved implant designs. It must be acknowledged that little data exists regarding the relationship of osteotomy dimension, implant placement, and resulting bone formation or resorption. Current clinical approaches to immediate loading advocate attaining high levels of primary stability and an array of methods for assessing implant stability are available (Table 3).[25,28,29,39,62-70] Initial studies of immediate loading suggested that insertion torque values of 40 Ncm to 45 Ncm were required; more recently, values of 30 Ncm to 32 Ncm have been reported. Additional analytical values of correlation of insertion torque or stability values with dental implant outcomes are needed.

In addition to surgical technique, implant design may affect primary stability. Careful examination of implant stability by resonance frequency analysis (RFA) after placement of implants in canine mandibles showed that implants with a rough surface and retentive elements in the transcortical region maintained implant stability better than machined implants of a traditional design.[71] Additional clinical data provided by RFA of implant stability after immediate loading further suggests that surface enhancement also contributes to maintained implant stability during healing.[72] This maintenance of implant stability has been confirmed, and implant surface modifications have been implicated in producing this result.[73]

The Role of Bone Resorption

As suggested above, maintaining implant stability is a key aspect of immediate loading success and depends on bone formation and the adaptive bone remodeling that occurs at dental implants after placement. The complex nature of the load experienced by dental implant interfacial tissues is beyond the scope of this report[74]; however, accepted generalizations (often cited as Wolff's Law) include concepts of moderate and controlled loading environments that support or enhance osteogenesis, higher loads that induce bone resorption, and reduced loading environments that lead to tissue atrophy. However, intervening resorption of crestal bone is a consequence of the transcortical implant placement.[51]

It is unlikely that a loading environment associated with tissue atrophy exists at an unloaded healing dental implant; continuous bone loss is not revealed at titanium root-form implants. More importantly, when primary stability is achieved, it is likely that a loading environment associated with osteogenesis is present. Preclinical histology from primate and canine models revealed that immediate loading of dental implants led to greater bone-to-implant contact, with incrementally more bone formed at the loaded, relative to unloaded, endosseous dental implants.[75-77] A possible conclusion is that the loading environment created by immediate loading at a primary stable implant is favorable.

Deleterious overloading and high magnitude loads, particularly in the crestal region of the implant, induces bone resorption.[78] Proof of reduced stability in the first 3 to 6 weeks after implant placement has been obtained by measuring implant interfacial stiffness using RFA.[23] Most immediate load failures occur at 3 to 5 weeks after implant placement.

Bone resorption is the result of cell and molecular regulation of osteoclasts.[79] At least 4 key molecular aspects of osteoclast activation are now well defined: (1) a specific transmembrane receptor and its ligand (RANK and RANKL) is essential for osteoclast differentiation; (2) cell adhesion via a specific transmembrane receptor (β3 integrin) are required for osteoclastic activity; (3) a key intracellular mediator of inflammatory signals (NF-κB) promotes osteoclastogenesis (lipopolysaccharides from oral bacteria are powerful inducers of this particular osteoclastic signal); and (4) mechanical strain of bone induces osteoclastogenesis. A combination of mechanical status and inflammatory environment at the implant surface determines the extent of local bone resorption, and thus affects implant stability during the osseointegration process.

