Immediately Loading Dental Implants: Doing It Right for Long-Term Success

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The immediate loading of dental implants is not a new technique, and the increased prevalence of this treatment option is evident by the increased number of clinical and scientific articles being published today, and the number of doctors who ask about it at continuing education events. This manner of treatment has become a very popular procedure in the last couple of years, giving patients the possibility to benefit sooner from the advantages of dental implant treatment.

The purpose of this article is not only to explain what it means to immediately load a dental implant, but to also concisely discuss the options, prerequisites, analysis, and restorative considerations that must be carried out in order to successfully provide this type of treatment. Some of the patient considerations, which can affect the success or failure of implant placement—such as systemic disease, medications, infection, and patient compliance—will not be covered. While all very important, the focus of this article revolves around the factors on which the practitioner has influence.

DEFINITIONS
When we speak of immediate loading of dental implants, it means the implant will be loaded by the placement of a restoration, temporary or final, within 72 hours of implant placement. Delayed loading would be carried out between 72 hours and 3 months. Finally, traditional protocol is defined as waiting 2.5 to 3 months with the implant being unloaded.

Now, let’s define this further. In reality, if the clinician places a healing cap or healing abutment which extends above the bony crest and can be activated by the tongue, musculature, or through mastication, the implant will take some load. However, for the purposes of this discussion, immediate loading will be considered synonymous with immediate function. Immediate function is defined as loading the implant immediately with full contact occlusion by the opposing arch.

Immediate placement will be defined as the placement of a dental implant at the same time that a tooth is extracted, with the implant being placed in the resultant extraction site.

Primary Stability
The key to successful implant placement is primary stability.² Schenk and Buser³ postulated this concept almost 20 years ago in their pivotal paper on the mechanisms of osseointegration with respect to delayed implant placement. In immediate placement, primary stability becomes pivotal for success. In fact, torque values and Ostell readings (implant stability quotient [ISQ] values) need to be much higher than the values corresponding to primary stability to predictably load these implants.

Torque
The literature, along with clinical evidence, shows us that 30 Ncm is considered the value that corresponds to primary stability of a dental implant. This is the final torque value that is recorded at placement. When talking about and understanding torque, we must look at the 2 types: insertion torque and seating torque.

Insertion torque is the rotational resistance against the implant as it is being driven into the prepared osteotomy. The amount of resistance is affected by the following:
- Cutting friction produced by the implant threads
- Friction between the implant and bone due to surface microstructure
- Lubrication, or the amount of bleeding
- The type of bone encountered
- The shape, or macrostructure, of the body of the implant. Seating torque, in contrast, is affected by the following factors:
- The final position of the implant in relationship to the crest and cortical walls
- Bone quality or type
- Whether the implant has a tapered collar or tapered body.
When immediately loading implants, it is the final insertion torque that is the key to successful treatment. In order to follow an immediate load protocol, a minimum seating torque value of 45 to 50 Ncm is necessary. A large percentage of implants on the market do not have a macrostructure that is conducive to high
immediate stabilization when compared to one designed and patented for immediate loading (Figure 1). In fact, if some of these implants are torqued to high values, the possibility of failure due to compression necrosis increases. An example of an implant that gains a very high seating torque value without deleterious effects is the OCO Biomedical ERI implant. This implant gains its high stability, or osseous fixation, by the unique macrostructure of the implant body (Figure 2).

The patented tip, body, cortico-microthreads, and embedded tapered platform all work in harmony to put the localized bone in tension rather than compression (Figure 3). By doing this, the high mechanical stability will not be lost as a result of biologic remodeling. Kobayashi et al. showed that bone cells placed in tension enhance the expression of transforming growth factor beta and osteoprotegerin along with a decrease in osteoclastic activity. The physiologic and biologic environment surrounding the implant is therefore influenced by the implant body. In simple terms, the implant becomes biomechanically active. The local environment is influenced positively, and the high initial mechanical stability allows for microstimulation of bone without exceeding the crucial movement value of 150 μm. This will facilitate potentially accelerated healing.

