Resonance Frequency Analysis – A key for successful implant Treatment

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Abstract

Initial stability of placed implants and development of osseointegration are two major issues in patients. Implant stability is a position-related mechanical phenomenon which is related to the Bone. Bone quantity and quality, surgical technique including surgeon skill,implant (shape, length, diameter and surface features) are the main factors affecting initial stability. Primary stability, bone modeling and reconstruction, and implant surface condition are the main parameters affecting secondary stability. As briefly discussed implant RFA is influenced by many factors, including implant surface characteristics and placement location, bone quality, bone mass, marginal mucosa cushioning effect, and osteoimplant contact. may receive Effective implant length and connection to transducer. RFA as a technique for measuring the stability of dental implants has attracted considerable scientific interest in recent years since its initial introduction.

Key words : Implant stability, resonance frequency analysis (RFA), Osseo-integration, implant stability quotient.

INTRODUCTION

Dental implants is one of the best options for restoring the edentulous regions of the oral cavity[1,] There is high survival rates have been reported for implants supporting prosthesis but bone loss still causes failure and Previous studies illustrate that peri implantitis induced crestal bone loss increases with patients age[2]. Bone loss may depend upon the location of the upper part of the implant in relation to the alveolar crest, the creation of an interface (micro gap) between the implant components and the type of neck and platform of the implant[3]. Commonly

titanium has traditionally been the preferred material for dental implants. The growing demands for metal-free materials in dentistry, together with the increased sensitivity and allergies, have promoted advancements in material science.[4]

Primary stability of an implant is the absence of mobility in the bone bed upon insertion of the implant and mostly comes from mechanical interaction with cortical bone. It is also named as "Mechanical Stability" which is the result of compressed bone holding the implant tightly in the bone.

Secondary stability, named as "Biological Stability" happens through bone regeneration and remodeling at the implant/bone interface. It is the result of new bone cells forming at the site of the implant and osseointegration. Osseointegration states that there is an absence of connective tissue in the interface between the implant and bone.[5,6,36],37The primary stability is the requirement for successful secondary stability

Survival of implant and its clinical success is demonstrated in numerous studies in relationship to the quantity & quality of the bone available in the implant bed[7] Although Osseointegration is a key factor in establishing many of the criteria that determine implant success or failure. However, osseointegration is a patient-dependent wound healing process that occurs in two distinct stages, primary and secondary stability.[8]

An indirect indicator of osseointegration, the stability measure of dental implants is a measure of the resistance of the implant to movement. Objective measurement of implant stability is a valuable tool for achieving consistently good results. Especially since the stability of the implant plays a very important role in the successful outcome.[9]

Insertion torque analysis as an invasive method describes the force exerted on the implant when it is inserted. The torque when inserting the implant is initially minimal and increases rapidly until the cortical layer is fully engaged with the jawbone. Once the implant is driven into the bone, repeated measurements are taken and often charted. The maximum value is reached when the screw head touches the cortex (hard, outer alveolar shell). The insertion torque measurement determines the maximum insertion torque value when the screw head contacts the cortex. This test is generally widely accepted and used to evaluate various implant designs. Insertion torque has been shown to correlate with bone density, resulting in increased implant stability.[10]

RFA as a method of monitoring implant/tissue integration was first introduced for dentistry in 1996. It is a non-invasive and objective method for short-term and long-term monitoring of changes in implant stability. As briefly discussed in this section, implant RFA is influenced by many factors, including implant surface characteristics and placement location, bone quality, bone mass, marginal mucosa cushioning effect, and osteoimplant contact. may receive Effective implant length and connection to transducer. RFA as a technique for measuring the stability of dental implants has attracted considerable scientific interest in recent years since its initial introduction.

Discussion

To detect implant stability, various diagnostic analyses have been employed including percussion test, standardized radiographs, cutting torque resistant analysis, reverse torque test, and resonance frequency analysis (RFA).

