Immediate Restoration and Loading of Dental Implants: Clinical Considerations and Protocols

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The use of dental implants to assist in the treatment of partial and complete edentulism is well documented. Most of the implant literature, however, reports results associated with implant survival and success when there has been adherence to rigid placement and loading protocols. Conventionally, these protocols call for the undisturbed healing of the implant—3 months in the mandible and 4 to 6 months in the maxilla. This article evaluates the literature and develops protocols for clinical procedures for the early or immediate restoration or loading of dental implants. Criteria are established for defining immediate loading, immediate restoration, early loading, and early restoration as compared to conventional protocols. The review assesses factors that influence accelerated loading and restoration decisions, including bone quality and quantity, implant design, splinting of implants, and prosthetic design. Conclusions and recommendations are made based on the experience of the consensus group charged with considering these procedures and on the current literature published on these protocols.
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Successful implant-based dental treatment has been associated with rigid protocols advocating lengthy periods of undisturbed healing.[1–3] Originally recommended for the edentulous mandible, implant-based treatment predicated on such protocols has expanded to include the edentulous maxilla, partially dentate arches, and single missing teeth. This expansion is the result of continued treatment success for these indications, despite the perceived increase in surgical and restorative risk.

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Because the recommendations for implant restoration and loading are observational in nature, clinicians have questioned their validity. Particular attention has been paid to the timing of restoration with no occlusal contact and/or loading with occlusal contact in centric occlusion or maximum intercuspation and what loading entails. Several authors have made efforts to define terminology and have suggested modifications to long-established clinical practices.

The literature addressing implant survival and treatment protocols has been addressed by other articles presented by this consensus group.[4,5] This literature suggests that implant loading has been associated with occlusal contact and with "abutment connection or torquing" and has typically occurred between 3 and 6 months after implant placement. It should be noted that this period of healing is recommended predominantly for smooth-surfaced or machined implants, and for earlier versions of rough-surfaced implants.

Recommendations for the loading of implants characterized by a rough surface can be less than 3 months. The loading of the sand-blasted, large-grit,

acid-etched (SLA) surface implant (Institut Straumann, Waldenburg, Switzerland), for example, has been associated with abutment torquing to 35 Ncm, has been evaluated in animal trials,[6] and has proven successful in humans when loaded as early as 6 weeks postplacement.[7] Although recommended, such loading is still early in comparison to the conventions established in the body of literature[4,5] and will be considered as such. Such early loading protocols have been used for both edentulous and partially dentate patients.

Clinical parameters associated with the success of early or immediate restoration or loading have been documented. Although the decision to immediately restore or load dental implants is made prior to initiation of care, progression can only be confirmed clinically at the time of implant placement with appropriate assessment of implant stability, bone quality, and general site health. Several authors have detailed clinical factors to be considered when assessing the applicability of immediate restoration or loading.[8–10] These authors emphasize the particular importance of the following:

1. Primary clinical stability of the implant(s)
2. Adequate implant splinting where appropriate
3. Provisional restorations that promote splinting and reduce or control the mechanical load applied to the implant(s)
4. Prevention of provisional restoration removal during the recommended period of implant healing
5. Incorporation of the team approach and the use of surgical templates

In addition, authors have identified risk factors associated with immediate restoration or loading of dental implants.[8,10] These include:

1. The presence of high masticatory or parafunctional forces
2. Poor bone quality or volume
3. The presence of infection

Masticatory function as related to dental implant-based treatment, however, has been considered only rarely in the literature. Degidi and Piattelli[11] described differences between functional and nonfunctional loading. *Immediate functional loading* of implants involved patients receiving prostheses with occlusal function on the day of implant placement, whereas *nonfunctional immediate loading* (termed *immediate restoration* by this consensus group) involved the provision of a prosthesis 1 to 2 mm short of occlusal contact. In their study, 646 implants were positioned immediately, 422 were functionally loaded, and 224 were nonfunctionally loaded. For the group characterized by functional load, implant (98.6%) and prosthesis (98.5%) survival were clearly within previously published parameters. Further, results for immediate nonfunctional loading did not establish a clear advantage when considering implant (99.1%) or prosthesis (98.3%) survival.

Bone quality and volume, and the presence or absence of infection, are relevant to survival and success results. The positioning of implants in bone that has been given the opportunity to heal from infection and inflammation, and that may have been effectively augmented, increases the likelihood for implant stability and increases bone quality and quantity. Immediate restoration or loading of immediately placed implants in bone that has not been allowed to heal, or that has not been effectively augmented, may lead to increased risk. Assessment of occlusal load magnitude and the effects of parafunction remain subjective, and no numeric relationship exists relating these factors with implant loading, whether immediate, early, or delayed.