ISQ Values
The advent of the Osstell Mentor in 1999 ushered in a new age for implantology. We now had a way to quantify the stability of an implant either at placement, during, or after healing. This technology has continued to evolve into the Osstell IDX (Figure 4).

The Osstell uses resonance frequency to establish the stability of an implant by producing an ISQ. This number can be used to determine when to load and when a traditional healing period

<table>
<thead>
<tr>
<th>IMPLANT SIZE</th>
<th>SURFACE AREA</th>
<th>DIFFERENCE (%)</th>
</tr>
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<tbody>
<tr>
<td>4.0 x 8</td>
<td>113.09 mm²</td>
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</tr>
<tr>
<td>4.0 x 10</td>
<td>138.16 mm²</td>
<td>18.15%</td>
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<td>4.0 x 12</td>
<td>163.65 mm²</td>
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<tr>
<td>5.0 x 10</td>
<td>178.70 mm²</td>
<td>36.72%</td>
</tr>
<tr>
<td>5.0 x 12</td>
<td>209.12 mm²</td>
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would be a more prudent treatment option. An ISQ value of 55 is considered to show primary stability and an ISQ value of 64 is the lower limit for immediately loading an implant.

The Osstell uses a smart peg that is screwed into the implant platform and, when pulsed by the transducer, it vibrates. This is, in turn, picked up by the receiver in the wand (Figure 5). This works on the same principle as a tuning fork. The tighter the implant is in bone, the higher the frequency vibration that is recorded when pulsed, and this is shown as a higher ISQ value.

The use and evaluation of torque and ISQ allows the clinician to know what degree of initial mechanical lock the implant has. This mechanical lock is crucial to prevent detrimental micro-motion between the implant and the surrounding bone. During healing, as the biological stability is increasing due to lamellar bone formation around the implant, this sliding motion must be kept at less than 150 μm to prevent soft-tissue formation, encapsulation, and eventual failure of the implant.

**The Effect of Implant Length and Diameter**

The size of the implant has much to do with a successful outcome. In traditional implant protocol, where the implant is allowed to completely osseointegrate before loading, size is not as relevant. The literature has shown us that, once integrated, minimal forces are transferred beyond 5.0 to 6.0 mm below the crest; however, when immediately loaded, the initial bone-to-implant contact becomes much more contributory to the outcome. The diameter of an implant has more effect on decreasing von Mises stress distribution than implant length at the crest.

By looking at the simple equation for the surface area of a cylinder \( (2\pi r^2 + 2\pi rh) \), we can see how diameter and length can influence surface area available for stress distribution and stability (Table).

Now, these calculations are rudimentary and do not take into account the differences created by thread patterns, taper, surface porosity, or anti-rotational features, but it is very evident that going long and wide can increase the initial stability within the peri-implant complex.

In Figure 6, we can see where a long implant going well beyond the apex of the extraction site can overcome stability and stress distribution issues. It allowed immediate loading at the time of extraction even in a cuspid which takes a tremendous amount of occlusal load.

Barikani et al. confirmed this concept by showing that in Dr bone, length did not have any effect on stability; however, in D3 bone, increasing length did have a significant influence on stability. It is possible to be successful with short and wide implants, as well as long and narrow ones (Figures 7 and 8) in immediate loading protocols, but this author believes that caution should be exercised when immediately loading shorter implants due to the combination of increased forces that can be applied from the restoration along with shorter linear length to withstand it. This is only an issue during the osseointegration phase of healing and, once integrated, the increased surface area...
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Implant Position
Implantology is a restoratively driven surgical procedure. This concept is so important to the short- and long-term success of dental implant treatment that it cannot be stressed enough.

Peri-implant tissue reacts most favorably to axial loading of the restoration and, as a result, forces directed down the long axis of the implant. Therefore, every effort should be made to take this into account during the planning and surgical phases of treatment. Figure out where the restoration must be, and then place the implant in the most advantageous position for success. Do not neglect to observe both Curve of Wilson and Curve of Spee (Figure 9) along with mesiodistal and buccolingual positioning.