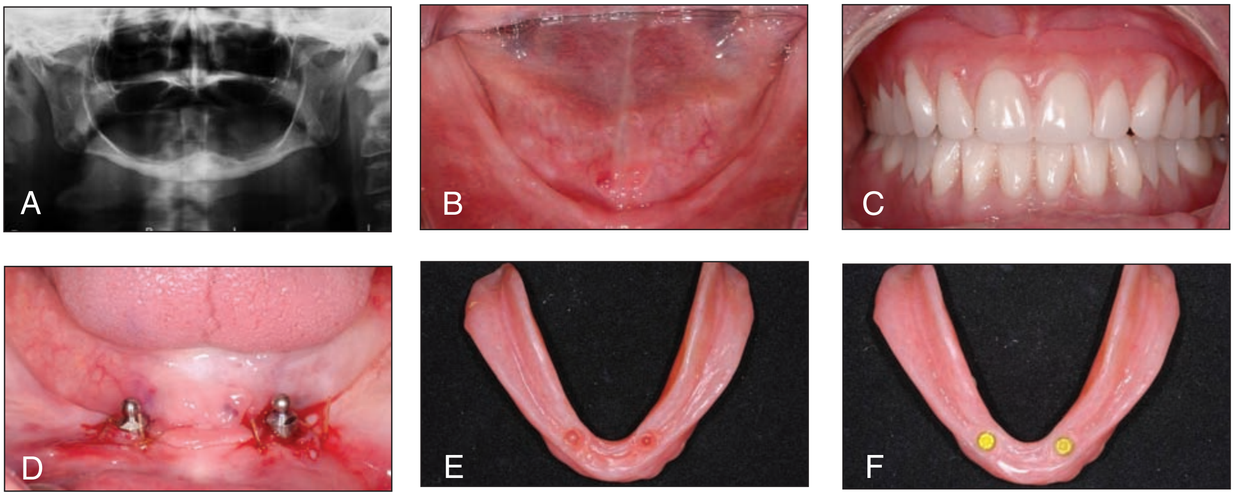
> The early increased rate or extent of osseointegration may be a central determinant of immediately loaded implant success.

Clinical guidelines for immediate loading success should also focus on reducing cortical or crestal bone resorption. Suggestions, in part derived from experience in immediate placement,[80] include avoiding elevation of mucoperiosteal flaps when feasible, careful and precise osteotomy preparation, and avoiding instrumentation of the buccal plate of the socket. Tooth resorption leads to bbuccal alveolar bone resorption that must be anticipated. Engaging a thin buccal plate with the implant places the implant at risk of loosening should subsequent resorption occur. The control of the periimplant inflammation also necessitates the implant placement at the appropriate axial depth and the use of components that preclude abutment loosening or experience retrograde bacterial colonization at the implant/abutment interface (unitary design, 1-stage or modular, solid, conus design implants, and implant-abutment interfaces that lack micromotion). Extended prescription of antimicrobial rinses can be valuable in limiting bacteria-associated inflammation at the healing implant site.

A Role for the Immediate Provisional Restoration

We have found that using a provisional restoration at the time of implant placement demands consideration of 3 factors: (1) reduction of mechanical challenges to osseointegration; (2) promotion of periimplant mucosal health and control of periimplant inflammation; and (3) establishment of periimplant mucosal architecture (development of transition contour).

The elimination and control of functional contacts is advocated for unsplinted implants. Eliminating tooth contacts at the maximum intercuspation position is possible. Excursive contacts are more difficult to control; however, development of contacts can be avoided, delayed, or strategically arranged. It is essential to check the provisional contacts during the first week follow-up visit and at the 3- to 4-week visit. This is particularly important after orthodontic tooth movement where minor changes in tooth position can evoke unintended contacts in centric or eccentric positions.



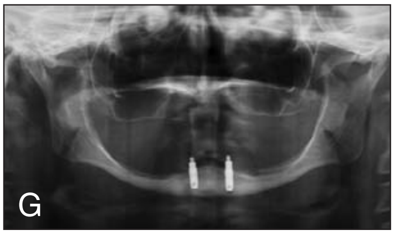


Figure 1—a) Initial panoramic radiographic examination. Notice the severe resorbed mandible. b) Clinical intraoral examination of the edentulous mandible reveals a thin atrophic mandibular ridge c) Complete maxillary and mandibular dentures are used as guides for surgery at time of delivery. Occlusion and tissue adaptation are evaluated prior to initiating surgery. d) Two implants and ball abutments were installed; in this case ball abutments were connected to the fixtures at time of implant placement and soft tissue was sutured around them using small full thickness mucoperiosteal flaps to reveal the local ridge crests and mandibular anatomy. The soft tissues were carefully closed around the ball abutments in preparation for immediate provisionalization. e) Intaglio surface of the mandibular complete overdenture at time of placement. Note that the attachment space was relined with a soft recline material (GC Reline) the day of surgery. f) Two preci-clix attachments were connected to the mandibular overdenture after 8 weeks of healing. At this time a clinical remount was performed. g) Panoramic radiograph taken right after implant placement was completed.

