Immediate Placement and Loading of Implants: Minding the Basics of Bone Biology

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Since the first clinical report by Brånemark and coworkers in the late 1970s, dental implants have undergone numerous design improvements to facilitate mechanical and biological functions. Not long ago, the strict protocol of waiting 12 months after tooth extraction to insert an implant in alveolar bone followed by 6 months of osseointegration prior to restoration was the mandatory procedure to ensure successful tooth replacement. Changes were sought when surgeons began to notice extreme ridge resorption that compromised implant placement, soft tissue shrinkage leading to esthetic concerns, and patient dissatisfaction with the prolonged timing of the treatment. Today, implants frequently are being placed immediately after tooth extraction and/or loaded immediately after placement in native or grafted bone. The enthusiasm of dentists and patients has increased dramatically with the expedited treatment. But, are these safe and predictable strategies? In this paper, we will discuss a few technical aspects that need consideration for these advanced implant protocols, including the need for clinicians to better understand and consider the basics of bone biology to ensure predictable implant placement and restoration.

Let us start by reviewing important aspects of bone healing following tooth extraction and place them in the context of implantology. Certain factors are important for bone regeneration and should be kept in mind when planning, placing, and restoring implants. After tooth extraction, the empty socket is filled with blood, and a clot is formed. Cells that secrete inflammatory mediators migrate into the coagulum, and clot degradation starts to occur. This event is overlapped by vascularization and migration of new cells into the coagulum to replace the granulation tissue with a connective tissue that will later mineralize (osteoid/woven bone). The blood clot acts as a scaffold to direct cellular movements and contains substances important to direct healing. If the coagulum is displaced or contaminated, the behavior of cells will change, leading to soft tissue formation and scarring.

The initial bone formation takes a few weeks. The early-formed woven bone is gradually replaced by lamellar bone and marrow through remodeling via osteoclasts. This replacement is beautifully counteracted by bone formation activity and takes place over several months. These biological events should be minimally disturbed when placing an implant to ensure proper osseointegration. The dental implant should not promote excessive micromotion (thus disturbing the clot), should not promote bacterial or soft tissue down-growth on the implant surface, and should not impair osteogenesis (vascularization, cell attachment and migration, collagenous and noncollagenous protein deposition and mineralization). Today, it is known that the topography and composition of implant surfaces can positively influence the healing of the surgical sites and certain modifications (acid-etching, fluorination, etc.) can lead to increased bone to implant contact and accelerated osseointegration.

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For immediate implant placement, besides respecting the stages of bone healing as described, the current protocol for a successful outcome requires meticulous and undersized osteotomy preparation, self-tapping implant insertion, and use of improved implant designs (i.e., with more retentive profile and ability to engage in cortical bone). To ensure implant stability at the time of surgery, the surgeon is advised to perform a tactile assessment and assure an insertion torque of >30 Ncm and a reverse torque of >25 Ncm.

After placement, controlling inflammation at the site also is important, as inflammation at the implant surface can increase bone resorption during the osseointegration process. Placing the implant at the proper depth and the use of appropriate components to reduce the migration of bacteria down to the implant surface is best. The use of antimicrobial rinses, particularly 0.12% chlorhexidine, is indicated for reducing inflammation at the healing site.

It is worth noting that the presence of an endodontic lesion or periodontitis are not absolute contraindications for immediate implant placement, and alveolar bone might not be better preserved by immediate placement of implants compared with delayed placement. Regarding the need for concomitant grafting of the socket, it is generally advised when a space greater than 2 mm between the implant and the socket wall is present. Grafting might also help preventing micromotion. At the same time, presence of a thin buccal or lingual bony wall in the socket (<2 mm) would lead to potential perforation of the wall during the resorptive phase compromising stability. In such events, grafting around the wall and implant is advised.

Although evidence based on case reports or underpowered studies is abundant, data on the survival of immediate implant placement from large randomized, controlled, clinical studies are limited. When comparing different modalities, satisfactory survival rates (implant is in place and may show less than ideal conditions but does not require clinical management) for implants placed immediately, early (within 2–3 days), delayed (within 8 weeks), or late (after 8 weeks) seem to be similar and approximately 95% in the short term. Successful immediate implant placement may be possible in all regions of mandible and maxilla, although replacement of posterior teeth is more challenging in the mandible because of high risk of perforation of the lingual plate or injury to the inferior alveolar nerve. Nevertheless, clinical data on immediate/early implant placement are promising, and the rate of patient satisfaction with the reduced number of surgeries is extremely high.