One must also take into consideration the specific tooth being replaced, or the position in the mouth with relationship to the temporomandibular joint (TMJ). The mandible and maxilla are 2 lever arms tied together by the masseter muscle and hinged at the TMJ. Biomechanically, this is not unlike the function of a nutcracker (Figure 10).

Therefore, the forces placed on teeth, or on the implants that replace them, are magnified as we get closer to the joint. Posterior teeth can have vertical biting forces in the range of 400 to 890 N compared to anterior teeth, which have loads of only 89 to 111 N.11 Single implants placed in an edentulous space that have teeth both mesial and distal to them are more predictable than a lone-standing tooth or the most distal tooth in the arch. Maxillary posterior implants are more vulnerable to these increased loads due to the poorer bone quality usually found in that area of the oral cavity.

From a biomechanical perspective, an implant-restored anterior maxilla is often a weak segment of the mouth for longevity. Compromised anatomical conditions can include narrow ridges

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Figure 9. (a) Curve of Spee and (b) Curve of Wilson.

Figure 10. The jaws as lever arms.

Figure 11. Typical signs of chronic bruxer.

Figure 12. Facial types.

Figure 13. Tooth versus implant.
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with the need for narrow implants. Restoratively, the use of facial cantilevers, oblique centric contacts and lateral excursive forces can all cause both short- and long-term issues. In addition, reduced bone density, the absence of a thick cortical plate at the crest, and accelerated bone loss in the incisor region (often resulting in instability when placing central and lateral incisor implants) can occur without substantial augmentation procedures. All of these issues plague conventionally loaded implants but can really cause issues when immediately loading.

**The Patient**

It is easy to treat the problem instead of the patient. When faced with an edentulous space, the practitioner needs to do a full intraoral exam and also look at extraoral clues that may contribute to implant success or failure.

Naert et al reported that overloading from parafunctinal habits such as clenching or bruxism seemed to be the most probable cause of implant failure and marginal bone loss. Intraorally, it is important to identify signs of bruxism such as worn occlusal facets and/or abfraction lesions (Figure 11). These are red flags to be cautious when establishing occlusion and cusp angles. The author prefers to restore these patients in a group function occlusal scheme, with the lateral and protrusive movements guiding on natural teeth rather than the implant restorations.

These parafunctional habits are dangerous to both immediate and traditionally loaded implants. Studies have shown that bruxers can have up to 6 times the masseter strength when compared to nonbruxers. This increased strength will result in higher then normal occlusal loads on both natural teeth and implants. These patients should be treated with caution, and if possible, all vertical stops should be placed on natural dentition. The use of an occlusal guard, designed to provide posterior disclusion, is highly recommended in these patients.

Extraorally, the patient's facial type or craniofacial morphology should be considered when treatment planning because it will influence not only the decision to immediate load, but also how to manage the case in the long run.

There is a negative correlation between mandibular inclination and bite force. Therefore, a dolichofacial individual will have lower biting forces than a brachyfacial individual (Figure 12). Additionally, brachyfacial patients will usually have thicker, more powerful masseter muscles that will result in much higher occlusal forces on the restorations and implants. In an immediate load scenario, this factor could contribute to premature failure of the case. It is better in these types of patients to defer to a traditional healing protocol. Once the implants are fully integrated—as long as the occlusal scheme, crown size, and cusp angles are correct—the potential effects of the craniofacial morphology are mitigated.

**The Restoration**

A restoration on an implant, whether it is temporary at the time of implant placement or permanent after healing, is subject to a variety of forces that could cause the loss of the fixture. These include cantilevers, improper occlusal designs, and premature contacts.