The nature of the provisional restoration and abutment-provisional crown finishing line are important factors in promoting periimplant mucosal health and limiting inflammation. Provisional crown margins should not approximate the implant/bone interface; therefore, UCLA-type abutments are not preferred because they place an interface with potential for micromotion and bacterial population at the crestal bone. Recommended are titanium or ceramic abutments placed opposing as much of the periimplant mucosa as possible. Dense acrylic denture teeth provide an ideal starting point for creating a provisional crown for single-tooth replacement. The fit of the provisional restoration should be refined on the abutment or abutment/fixture analogs using an extraoral step for finishing and refinement to keep restorative particulate materials from the healing tissue.

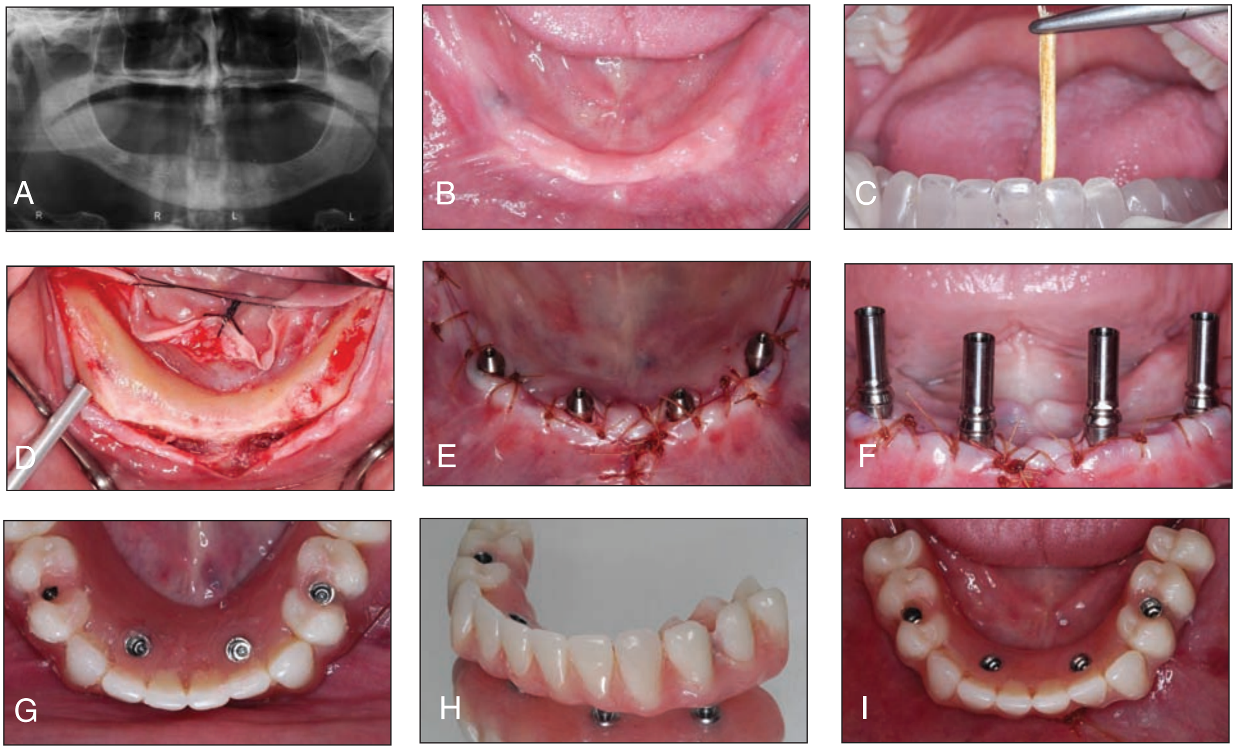
Cementation of the interim prosthesis is an important step in the immediate loading scenario. Permanent cements (eg, glass ionomer and polycarbonate) offer an additional level of security against debonding and uncontrolled or unintended loading because of a loose prosthesis. Careful examination of the periimplant sulcus after cementation and at the first recall after surgery should include the highest suspicion for retained cement that must be removed at this time by scaling and lavage. At the 7- to 10-day recall, examination for retained cement and its removal should be repeated. This complication makes a compelling case for the use of screw retained prostheses.

