ISSN Print: 2394-7489
ISSN Online: 2394-7497
IJADS 2020; 6(2): 315-317

www.oraljournal.com
Received: 25-02-2020
Accepted: 26-03-2020

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The accuracy and consistency of RFA in measuring implant stability

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Abstract
The purpose of this study is to provide accurate data of not only the stability of dental implants but also the healing stages of the bone around the implant that occurred during osteointegration. The study has used 100 patients to provide very sophisticated information about RFA (Resonance Frequency Analysis). RFA is the measurement of frequency with which a device vibrates. Different readings give you different amounts of stability.
Different ages, gender, surgical sites, health conditions, social conditions, and implant types have been used to conduct this study.
It provides readings of implant stability at different stages which will allow the dentist to have baseline records of the implant stability, to compare with the final stability readings.
This will give the confidence to the dentist to load the implant successfully without the need to use the old invasive reverse torque technique, which may sometimes result in loosing some of the integration the has happened if the implant did not fully integrate with the bone.
The ISQ (Implant Stability Quotient) readings will fall between:
Less then 60, which indicates the need for longer healing time, follow-up in 2 months.
60 and above, which indicates immediate loading.
The RFA is a valuable tool to use when you have medically compromised patients, smokers, and cases where bone density is not idea. It is of great value for immediate loading of implants.

Keywords: Implant stability, RFA, pros and cons of each method

Introduction
[1] Osseointegration is defined as direct bone attachment to the implant surface. This process starts immediately after placing an implant in the bone. This integration plays a major role in the success of any implant [2, 3]. The stability of the implant will be determined by the amount of osseointegration. There are two types of implant stability; Primary stability, which is the amount of the mechanical retention of the implant during the process of placing the implant in the osteotomy. It can be affected by many factors like bone density, quantity, implant design, surface texture, size, and also the surgical technique. Primary stability is very important to achieve secondary stability, hence a successful implant [4]. Secondary stability is the amount of osseointegration which happens between the bone and implant. It starts after placing the implant and in most cases is completed after 6-8 weeks. However, this can vary, and longer healing time may be required to achieve the final stability. Many factors can affect the secondary stability like time, load, bacteria, and general health of the patient. There are many ways to check the stability of any implant, some of them are direct (invasive), others are indirect (non invasive).
The purpose of this study is to show the importance of using RFA as a non invasive technique to get consistent, repeatable measurement of not only the implant stability, but also the healing stages of the implant.

Invasive (direct methods)
- Histological test [7]
- Reverse torque
- Insertion torque
- Tensional test

Non Invasive (indirect)
- Periotest
- Resonance Frequency Analysis (RFA)

Other Tests
- Percussion test
- Imaging

Reverse Torque [2, 6]
It is a direct invasive method of checking the implant stability. It is done after healing of the implant. The maximum torque value that can be applied is 20 NCM, if the implant did not move then it can be loaded successfully. However, the reverse torque can damage the integration that happened during the healing process knowing that different patients show different healing time length. That's why it is risky to use this test as a standard method for all patients.

Insertion Torque
It can be measured when the implant reaches the final apical position in the prepared osteotomy. It can be taken from the implant motor monitor. It gives a good idea about the primary stability. Another way it might be taken from the torque wrench tool while securing the implant to its final place in the osteotomy, the shortfall of this torque is the inability to give any information about the healing or the final stability, whether the implant is ready for loading or not.

Percussion Test [5]
It is a simple test that relies on the sound produced after tapping the implant. Dull sound means failing implant versus ringing which indicates successful osseointegration. It depends on the clinical experience of the dentist, that's why it could be considered as an ideal method for checking implant stability.

Imaging
X-rays are considered one of the main adjunctive tool in diagnosing and assessing the bone quality and the risk factors for the implant patient. However, it can't be used to make a final decision about the implant stability. CBCT scan can give more information about the osseointegration than the normal PA or panoramic X-rays.

Cutting Torque resistance
Cutting torque resistance lacks the consistent reading, hence can't be considered practical in a clinical setting. Cutting torque resistance specifies weak bone area during osteotomy preparation for implant placement. This can give enough information about the bone quality and the time needed for successful integration.

Periotest
It was presented by Schulte to assess the mobility of teeth by measuring the dumping characteristic of periodontium. This instrument is based on electromagnetic impact applied by a metallic rod that is controlled electronically. The values range from -8 to +50 and correlate mobility with Miller's classification of tooth mobility where -8 to 9 is considered firm, 10-19 slight mobility (CL 1), 20-29 visible mobility (CL 2), PTV 30 and over is (CL 3) is mobility.
The measurement value relies on the assessment of the time of contact between tapping rod and the target implant. The time is converted to periotest values. It is an accepted method in assessing healing and bone density at the time of implant placement and post surgically.

Resonance Frequency Analysis (RFA) [8]
It is widely used nowadays to have baseline records of implant stability and bone density during the different stages of osseointegration. The most common devices that use RFA are Osstell and Penguin. Both devices use a transduce (smart peg). The magnet rod (smart peg) is activated by a probe. This probe sends magnetic pulls, the rod will vibrate and induce voltage by the RFA. The smart peg should be torqued to 10-15 NCM, and usually come by the peg mount that can make carrying and torquing of the peg easier. The reading units of the ossetell expressed in ISQ (implant stability quotient). This ISQ scale ranges from 1-100 each ISQ corresponds approximately to 1000. A high reading value of 55 and over indicate healing implant. These values can be increased with time. Thus, this device can show a variable amount of osseointegration during the process of healing. RFA can give predictability and assurance of when to load the implant as different patients can show different ways of healing, hence different lengths of time of final stability. It can be of huge assistance in medically compromised patients or the primary stability is low. RFA can give an idea of the healing progress and can help the surgeon to reach the final decision as when to load the implant. The RFA can help when immediate loading is considered in the treatment plan. Nowadays, many patients prefer to get their implant restored immediately for aesthetic or functional reasons. Having the value of the amount of primary stability will be very useful in determining the time of loading the implant.

0sstell

Penguin

The Study
Compromised and healthy patients were selected. Maxilla and mandible, anterior and posterior sites were selected. Straumann and Osteoready implants used in different patients. Full mouth reconstruction, four lower and upper overdenture cases were selected for the study. Short implants

(Osteoready), conventional and immediate techniques were used. Stability was measured at the time of implant placement, four weeks, eight weeks, and four months later. Osstell and penguin devices were used to take measurements.

Result

1. All implants measured 57 and over after four weeks were successful.
2. 99.5 implants measured 60 and over immediately after conventional implant places were successful.
3. One case failed (Straumann) in one patient. After placing three implants, readings after three months were over 65, two implants were loaded after torquing the abutments to 35 NCM and one failed after torquing it to the same torque value and the reading of that implant was 67 with Osstell at the day of implant loading.
4. Penguin measurements were higher than Osstell by 2 to 3 units.
5. One Case was followed for one year after placing the implant. Patient was healthy ASA1. Immediate extraction and implant placed in site 12. The reading at the day of placement was 53 and remained the same for 3 months. Four months later, the reading went higher to 54. After waiting for a year, the reading value was 69. Decision was made to load the implant. The screw of the abutment was torqued to 35 NCM. The tooth is still in function after almost 3 years of follow up.

Conclusion

RFA is a simple, predictable and inexpensive way of measuring the stability of an implant. The feature of being able to have the value of bone healing around the implant is very crucial in the success of implants. This technique is of great help when it comes to placing implants in high risk areas in the mouth, like maxilla or in medically compromised patients.

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