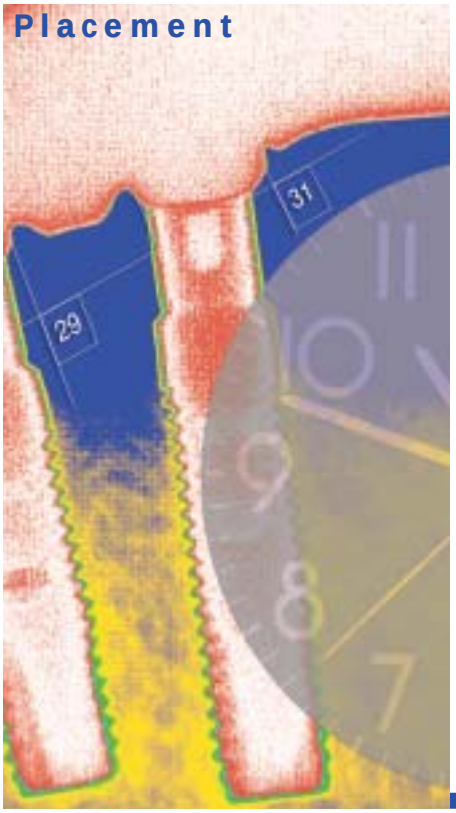
Placement



When Is an Implant Ready for a Tooth?

Robert G. Tupac, DDS

Abstract

The capability of placing an osseointegrated implant at the time of tooth extraction and immediately placing a restoration on the implant depends upon a number of factors. This paper describes the traditional Brånemark protocol, the evolution of single-stage surgery, the guidelines for immediate placement, the measurement of implant stability, and the considerations critical to immediately loading.

The patient is a healthy 32-year-old with a fractured maxillary left second premolar. Restoration of the remaining root with crown lengthening, a cast post, and a crown would be the first conservative treatment option. Prudent discussion would include extraction and fabrication of a three-unit fixed partial denture, but the adjacent teeth have no previous restorations and no caries. The dentist further explains the alternative of an osseointegrated implant. What does the patient want to know? "How soon can I have a tooth?" While numerous studies have confirmed the predictability of dental implants for the replacement of a single missing tooth, the answer to the question depends upon many factors.

Historical Perspective

The original Brånemark protocol[1] calls for a two-stage approach. The implant is placed at the first stage, countersunk to a subcrestal position, and covered with tissue during the osseous healing period. Reasons for using this approach are to minimize the risk of infection, prevent apical down growth of the mucosal epithelium, and minimize the risk of undue early transmucosal loading. A second-stage surgery uncovers the implant and abutment connection, which is required to expose the implant prior to functional loading, the necessary next step toward successful osseointegration.

The traditional method has been so successful that the protocol has been progressively modified. A single-stage surgical approach involves the simultaneous placement of the implant and transmucosal abutment, thereby avoiding the need for a second surgical procedure for the patient and clinician.[2] The outcomes of one-stage and two-stage surgeries were compared in terms of hard- and soft-tissue parameters and were found to be equally successful.[3] Accordingly, studies of early loading (two to four weeks) of implants in the anterior mandible for overdentures[4] and the anterior maxilla[5] were undertaken to determine if, under controlled circumstances (the absence of infection or inflammation, implant placement in bone of sufficient volume and density to achieve initial stability, and elimination of occlusal and especially lateral forces

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during the healing period), equivalent success rates could be achieved. There is now overwhelming evidence that a two-implant overdenture is the first choice for the edentulous mandible. These successes have also resulted in the application of single-stage surgeries in the treatment of posterior partial edentulism.[6] The concept of single-stage surgery becomes critical because dental implant therapy has progressed to include immediate placement and immediate loading procedures. Consequently, dental implant therapy is becoming the new standard of care for tooth replacement.[7]

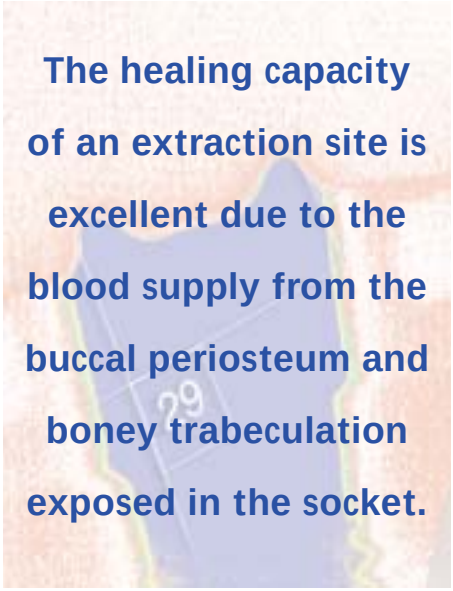
Definition of Terms

■ **Delayed placement:** The extraction site is allowed to heal for a minimum of four to six months before the implant is placed. Critical factors for placement are considered in three dimensions:

- Occlusogingivally — Biologic width elements are the same for implants as for natural teeth, so the mid-buccal crest of bone will be 3 mm from the free gingival margin and 3 mm higher than the interproximal bone.
- Mesiodistally — The sides of the implant must be 1.5 mm from the adjacent teeth for healthy biologic width in the horizontal aspect.
- Faciolingually — The implant access is to be aimed at the cingulum for anterior teeth, not the incisal edge, or in the middle of the occlusal surface for posterior teeth.

■ **Immediate placement:** The implant is placed directly after tooth extraction. The three-dimensional factors apply. Because the biologic width starts to form immediately, implant placement relative to the buccal crest is important. If initial stability depends upon the cortical plate, submerged placement will result in the erosion of initial stability, and there is the risk of mid-buccal recession.

■ **Initial stability:** A purely mechanical lock created between the threaded, roughened surface of the implant and the proximity and density of its boney housing. Initial stabilization is not the same as osseointegration; it must carry the implant during the critical time of the early stages in the development of osseointegration, during which the implant is at risk. Initial stability is measurable by resonance frequency analysis or torque test values.



■ **Immediate provisionalization:** The placement of a provisional restoration at the time of implant placement, with special care to create accuracy of abutment fit and emergence profile mimicking that of the removed natural tooth so as to maximize preservation of the interproximal papilla. Usually, the provisional restoration has no occlusal contact, so the term "immediate nonfunctional loading" applies. The permanent restoration is placed two to four months after implant placement, allowing adequate time for osseointegration and soft-tissue maturation.

■ **Immediate loading or immediate occlusal loading:** The placement of a restoration in occlusal function immediately upon implant placement. Usually this is possible only in Type I or Type II bone.

■ **Provisional loading:** The use of more-interim restorative materials (e.g., acrylic resin) for restoration of implants after stage-two surgery, then, after a time for osseointegration to achieve a steady state, conversion to harder materials, such as porcelain and gold.

Guidelines for Immediate Placement

The healing capacity of an extraction site is excellent due to the blood supply from the buccal periosteum and boney trabeculation exposed in the socket. Is the patient medically healthy, is the patient behaviorally compliant, and does the patient have good oral hygiene? Is the gingival, periodontal, and periapical status of the adjacent teeth healthy? Is the occlusal relationship favorable and stable? Is the implant site free of apical disorder and inflammation? Is there sufficient intermaxillary space to allow positioning of the implant, abutment, and restoration? Is there sufficient bone volume and density? Is bruxism not an issue?

To be an accepted treatment modality, immediate implantation had to be proven to have comparable short-[8] and long-term[9] survival rates.[10] Immediate placement provides the advantage of preventing post-extraction bone resorption, due to the possibility of ridge resorbtion during the socket healing phase, and decreases the risk of papilla loss because there is no flap elevation. Clinical and histological studies have demonstrated that non-submerged implants osseointegrate as well as submerged implants and function comparably under load over extended periods.[11] In addition, successful bone regeneration in extraction sockets around immediately placed

implants has been shown to have comparable clinical results to conventional techniques.[12]

Surgical Technique

Periodontal probing before extraction allows prediction of final soft tissue contours, regarding the 5 mm rule for interproximal papilla height relative to the distance from the contact point of the adjacent tooth and the interproximal bone height,[13] to be included in preoperative informed consent. If the adjacent teeth are to be crowned, there is greater eventual control over the interproximal contact point height and shape. Flat, thick gingival architecture is more predictable than scalloped and thin. How wide is the zone of keratinized tissue? Because the biologic factors influencing the entire process are under less control than with conventional (delayed) techniques, the patient must be made to understand that realistic expectations are limited to what is biologically possible for the existing oral anatomy.

Extraction of the tooth is achieved without flap elevation, with particular attention to preserving the labial (buccal) plate. The lack of visualization of the buccal bone site can be compensated for through preoperative planning and computer tomography scans. Use of periotomes or small diamond points interproximally and palatally (not buccally) can be helpful to establishing a purchase point for leverage. Molars can be hemi- or trisected. After the labial plate has been verified as intact, all remnants of soft tissue are to be removed from the socket. A surgical guide can compensate for the lack of direct vision. The implant is to be aligned ideally, independent of the tooth/root extraction socket. The slope of the palatal wall is used as a drilling guide and for maximum engagement for stability, maintaining drill positioning so that the implant will not exert pressure against the labial bone when inserted. The implant site is to be prepared 3 to 5 mm beyond the apical end of the extraction socket, enabling the use of a 13 or 15 mm length implant. This allows the surgeon to make "2 mm twist drill" treatment planning decisions at the time of surgery. There must be a minimum of 1.5 mm interproximally between the implant and the adjacent tooth. Adjacent implants, placed at the same time, must be at least 3 mm apart, or there will be a loss of 1 mm height of bone. The gap between the cervical portion of the implant platform and the bone wall, if greater than 1.5 mm, must be covered with a membrane.