Whether the interim prosthesis is fixed by a screw or cement, it should be retained for the 6- to 12-week healing period. Excluding the short-term removal of immediately loaded implant prostheses for implant evaluation led to improved success rates.[43] Clinical manipulations such as forming impressions, provisional restoration delivery, or debonding could perturb the osseointegration process.

Illustrating Immediate Loading for Clinically Validated Scenarios

Implants have been either immediately loaded after insertion (2-3 days), loaded early (6 weeks), or conventionally loaded (3-8 months) in edentulous mandibles of adequate bone quality and shape. The Cochrane collaboration found 3 relevant randomized clinical trials and 2 trials including 68 patients of high scientific merit.[15] Statistical evaluation of this data indicated there were no differences on measures of prosthesis failure, implant failure, and marginal bone loss on intraoral radiographs when immediately loaded implants were compared with conventionally loaded implants in the parasymphyseal mandible. Several additional cohort trials have been published that suggest high implant and prosthesis short-term survival. This conclusion supports the immediate provisionalization of mandibular overdentures (Figures 1A - 1J) and immediate loading of implant-supported fixed dentures (Figures 2A - 2G) for comprehensive rehabilitation of mandibular edentulism.

There also is data to guide the clinical decision for immediate provisionalization of the single tooth implant placed in healed or intact alveolar ridges. Early loading of TiO_2-grit blasted single-tooth implants[a] replacing anterior maxillary teeth (loading at 3 weeks with provisional crowns in centric contact) was successful in the short



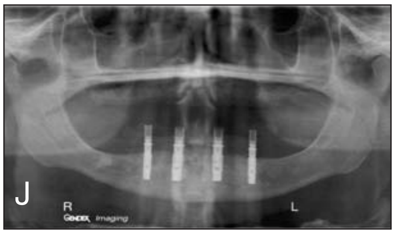


Figure 2— a) Initial panoramic radiographic examination of the edentulous jaws. b) Initial clinical examination of the edentulous jaws. c) Surgical guide positioned in the mouth with parallel drill access holes (duplicate denture). d) A midcrestal incision is made, and full-thickness flap is elevated, allowing the alveolectomy needed to create sufficient occlusogingival clearance for the prosthesis and abutments. e)Four implants and abutments (AstraTech 4.0x 11mm; uniabutments 20°) were placed. Primary stability was assumed. f) Temporary cylinders were connected to the abutments, for interim acrylic fixed denture fabrication by a direct technique. g) Interim acrylic fixed completed denture. Temporary cylinders were picked up intraorally with cold cure resin the day of the surgery by the conversion denture technique. h) The interim acrylic fixed complete denture was carefully finished before delivery. i) Interim acrylic fixed completed denture delivered within 2 hours of surgery. j) Panoramic radiographic examination obtained at time of implant placement. Four implants were placed in the anterior mandible and abutment connection.

term.[21] Implant survival and periimplant bone levels were stable over a 3-year follow-up period.[80] Loading of 8 TPS-coated titanium implants[b] 1 week after placement was successful; no implants were lost, and marginal bone levels were increased by 0.53 mm over a 5-year period.[20] In a study of immediate loading in diverse applications, 20 single tooth oxidation-processed titanium implants[c] were successfully loaded.[24] A one-part implant/abutment was evaluated in 93 subjects. Altiva implants[d] (n=142) were immediately loaded, and the implant survival rate was 93.7%.[15] There is a growing database for immediate provisionalization of unsplinted implants in healed anterior alveolar ridges to support this procedure.