First of all, an implant is very different than a natural tooth. Osseointegrated implants, unlike natural teeth that have a periodontal ligament (PDL), react biomechanically in a different fashion to occlusal force. Implants are ankylosed to surrounding bone and do not benefit from the same proprioceptive and shock absorbing ability that natural teeth have. Without proprioception, there is no feedback to the nervous system with regard to the force generated by biting or clenching. When looking at the shock absorbing ability afforded by the PDL, teeth in a socket have 25 to 100 μm of movement, as compared to an implant that has approximately 3 to 5 μm (Figure 13). In addition, the crestal bone may act as a fulcrum point for a lever action when force is applied, indicating that peri-implant tissues could be more susceptible to crestal bone loss by applying force. It is imperative during immediately loading that sound restorative principles are followed in order to assure long-term success. The presence or absence of PDL functions makes a remarkable difference in detecting early phase of occlusal force between teeth and implants.
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Cantilevers
The effects of cantilevers can be devastating. Implants and the peri-implant tissues are best suited for axial loads; when a cantilever is introduced, lateral and torsional loads are now applied to the bony complex. The longer the cantilever, even on a single-tooth restoration, the higher the forces that will be distributed (Figure 14). A 1:1 cantilever doubles the compressive load at the fulcrum, while a 2:1 cantilever generates 3 times the compressive load.\(^1^8\) Occlusal forces that are directed off-axis buccally or lingually will produce a vertical cantilever which can cause crestal bone loss. This bone loss will change the position of the fulcrum from the top of the implant to somewhere further down the body. Excessive cantilevers can, throughout time, also cause work hardening of an implant with the eventual failure of the fixture (Figure 15).

Even in full-arch restorations, where cross-arch stabilization exerts a positive biomechanical advantage, long cantilevers (≥15 mm) induce more implant-prosthesis failures as compared with cantilevers shorter than 15 mm.\(^1^9\) If the forces are high enough to fracture componentry, then they are definitely high enough to induce crestal bone loss.

Premature Occlusal Contacts and Nonworking Side Interferences
Loss of osseointegration and marginal bone loss from excessive lateral load has been demonstrated to be a result of premature occlusal contacts.\(^2^0\) Aggressive enameloplasty should be carried out if there are working or nonworking cusps that could cause these prematurities. It is estimated that less than 5% of practitioners know of, or can correctly identify, nonworking side interferences. This type of undiagnosed occlusal interference can be devastating to implants and a chronic nightmare for patients and doctors alike.

In our clinic, we recently saw a young woman who had gone through 10-plus years of dental issues due to an undiagnosed nonworking side interference. This patient had a lower first molar that had been lost more than 10 years prior due to a catastrophic fracture of an endodontically treated tooth. The tooth was extracted and an implant placed after healing by her dentist. Once loaded after integration, she suffered multiple bouts of crown and screw loosening, which ended with complete delamination of the porcelain from the restoration. When evaluated by a new dentist almost 10 years later for a loose abutment and fractured screw, it was found that the implant itself had fractured (Figure 16). When she was then subsequently examined in our clinic, it was evident that a nonworking side interference along with a large palatal cusp on No. 3 were contributory to the problem. Unfortunately, the fractured screw could not be removed and the implant needed to be explanted (Figure 17) using a trephine. A new implant (OCO Biomedical) was placed immediately and loaded (Figure 18). The interference was removed by aggressive alveoloplasty with a barrel-shaped coarse diamond. The patient then returned to her general practitioner, who restored the tooth (Figure 19). It has
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been asymptomatic ever since. Upon follow-up, the patient remarked that her “bite” never felt better and was amazed how such a small interference could have caused such a huge problem for so many years.

**Cusp Inclination and Occlusal Schemes**

Cusp inclination has been found to produce a high level of torque. For every 10° of increase in cusp inclination, there is approximately a 30% increase in torque. For this very reason, it is imperative to control the forces by using relatively shallow cusp angles when restoring implants (Figure 20). This becomes even more crucial when immediately loading an implant. The mechanical stability at the time of placement can be easily overpowered if large torqueing forces are encountered during the healing phase of treatment. Cuspal inclination produces the most torque, followed by maxillary horizontal implant offset, while implant inclination and apical implant offset produce minimal torque.

There are many occlusal schemes that have been proposed throughout the years. Implant-protected occlusion, as originally developed by Misch, refers to an occlusal plan that is often unique and specifically designed to restore an endosseous implant, by providing an environment for improved clinical longevity of both the implant and prosthesis. Misch and Bidez published the biomechanical rationale for this concept after long-term evaluation and proposed implant-protected occlusion by reducing the occlusal forces on implant prostheses to protect the implants.