CLINICAL PROCEDURES

Clinical procedures will vary for immediate and early restoration and loading for edentulous and partially dentate patients. For each clinical indication, the presence or absence of immediate implant placement in extraction sockets is an additional consideration, evaluated elsewhere in this publication.

Many of the suggested considerations for immediate or early restoration or loading are not applicable in all clinical situations, as, for example, it is not possible to achieve adequate implant splinting in single-tooth sites. Further, some prostheses, by virtue of arch position and the teeth involved, may be subjected to excursive loading even when centric occlusion or maximum intercuspation contacts are absent. The ability to obtain load distribution between the remaining natural or restored teeth needs to be considered.

In addition, measurable parameters are evaluated in varying ways. Primary stability of implants, for instance, has been associated with placement torque, Periotest values (Siemens, Mannheim, Germany), and resonance frequency analyses. Possibly the most frequently used method of stability evaluation is a subjective opinion formulated by the surgeon. While each may be useful, at this point it is not possible to compare results from each group and quantify a uniformly acceptable standard for measurement of

implant stability. Therefore, as there is no consensus, a particular method of clinical evaluation of implant stability at the time of placement cannot be recommended at this time.

However, it is felt that simple assessment of implant stability throughout treatment may prove beneficial in helping practitioners to understand the possible long-term effects of immediate and early restoration or loading, allowing for more accurate identification of treatment risks.

Edentulous Arches

Clinically, it is possible to use removable or fixed prostheses in the restoration of edentulous arches. Immediate loading results for such restorations are dependent on the number of implants, the type of prosthesis, the presence or absence of splinting, the occlusal scheme, and the jaw being restored.[12]

The use of immediate or early loading of splinted implants to restore edentulous arches has been documented. Tarnow and coworkers[8] published their experiences with the immediate loading of edentulous arches in 10 patients. The group placed 107 implants, 50 of which were immediately loaded. Two failures were recorded in the mandible of the experimental group. The authors attributed the failures to removal of the provisional prostheses for evaluation of implant healing, and this protocol was therefore discontinued. Emphasis was placed on fundamental clinical procedures, including the need for diagnostic procedures and the use of templates and provisional restorations. In conclusion, however, the authors found that immediate loading should "be attempted in edentulous arches only" and that implants should be splinted. Despite the obvious merits of this article, based on the content, such a statement cannot be justified. This conclusion would require evaluation of implants in partially dentate patients as a comparison, along with an evaluation of implants lacking in cross-arch stability.

In a retrospective evaluation of 776 immediately loaded implants followed between 2 and 13 years, implant success (96.9%) and prosthesis survival (98.5%) were found to be similar to results established for implants loaded according to conventional loading protocols.[12] For patients in this study, a bar was rigidly attached to 4 implants and an overdenture was supported and retained by means of clips (U-shaped Dolder). When the immediately positioned prosthesis opposed a maxillary denture, balanced occlusion was utilized, with group function preferred when the opposing arch was characterized by natural or restored teeth.

Credence should be given to these findings, because the study was multicenter and included prospectively defined criteria for inclusion, exclusion, and evaluation. In addition, 4 different implant systems were used to support the prostheses, resulting in evaluation of the treatment modality and not the implant system. The same protocol was used (albeit with a single implant system) in a prospective evaluation of a separate patient population.[13] Eighty-four immediately loaded ITI implants were placed between the mental foramina and evaluated, with similar results.

The results attained by the 2 previously described research studies have been summarized in a life table analysis of 328 implants loaded within 24 hours of implant placement.[14] The authors found cumulative survival rates exceeding 96% and cumulative success rates exceeding 88.2% through 8 years of follow-up. The numeric difference between the 2 groups was associated with marginal bone loss. In this publication, the results were not related to the occlusal scheme or to the form of the opposing arch. In addition, since the restorative procedures were not detailed, passivity of the bar and the functional characteristics of the prostheses cannot be related to the results and a relationship can at best be assumed.

In a prospective evaluation of 7 patients characterized by mandibular edentulism, Lorenzoni and coworkers[15] compared 14 implants that were loaded 2 to 4 days postplacement with 28 implants that were allowed to heal for 6 months prior to second-stage surgery. Two of 6 interforaminal implants in each patient were joined by a bar and loaded by way of a prosthesis subjected to normal occlusal function. The bar was fabricated in the laboratory from an impression made at implant placement, and preexisting dentures were modified to incorporate a retentive clip. No description of prosthesis design (occlusal scheme and contact distribution) was reported. It is important to note that each patient's pre-existing prosthesis was used, although no description of quality (or evaluation criteria) was provided. Although all implants survived the follow-up period, the authors concluded that the immediately loaded implants suffered a significantly greater loss of marginal bone (0.9 ± 0.40 mm) than the nonloaded implants (0.33 ± 0.34 mm) and had significantly higher Periotest values (–3 versus –6). They concluded that while their results illustrated a statistically significant difference associated with the timing of loading, the measurable parameters were acceptable clinically, and further evaluation of long-term ramifications of these findings was required.