Illustrating Immediate Loading for the Yet to be Fully Validated Clinical Scenarios

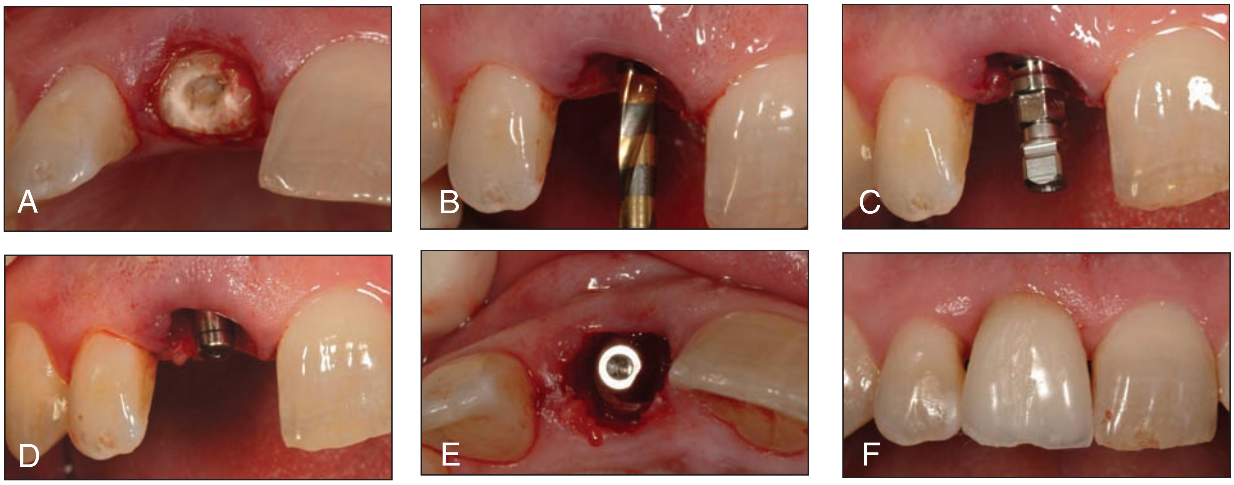
Additional short-term data suggest that immediate placement and provisionalization of single tooth implant may be achieved with success. Thirteen machined implants[c] were placed immediately after anterior maxillary tooth extraction and provisionalized without occlusal contacts. Failures were not detected.[44] A similar result with a similar protocol using Steri-Oss implants[e] was reported after a 12-month evaluation of 35 patients.[17] Thirty-five SLA surface implants were placed in maxillary single-tooth extraction sockets, and provisional crowns without occlusal contacts were placed at surgery. The 6- to 12-month evaluation of these implants indicated no implant failure.[19]

Evaluations of single tooth replacement by immediate dental implant placement and loading suggest that the expected success will be defined, and uniform clinical procedures will be established (Figures 3A - 3I). This procedure encounters the complexity of diverse tooth socket anatomy challenging primary stability and implant positioning; there exists a limited number of short-term reports that support this approach to tooth replacement with endosseous implants.[83,84]