The ideal occlusal contact is over the implant body, leading to the axial loading of implants. Hence, a posterior implant is placed under the central fossa of the implant crown. A buccal cusp contact is an offset or cantilever load. A marginal ridge contact is also a cantilever load, as the marginal ridge may also be several millimeters away from the implant body. Furthermore, the marginal ridge contact may be more damaging than the buccal offset, since the mesiodistal dimension of the crown often exceeds the buccolingual dimension.

Light contacts, smaller occlusal table width, and lingualized occlusion all have their place and their merit. Typically, a 30% to 40% reduction in the occlusal table in a molar region has been suggested because any dimension larger than the implant diameter can cause cantilever effects already discussed.

It should be noted that the author does not like limiting the occlusal table width. The main reason is that most patients today are very concerned about aesthetics, and that aesthetic consciousness sometimes extends all the way back to the second molars. They are not satisfied with treatment that results in tooth size discrepancies.

Limited width restorations are used to minimize buccolingual cantilevering by reducing the chance of offset loading and increasing axial loading. Clinically, this can be minimized just as easily and more effectively with a wider diameter implant (Figure 21) if the ridge with can accommodate one of this size. These wider diameter implants can also allow for more predictable extraction, immediate placement, and immediate load protocols in molars.

Finally, lingualized occlusion represents an established method for the development of aesthetic and functional complete denture articulation. In the author’s opinion, it is also beneficial for implant restorations, especially those that are immediately loaded, in order to decrease the lateral forces placed on the restoration in excursive movements.
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CLOSING COMMENTS
Immediate implant placement not only has the ability to increase patient satisfaction but also to grow your dental practice. It cannot be stressed enough that attention to detail must take place in order to provide predictable and successful treatment. Not recognizing the contributory factors can, and most likely, will result in negative outcomes that are definitely not practice builders.

Many factors that we already routinely follow in general dentistry will directly affect the success or failure of dental implant treatment. These factors are magnified in importance when choosing to immediate load implants, and it is easy to overlook them when focused on the surgical side of replacing a missing tooth. Choose the right implant to immediately load, follow sound restorative protocols, and be successful in providing the best patient care possible.

References
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1. When we speak of immediate loading of dental implants, it means the implant will be loaded by the placement of a restoration, temporary or final, within one hour of implant placement.
a. True    b. False

2. In order to follow an immediate load protocol, a minimum seating torque value of 40 to 45 Ncm is necessary.
a. True    b. False

3. An implant stability quotient (ISQ) value of 55 is considered to show primary stability and an ISQ value of 64 is the lower limit for immediately loading an implant.
a. True    b. False

4. The length of an implant has more effect on decreasing von Mises stress distribution than implant width.
a. True    b. False

5. Peri-implant tissue reacts most favorably to axial loading of the restoration and, as a result, forces directed down the long axis of the implant.
a. True    b. False

6. Naert et al reported that overloading from parafunctional habits such as clenching or bruxism seemed to be the most probable cause of implant failure and marginal bone loss.
a. True    b. False

7. There is a negative correlation between mandibular inclination and bite force; therefore, a dolichofacial individual will have lower biting forces than a brachyfacial individual.
a. True    b. False

8. The presence of absence of periodontal ligament functions makes a remarkable difference in detecting early phase of occlusal force between teeth and implants.
a. True    b. False

9. Occlusal forces that are directed off-axis buccally or lingually does not cause crestal bone loss.
a. True    b. False

10. Cusp inclination has been found to produce a high level of torque; for every 10° of increase in cusp inclination, there is approximately a 15% increase in torque.
a. True    b. False
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11. The marginal ridge contact may be more damaging than the buccal offset, since the mesiodistal dimension of the crown often exceeds the buccolingual dimension.
   a. True  b. False

12. Lingualized occlusion represents an established method for the development of aesthetic and functional complete denture articulation.
   a. True  b. False
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Please check the correct box for each question below.

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4. ☐ a. True. ☐ b. False
5. ☐ a. True. ☐ b. False
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8. ☐ a. True. ☐ b. False
9. ☐ a. True. ☐ b. False
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