Such citations detail the ability to use immediate and early loading of implants to support complete mandibular dentures. Clinically, 2 or 4 implants

have been rigidly splinted across the midline with a bar. Although authors often describe the dentures as being "subjected to loading," few detail the preexisting or the postloading occlusal scheme or contact distribution desired or obtained. Therefore, the relationship of conventional prosthodontic procedures (clinical rearticulation and occlusal adjustment) to success cannot be established. Further, the analysis of success is related only to the survival of the implants and compared to previously published protocols. An evaluation of the restorative outcome from the perspective of both the clinician and the patient is desirable.

While it appears evident that implants loaded under such circumstances are capable of surviving accelerated restoration or loading protocols, the advantage to patients needs to be clarified. Are patients more satisfied with prostheses placed immediately versus prostheses placed according to more conventional loading protocols? Such assessments should be made from functional and esthetic perspectives. Because the procedures associated with immediate and early restoration or loading are, from a prosthodontic perspective, more challenging, it is possible that the functional result may be inferior because of the clinical difficulty. Therefore, the quality of the prosthodontic outcome also needs to be addressed.

Although such an assessment has not been made with regard to overdentures, immediately restored or loaded implants have been used to improve the treatment outcomes of fixed prostheses placed in edentulous arches. In a comparative clinical trial, 14 patients received between 5 and 8 implants in the edentulous mandible.[16] In the control group, 7 patients received between 5 and 7 interforaminal mandibular implants, placed according to a 2-stage procedure and provided with 3 to 4 months of undisturbed healing beneath a denture lined with tissue conditioner. The study group patients each received between 5 and 7 implants, 4 of which were placed interforaminally. The implants in this group were loaded on the day of placement with a fixed provisional prosthesis. The implants were rigidly splinted by incorporation of components in the acrylic resin denture. Two distinct methods were used to relate the implants to the existing prosthesis. The first involved picking up provisional cylinders in the patient's mouth with the prosthesis in occlusion. The second method involved articulation of the denture, which was concurrently serving as an impression tray. Provisional cylinders were attached in the laboratory and used to retain the provisional prostheses.

Although the manufacturer and type of implant were not provided, the authors reported that all implants integrated. Patients in the control group received an average of 5.4 postplacement visits for maintenance of the tissue conditioner and repair of fractured prostheses, versus 1 postloading visit for the study group patients. All patients in the study group reported satisfaction with the prosthesis, although complaints related to the difficulty of oral hygiene maintenance were common. The authors described the lack of a removable transitional prosthesis as a clear advantage for patients, adding that "decreased chair time, psychologic advantages and reduced maintenance" are also beneficial. This illustrates a treatment improvement for patients beyond measurable parameters of implant survival, and additional evaluations of this type are encouraged.

Other groups have evaluated loading of implants with fixed restorations in the mandibular arch. In a 10-year follow-up of 28 immediately loaded implants, Schnitman and coworkers[17] found survival rates (84.7%) to be significantly lower than the results achieved in the control group (100%). Jaffin and associates[18] reported findings associated with 27 patients who received fixed prostheses either on the day of implant placement or within 72 hours. Prerequisites for immediate loading included acceptable clinical and radiographic evaluation of bone volume and quality, appropriate implant distribution, and the absence of an unfavorable occlusal scheme (edge to edge). All implants were placed with the aid of a template and restorative abutments were positioned. Provisional fixed prostheses were fabricated and delivered on the day of placement, or an impression was made for indirect fabrication of a provisional prosthesis to be delivered within 72 hours. Clinically, 8 of 122 immediately loaded mandibular implants failed to integrate. Seven of the 8 failures were machined-surface implants. All 27 implants placed in the maxilla were characterized by a rough surface (titanium plasma sprayed or sandblasted/acid etched) and none failed. Success was determined at 6 or 12 weeks post-implant loading and was based on lack of pain or mobility, ability to torque to recommended levels, and absence of peri-implant radiolucency. Consistent with previous publications, the clinical success of the prosthodontic procedure (immediate restoration or loading) was assessed by way of surgical parameters and implant survival. However, the authors did include a "well-balanced" occlusal scheme as a goal and requirement. The lack of removable prostheses was related to increased patient and clinician satisfaction and, although this makes intuitive sense, no description was provided regarding how this conclusion was reached.