Several cohort investigations of immediate loading protocols have included maxillary rehabilitation.[24,27,36-39,42] These limited reports have included the placement of 8 to 12 implants restored using provisional splinted pros-

a Astra Tech Inc, Waltham, MA 02451; www.astratechusa.com
b Straumann, Andover, MA 01810; www.straumann.com
c Bio-Dent, Toronto, On, Canada; www.biodentlab.com
d Altiva Corporation, Charlotte, NC 28273; www.altivacorp.com

e Nobel Biocare, Yorba Linda, CA 92887; www.nobelbiocare.com



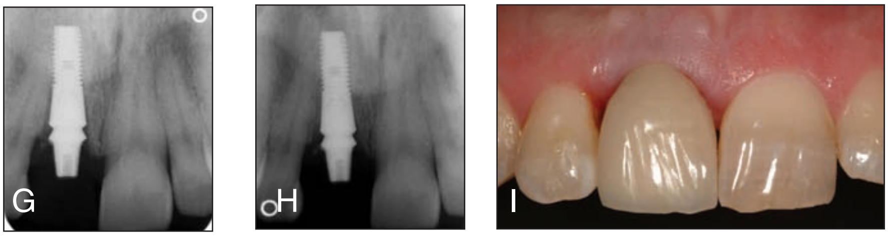


Figure 3—a) Occlusal view of the remaining tooth structure of tooth # 8 prior to extraction. The opportunity for endodontic treatment and conventional prosthodontics was excluded because of a vertical root fracture. b) Osteotomy being prepared with a 2.5 mm drill right after tooth extraction for immediate placement of the fixture in space of tooth # 8. A flapless approach was chosen only after the integrity of an abundant buccal osseous plate was clinically confirmed. c) Implant placed in position of tooth # 8, in an ideal coronal-apical and mesio-distal position. There should be no contact with the buccal plate and primary stability must be achieved at the depth of placement consistent with an acceptable restoration. d) Direct abutment attached to fixture at time of implant placement. For the immediate provisionalization, an abutment for a cement retained crown was selected (Direct Abutment). e) Occlusal view of the abutment placed at the time of implant placement, confirming an ideal facio-lingual position. f) Immediate loading of the fixture with a provisional restoration in place after immediate placement of the implant. Careful attention to cement removal is required. g) Periapical radiograph obtained at time of implant placement with a DA5 medium titanium abutment. h) Postoperative periapical radiograph taken 3 months after implant placement. i) Final crown the day of delivery. Note that the gingival levels have been maintained from tooth extraction to crown delivery.

thesis. Development of protocols for reproducible management of the maxilla using immediate loading protocols is ongoing. One possible approach is the use of 6 to 8 implants loaded using a cement-retained interim fixed denture composed of acrylic resin (Figures 4A - 4I). An alternative approach involves the computer-aided fabrication of a surgical guide and final prosthesis for delivery immediately after surgery.[36] The immediate loading of splinted implants for maxillary rehabilitation has shown great promise.[40] However, one preliminary report indicated that for the 95% survival recorded at the implant level, nearly one third of the patients had experienced an implant failure during the provisionalization period.[85]

There is less clinical information for unilateral fixed partial dentures. Compelling data has been reported by Glausner and includes implant-supported prostheses in low-density posterior regions.[26] Histological evidence for successful osseointegration has been provided.[22] The potential value of immediate loading of unilateral fixed partial dentures can be described for the replacement of failed fixed partial dentures. As illustrated (Figures 4A - 4I), rapid restoration of function can be achieved by replacement of failed abutment teeth using dental implants and immediate loading with a provisional fixed partial denture. While this has been attempted in select cases with comprehensive informed consent, there remains only limited published data and experience to support this procedure in clinical practice.

Conclusion

An understanding of bone physiology dictates the clinical procedures that lead to success for immediate loading of endosseous dental implants, and the clinical checklist for immediate loading is as follows:

- Absence of active disease (eg, periodontitis, caries, periapical infection).
- Presence of or ability to establish a stable interocclusal relationship.
- Sufficient bone volume for implant placement.
- Implant placement consistent with global treatment planning goals.
- Implant placement occurs with verified primary stability.
- Implant placement does not compromise restoration (too deep axial placement).
- Buccal bone resorption immediately following extraction may challenge immediate placement andloading protocols.
- Provisional restoration develops proper transition contour.
- Provisional restoration supports periimplant mucosal health and architecture.
- Occlusal contacts controlled or avoided.
- Control periimplant inflammation (antimicrobial mouthrinse).
- Follow-up evaluating soft tissue and occlusal relationships at 1 and 4 weeks.

