Determining Implant Stability

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Introduction

Implants revolutionized dentistry and provide a viable treatment modality in the replacement of missing or un-restorable teeth. Long-term implant survival rates are reported in a range from 85-99%\(^1\) and can be influenced by several elements including healing time, implant surfaces characteristics, bone quality and surgical and restorative techniques. Classic guidelines used to enhance successful implant therapy include an unloaded healing period of 3 to 6 months to promote osseointegration, which is defined as the bone to implant contact at the light microscopic level.\(^2\)\(^3\) However, patients today would like the treatment and healing time shortened to allow for immediate provisionalization and an earlier restoration.

There are several surgical objectives that are thought to be important in accelerating the healing process of osseointegration. One of the more important of these objectives is to achieve initial primary stability. The torque value at time of placement is one indicator of determining initial stability. The literature shows that at a minimum, insertion torque of 20Ncm led to higher success rates.\(^4\)\(^5\) In addition, the initial torque value has been used to determine if an implant can be single-staged by placing a healing abutment/provisional at the time of surgery or if the implant needs to be submerged and allowed to heal for a longer period. It is prudent, therefore, to ensure that the implant is clinically stable prior to the restorative phase. Several clinical tests can be used to determine stability and are used as indicators of osseointegration, however most are only gross subjective measuring techniques.

Determinants and Tests of Implant Stability

Implant stability can be simply stated as the absence of clinical mobility. Initial implant stability is determined by two factors. The first is the quality of the bone where the implant is being placed (cancellous-less dense vs cortical-denser). The second factor is the degree at which the implant engages the bone. This is influenced by the type of bone as described above along with the design of the implant threads and the implant surface characteristics. It is also directly related to the surgical technique during placement. At the time of implant placement, the bone quality is assessed by the surgeon. In less dense bone, the surgeon may opt to undersize the osteotomy, potentially maximizing the initial bone-to-implant contact and implant stability. The last determinant of implant stability is how the bone heals around the implant.

Once an implant is placed and restored into function, it is subject to loads in axial, lateral and rotational directions. When testing implant stability, different tests are used depending on the direction of the load that is being evaluated.

Albrektsson used mobility as one of the criteria to determine stability and success.\(^6\) While there are different indexes to assess mobility, the ability to visually detect and measure clinical mobility is difficult, and is more subjective in nature. Typically, mobility is determined by applying lateral pressure, using the end of two mirrors, and a visual estimate of the distance of movement in one direction is noted. The observation of clinical implant mobility utilizing this technique only grossly measures mobility and signifies implant failure either at the surgical stage or post healing. This technique is not sensitive enough to allow for making better clinical decisions for determining appropriate healing periods post-placement and may lead to restoring an implant after what is thought to be successful osseointegration.

Another non-invasive way to check the stability of a healed implant is the percussion test. The percussion test uses the blunt end of a mirror handle which is tapped on the implant or restoration in the axial direction. A stable implant will sound similar to that of an ankylosed tooth. The downfall of this test is that it cannot be standardized from one provider to another and that it can only identify a failed implant, not one that may have achieved only partial osseointegration or is in the process of failing. Similar to testing for lateral mobility after healing, this technique could lead to a definitive restoration being delivered on a poor foundation, costing time and money to the patient.

Torque testing is more commonly utilized to determine stability both at the time of implant placement or following healing. However, this technique is time consuming and is a difficult process. At the time of implant placement, torque values are measured utilizing a hand-held torque wrench or the hand piece unit. Most handheld wrench markings indicate larger increments between torque values, making the accurate assessment difficult. Utilizing the hand piece unit can provide a more accurate assessment of torque values at implant placement. However, this is time consuming as one must incrementally dial the torque forces on the unit multiple times once the implant is seated to determine the final seating torque at implant placement. This technique cannot be used to monitor osseointegration over the healing period as micro-motion during the early healing phase can play a negative role in osseointegration.\(^7\)

Following healing, the reverse-torque test can be utilized to determine stability/osseointegration. During this test, a set reverse torque value is applied to the implant at any time after a period of healing, typically during the final impression visit. Sullivan in 1996 determined that using a reverse torque of 20Ncm provided a safe and reliable method to confirm that an implant is osseointegrated.\(^8\) Ideally, during this test, the implant will not rotate. However, the invasive nature of this test may not allow for implants that are healing slowly to fully integrate, and may not detect partial integration or failing implants.

Resonance Frequency Analysis

Until recently there has not been developed a reliable, efficient and non-invasive technique to objectively test implant stability however, with the development of resonance frequency analysis (RFA) a more sensitive, objective and non-invasive way to measure implant stability can be achieved. RFA has been researched for 15 years and has recently been used clinically. RFA is a test that sends a frequency through a transducer attached to the implant that applies a fixed lateral force to the implant and measures its displacement, simulating a clinically loaded implant.\(^8\)

The Osstell company has produced an instrument (Ostell ISQ) designed to measure a proprietary measurement called “implant stability quotient” (ISQ). ISQ evaluates the stability of the implant by measuring the stiffness of interface between the implant and bone.\(^8\) Publications recommended surgical and restorative protocols based on over 500 studies can help providers in making clinical decisions
and provide for better communication between the surgeon and restorative dentist. (Fig. 1) RFA has been able to objectively show a different implant stiffness when comparing initial and post healing ISQ values indicating osseointegration and has been able to detect failing implants prior to clinical mobility. In addition, ISQ values were significantly positively correlated to initial torque values in determining stability at 6 weeks.

**References**


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