Functional loading of fixed metal-ceramic prostheses on Mk II implants (Nobel Biocare, Göteborg,

Sweden) placed in edentulous mandibles has been evaluated.[19] Although considered immediate by the authors, all prostheses were delivered within 20 days of placement, and loading should therefore be considered "early" according to definitions established by this consensus group. Five or 6 implants were placed bicortically positioned and patients were prevented from wearing any interim prosthesis for 10 days. After 10 days of healing, impressions were made, articulation procedures were undertaken, and the patient's denture was lined with tissue conditioner. Although survival parameters were considered (integration, radiographic, and periodontal), no discussion of occlusion, delivery procedures, evaluation of passivity, or patient satisfaction was evident. These procedures, therefore, can only be considered as having no detrimental effect on implant survival. A restorative benefit (other than time) cannot be established from the information provided.

Partially Dentate Patients

As a follow-up to the work of Randow and colleagues,[19] Ericsson and associates[20] described the immediate restoration of single missing teeth. Fourteen patients received machined-surface implants (Mk II, Nobel Biocare). Prospective description of inclusion criteria (the ability to obtain bilateral occlusal stability from the remaining teeth and adequate bone volume) was provided. An impression was made on the day of surgery and a provisional prosthesis positioned within 24 hours. All provisional restorations were characterized by minimal or no occlusal contacts and were allowed to heal for 6 months prior to fabrication of the definitive prosthesis. Several parameters were evaluated, including implant stability and marginal bone levels. These were related to implant survival and were within expectations. The authors indicated that the occlusal circumstances were to be evaluated, as was the degree of patient satisfaction. However, the results for these restorative parameters of success were not clearly evident.

Calandriello and coworkers[21] evaluated 50 implants placed in healed sites for first (n = 42) and second (n = 8) molar replacement. Each implant was characterized by high insertion torque values (60 Ncm). Importantly, 16 of the implants were the most distal functional unit in the quadrant being restored, meaning that occlusal protection could not be obtained both mesial and distal to the restoration. Provisional crown restorations were positioned on the day of implant placement and were characterized by a centric occlusal contact. Patients were not instructed to alter oral habits—only requested to avoid hard food. Although follow-up was limited (only 24 implants were followed for more than 12 months), no implants were lost. In contrast to recommendations made for edentulous-arch restorations, the authors routinely removed the provisional restorations to evaluate implant stability, and no detrimental effects were noted. The conclusion encouraging the immediate loading of wide-platform implants with defined form is based again on implant survival and not on parameters related to the restoration or satisfaction of the patient.

Experiences with the early restoration of ITI dental implants (Institut Straumann) characterized with a titanium plasma-sprayed surface have been reported.[22] Eight implants positioned in the anterior maxilla were followed for 5 years, with evaluation centering on bone maintenance and soft tissue conditions. The first consensus group has related these parameters to the esthetic outcome of implants. No implants were lost during the follow-up period, and gains in marginal bone levels were observed. All implants were placed with bone preservation and the restoration in mind, although no detailed discussion of methodology was offered. All implants received an abutment torqued to 35 Ncm on the day of implant placement but did not receive provisional restorations until 1 week later. All provisional restorations were modified to remove incisal contacts, and diet modification was recommended.

CONCLUSIONS AND RECOMMENDATIONS BASED ON THIS REVIEW FOR THE EARLY OR IMMEDIATE RESTORATION OR LOADING OF DENTAL IMPLANTS

Surgical Considerations

1. Implant selection, position, and distribution should be guided by the restorative plan.
2. Diagnostic and surgical templates indicating the prosthodontic plan should be used where possible.
3. Care should be taken to optimize distribution of implants placed in edentulous arches and intended for immediate or early restoration or loading.
4. Minimizing biomechanical risk to implants in edentulous arches and in patients exhibiting extended edentulous regions is recommended. Effort should therefore be made to reduce the influence of cantilevers by using an appropriate number of implants and by optimizing distribution. Also, an adequate number of implants should be positioned to facilitate splinting and protection from the possible effects of micromotion.
5. Clinical stability of dental implants should be achieved. This is made possible by selecting

patients who exhibit adequate bone quality and quantity, by selecting an implant with a rough surface and adequate dimension, and by using good clinical technique to maintain contact between the implants and bone.

Restorative Considerations

1. Where possible, a clear advantage for the patient should be established prior to treatment.
2. Where possible, the biomechanical effects of the provisional restoration should be controlled by *(a)* limiting and distributing occlusal contact in centric occlusion or maximum intercuspation, *(b)* removing all excursive contacts from the provisional restorations, *(c)* limiting the effects of cantilevers and off-axis loading, and *(d)* splinting implants together where possible.
3. Traditional prosthodontic procedures associated with accuracy of fit and passivity, evaluation of occlusal scheme, and assessment of patient satisfaction should be encouraged.
4. Where possible, provisional restorations should remain in place throughout the process of healing, allowing adequate healing of the hard and soft tissues in contact with the implants and the prosthesis.
5. Clear parameters are required to evaluate the outcome of the restorative treatment.

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