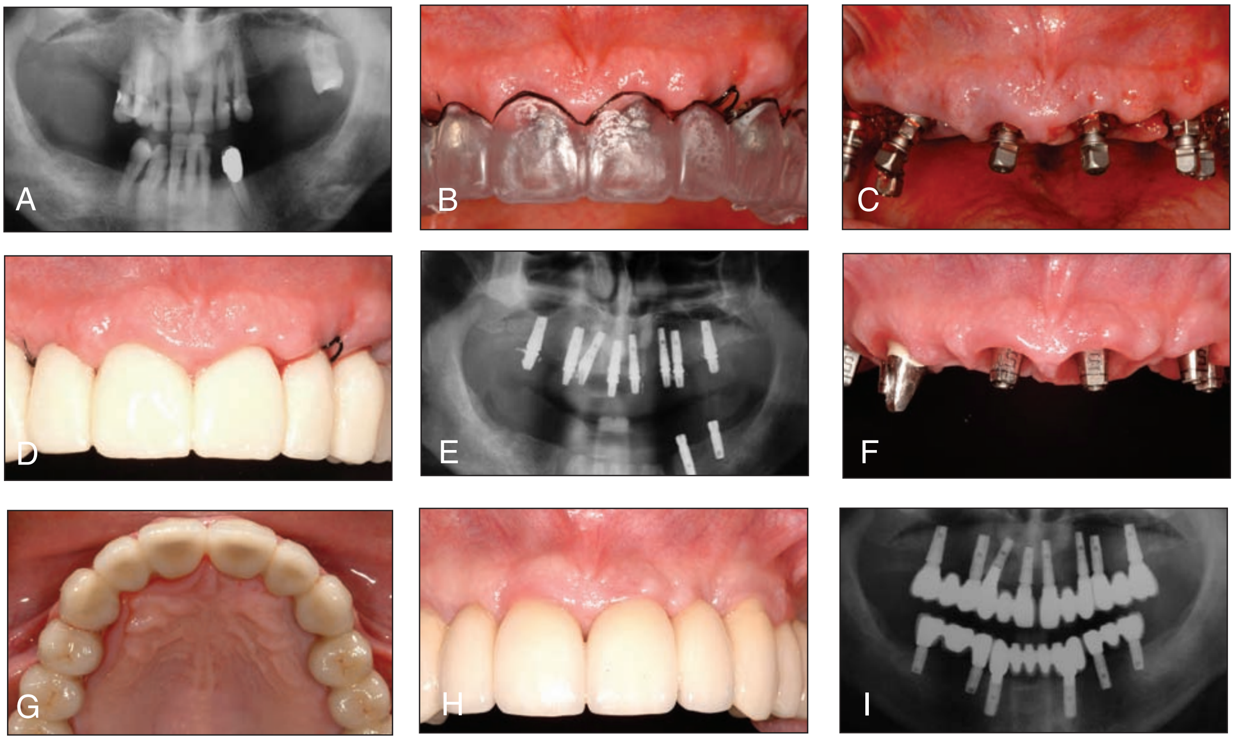


Figure 4—a) Panoramic radiograph at time of initial examination. b) Frontal view of the surgical guide created from the diagnostic waxing in place showing the ideal position of the cervical contours of each tooth. These contours direct proper implant placement. c) Eight implants were placed into both residual alveolar ridges and immediate extraction sockets. All implants were placed in relationship to the surgical guide cervical contours. The absence of sufficient buccal bone at the #6 tooth position mandated the palatal orientation of the implant. d) A cement-retained provisional fixed denture was created on cement-retained abutments and careful adjustments to the cervical contours were made to guide tissue healing. e) Panoramic radiograph after 8 implants were immediately placed and loaded. f) Soft-tissue contours after 3-month healing. Direct abutments and a single custom abutment for the # 6 implant were used. Note the absence of periimplant inflammation. g) Occlusal view of the final maxillary prostheses. h) Facial view immediately after delivery of the all-ceramic prostheses in the maxilla. Note the control of the cervical tissue contours has been maintained from implant placement through provisionalization to final prosthesis delivery. i) Final panoramic radiograph with the final prosthesis cemented