Numerous clinical studies have documented successful immediate loading of multiple implants placed in dense bone and splinted with a fixed prosthesis.

Immediate Loading

Numerous clinical studies have documented successful immediate loading of multiple implants placed in dense bone and splinted with a fixed prosthesis.[14-19] The significance of splinting as a contributing factor to a successful outcome is related to the amount of micromovements at the bone/implant interface (resulting from inadequate initial stability) during the period of osseointegration. The amount of micromovement that appears to be tolerable is about 100 µm for smooth machined surfaces,[20] and slightly higher for rough surfaces. Hence, the need for high initial stability to be able to consider immediate provisionalization, making sure the provisional restoration has no functional contact.

Initial stability is a function of a number of factors. The surgical technique, previously discussed, creates an osteotemy site that allows precision fit of the implant. Bone volume must be sufficient, and density is more favorable if higher (Type I or II). It can be evaluated by drilling torques.[21] For immediate loading, minimum insertion torques of 35-50 Ncm, have been suggested.[22]

The evolution of the immediate placement, immediately provisionalized dental implant as a successful treatment regimen (under optimal circumstances and rigorous guidelines)[23] has created intense interest in its use in the esthetic zone.[24] With the advantage of preserving the tooth structure of adjacent teeth, reducing the spans of restorations, being retrievable, and having long-term documented success, it is often the first treatment of choice.

Quantitative Evaluation of Implant Stability

When Brånemark introduced osseointegrated implants, the percussion test was used to test osseointegration. The positive sign of initial stability was the high-pitched tone caused by tapping a mirror handle on the fixture mount after the implant had been placed. Radiographic interpretation is a standard two-dimensional method to evaluate the amount of available bone. The Periotest (Seimens, AG, Bensheim, Germany) quantifies the mobility of an implant by measuring the reaction of the peri-implant tissues to a defined impact load, but studies found the re-

Figure 1. The transducer of the Ostell unit is secured to the implant, after the implant is placed.

Figure 2. The Ostell unit.

Figure 3. The implant stability quotient reading from the Ostell unit.

sults to be inconsistent. An osseointegration test was created for titanium screw-type implants, using a surgical handpiece operating in reverse at 20 Ncm in an attempt to remove the implant. If the implant survived this "pass-fail" test, it was ready to be loaded, but the test was not quantitative and was not suitable for longitudinal testing. Today, an electronic method for testing implant stability, called resonance frequency analysis, is available.[25] The method quantitatively and objectively measures stability by the application of microscopic flexural stress. The system consists of an autoclavable transducer that is secured to the implant (**Figure 1**) or to the abutment, a frequency analyzer, a computer, and proprietary software. After stimulating the transducer, the resonance frequency of the system is recorded (**Figure 2**). This value measures the degree of rigidity at the bone/implant interface. In the Osstell system (Integration Diagnostics AB, Savedalen, Sweden), the resonance frequency values are translated into an index known as the implant stability quotient (**Figure 3**). The implant stability quotient may be measured at the time of implant placement or during the osseointegration process as a deciding factor to determine the time of loading (indicating whether an implant should be submerged and undergo a longer period of healing). The Osstell may also be used to evaluate the prognosis of existing implants at the time of prosthesis replacement. Quotient values range from 0 to 100. Almost 10 years of data from the Osstell Users' Group suggest that scores below 50 indicate questionable integration, 50-55 possible to convert to single-stage, 55-60 single-stage, 60-65 possible early load, above 65 immediate provisionalization. It is advisable that the provisional be screw-retained, rather than cemented, not removed during the first two months of healing, and, when possible, splinted (provisionally with resin fibers and composite resin, for example) to the adjacent teeth. The provisional restoration must be out of occlusion.

Conclusion

With preoperative casts, the patient can have a tooth, by means of a mucoadhesion removable partial, at the time of extraction. Under the best of circumstances, through a series of critical steps, each one dependent on the one before, the patient may be able to have an implant placed at the time of extraction. The final decision as to whether the implant may be immediately provisionalized can be made when the initial stability of the implant is determined after placement. CDA

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