How about immediate loading? The concept of immediate loading refers to the placement and restoration of the implant in the same appointment (or as defined by some authors, up to 3 days after implant placement). It should be performed in a manner that centric and eccentric occlusal contacts are avoided to prevent risks of function compromising stability. Immediate loading is in essence a non-functional loading. It is now well established that edentulous mandibles with overdentures or fixed partial dentures and single-tooth late implants (8 weeks or more post-extraction) are cases with high success rates for immediate loading. Several studies have reported no statistically significant differences in survival based on immediate or delayed loading. Establishment of function, evaluation of occlusion in the provisionals, immediate esthetic improvement, and potential manipulation of soft tissue for final restoration are the main advantages of immediate over delayed loading.

Combination of immediate placement and immediate loading is the newest trend in implants. Many variables are involved with this combined approach including bone anatomy, questionable primary stability, and implant positioning, which are limiting factors to assure predictable outcomes. Nevertheless, this is a treatment protocol that has shown success in some studies in the range of 90% but will likely be more successful in the hands of skilled surgeons and experienced restorative dentists. There are very limited reports on the literature for this treatment modality, which therefore must be viewed with caution.

Despite the most careful technical steps, the success of immediate dental implant placement or loading is highly correlated with the inherent bone status. An

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undiagnosed bone turnover problem, for instance, may lead to an unsuccessful outcome despite the state-of-the-art technology of implant therapy today. The host response toward injury is key. The so-called "systemic link" to oral health needs further understanding, as not only patients with obvious systemic compromises (heavy smokers, uncontrolled diabetics, etc.) are at risk in implant therapy. Stress and autoimmune disorders are often underestimated during treatment planning. Similarly, nutritional status and diet assessments are overlooked and may show to be of significant impact in implant outcome in the near future.

To improve implant survival, individualized implant treatment planning (much like the new trend in medicine, personalized medicine) may be considered to avoid cases of compromised survival or outright failure. Personalized medicine is a modern concept that proposes the customization of health care based on the individual's constitutional and functional profile. Thus, new advances in medicine based on studies of individual genomic (DNA fingerprint for polymorphisms, other modifications, and specific gene expressions), proteomic (levels and structures of hormones, growth factors, cytokines, etc.), and metabolomic (excreted degradation products of tissues, levels of metabolites of foods, supplements or drugs, etc.) characteristics could incorporate the impact of environmental factors on one's health and allow for better planning of implant therapy.

Currently, some metabolic tests available for measuring bone turnover are collagen telopeptide and cross-link counting. There are some reports showing their use to monitor bisphosphonate therapy in osteoporotic patients and even periodontal disease progression. These tests measure the degradation of collagen by identifying and counting the amount of a specific structural part of this protein that is released in urine. However, there is no absolute proof of correlation between these and defective bone turnover because in part of poor specificity and sensitivity of some tests for bone collagen and variability in collagen degradation from individual to individual influenced by medications, diet, etc. Other molecular targets could be more promising in evaluating the coupling of bone resorption/deposition to predict implant treatment (e.g., receptor activator of nuclear factor Kappa-B ligand/osteoprotegerin balance, molecules that regulate osteoclast formation).

Research on the "omics" areas has developed significantly in the past few years because of increases in clinical interest and research funding. In the future, serum, blood, or urine may be used to identify bone quality and turnover more precisely through genomic, proteomic, or metabolomic methods. Screening for the bioavailability of anabolic bone molecules and not only markers of resorption is also a promising avenue. Bone is a very dynamic tissue, and predicting its response to wounding on a more biological and individualized manner is a key factor for 100% success (not just survival) in dental implantology as well as in other bone therapies such as in orthopedics.

SUGGESTED READING

Biver E, Chopin F, Coiffier G, et al. Bone turnover markers for osteoporotic status assessment? A systematic review of their diagnosis value at baseline in osteoporosis. Joint Bone Spine 2012;79:20–5.

Cooper LF, De Kok IJ, Rojas-Vizcaya F, et al. The immediate loading of dental implants. Compend Contin Educ Dent 2007;28:216–25.

Esposito M, Grusovin MG, Polyzos IP, et al. Timing of implant placement after tooth extraction: immediate, immediate-delayed or delayed implants? A Cochrane Systematic Review. Eur J Oral Implantol 2010;3:189–205.

Esposito M, Grusovin MG, Achille H, et al. Interventions for replacing missing teeth: different times for loading dental implants. Cochrane Database Syst Rev 2009;Jan 21(1):CD003878.

Razzouk S. Bone remodeling and individual-based implant therapy. NY State Dent J 2010;76:39–41.

Razzouk S, Teixeira C. Personalized implant therapy: new perspectives in bone remodeling assessment. NY State Dent J 2010;76:50–2.

Zaidi M. Skeletal remodeling in health and disease. Nat Med 2007;13:791–801.

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