Once primary stability is established, loading environments and potential inflammatory changes must be controlled to permit maintained implant stability in support of osseointegration. Modification of implant surgery and provisional prosthesis techniques can promote tissue integration. Improved implant components are one aspect of clinical success for immediate loading. With detailed planning and execution, the parasymphyseal mandible and anterior single-tooth implants placed into an intact alveolus appear successful in the short term. The generalized and widespread application of immediate loading requires additional evaluation and development.

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Quiz 3

1. **Immediate loading should refer to the placement and restoration of an endosseous dental implant:**
   a. during the same clinical visit.
   b. between 0 and 20 days.
   c. when there is an opposing tooth.
   d. when there is an opposing implant.

2. **The biologic factors that emerge in consideration of osseointegration and immediate loading include:**
   a. factors affecting interfacial bone formation.
   b. micromotion effects on periimplant osteogensis.
   c. periimplant bone resorption.
   d. all of the above

3. **What is the clinical means of controlling micromotion between the implant and the new, forming interfacial tissue?**
   a. covering the implant with a barrier membrane
   b. implant placement in Type IV bone
   c. primary suturing of the implant
   d. primary stability

4. **Accepted bone resorption generalizations (Wolff's Law) include:**
   a. moderate and controlled loading environments.
   b. higher loads that induce bone resorption.
   c. reduced loading environments that lead to tissue atrophy.
   d. all of the above

5. **Most immediate load failures occur how long after implant placement?**
   a. 0 to 2 weeks
   b. 3 to 5 weeks
   c. 4 to 6 months
   d. 1 to 2 years

6. **A key intracellular mediator of inflammatory signals that promotes osteoclastogenesis is:**
   a. RANK and RANK-L.
   b. ,3 integrin.
   c. NF-ÎB.
   d. osteoprogentin.

7. **Which offer an additional level of security against debonding and uncontrolled or unintended loading because of a loose prosthesis?**
   a. petroleum-based lubricants
   b. temporary cements
   c. permanent cements
   d. composite sealers

8. **Implants have been loaded early, which is:**
   a. 0 to 2 days.
   b. 2 to 3 days.
   c. 6 weeks.
   d. 3 to 8 months.

9. **For immediate loading of splinted implant for maxillary rehabilitation, one preliminary report indicated that for the 95% survival recorded at the implant level, nearly how many of the patients had experienced an implant failure during the provisionalization period?**
   a. 10%
   b. one third
   c. two thirds
   d. 75%

10. **Once primary stability is established, what must be controlled to permit maintained implant stability in support of osseointegration?**
    a. food/debris accumulation interproximally
    b. excessive vertical/centric contacts only
    c. excessive lateral excursive contacts only
    d. loading environments and potential inflammatory changes

Please see tester form on page 227.

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3.	a	b	c	d	**3.**	a	b	c	d	**3.**	a	b	c	d
4.	a	b	c	d	**4.**	a	b	c	d	**4.**	a	b	c	d
5.	a	b	c	d	**5.**	a	b	c	d	**5.**	a	b	c	d
6.	a	b	c	d	**6.**	a	b	c	d	**6.**	a	b	c	d
7.	a	b	c	d	**7.**	a	b	c	d	**7.**	a	b	c	d
8.	a	b	c	d	**8.**	a	b	c	d	**8.**	a	b	c	d
9.	a	b	c	d	**9.**	a	b	c	d	**9.**	a	b	c	d
10.	a	b	c	d	**10.**	a	b	c	d	**10.**	a	b	c	d

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