Insertion torque analysis as an invasive method describes the forces exerted on the implant during insertion. The torque when inserting the implant is initially minimal and increases rapidly until the cortical layer is fully engaged with the jawbone. The insertion torque measurement determines the maximum insertion torque value when the screw head contacts the cortex.[20]

The RFA method has become popular recently because it is a non-invasive diagnostic method and is the most accurate technique. Resonance frequency analysis is a test method that provides an objective and reliable measurement of lateral micromobility at various stages of the injection process. This method analyzes the first resonant frequencies of miniature transducers attached to implant mounts or abutments. The unit of measurement is ISQ.[18]

Bone density values provide predictable data about bone quality and quantity. To this end, monitoring bone density using CT technology has become popular in recent years..[19, 20] Significant correlations between bone density on CT and implant stability were reported in previous studies.[21, 22] High radiation exposure, however, the current literature focuses on the concept of using cone-beam computed tomography (CBCT) to quantitatively determine bone density because of the drawbacks of this technique: Focused. A recent previous study showed significant correlations between bone density scores from CBCT and density scores from CT and implant stability parameters.[23] Most previous studies on bone density by CT have focused on cadaver specimens, making direct comparisons between this study and previous studies difficult.

However, due to the high radiation exposure of this technique, the current literature focuses on the concept of quantifying bone density using cone-beam computed tomography (CBCT). increase. A recent previous study showed significant correlations between CBCT bone density scores and CT density scores and implant stability parameters.[24] Most previous studies on bone density by CT focused on cadaver specimens, making direct comparisons between this study and previous studies difficult..[25]

Wang *et al.* [26] Considering the different stages of osseointegration into primary stability, the tissue was divided into three stages. It is composed of granulation (fibrous connective tissue), an intermediate stage where fibrous tissue is predicted to callus, and terminal tissue where cartilage (flexible connective tissue) is formed.[27] Since the mechanical properties of all these phases are softer than the surrounding cortical and cancellous bone, it has been hypothesized that there is a first-order stability relationship between implant resonance frequencies and soft tissue.

ANDREAZA DA CUNHA et al A study was conducted to evaluate primary stability and placement torque in these two types of implants to determine whether advances in implant design have truly improved implant performance. In this study, it was determined that there is no direct relationship between ISQ (ie first order stability) and mounting torque. Some implants showed higher placement torque but no improved initial stability.[28]

al-Saadi et al. [29] found that subjective assessments of bone quality correlated well with the results of RFA, Periotest values, and measurements of placement torque during implant placement. Fischer ET a[l5] found a significant correlation between her RFA at placement and bone quality/quantity. Previous studies have shown differences between Hounsfield Units (HU) values obtained from spiral CT and implant stability parameters [(6,7,24),] and density values obtained from CBCT and implant stability parameters [(11,12, 14)] were also found to have significant correlations. Previous studies cited above evaluated correlations between techniques that provide predictable information about implant stability. This is pre-implantation (ie, density score obtained from CT or CBCT) and during implantation (ie, subjective bone quality classification, ITV and RFA).
.A clinical study by Song et al.[32] showed that bone density obtained by CBCT showed strong correlation with ISQ.
An animal study by Isoda et al [33] reported significant correlations between CBCT-derived bone density and implant stability parameters.

TurkyilmazI, tumer c, ozbek en, tozumtf. Their study determined the relationship between bone density, insertion torque, and implant stability during implant placement. A statistically significant correlation was found between bone density and insertion torque values ($p<0.001$). Bone density and ISQ value ($p<0.001$); and insertion torque and ISQ value ($p<0.001$).[29]
wada M, tsuiki Y, suganami T, ikebe K, sogo M, okuno I and maeda Y in their study investigated the correlation between the thickness of the cortical bone or the voxel values that are obtained by cone beam computed tomography (CBCT) and the insertion torque values (ITVs) or the implant stability quotient (ISQ) values. Evaluated the influence on the ITVs and the ISQ values among multiple factors, multiple regression analysis was performed. $P < 0.05$ was considered statistically significant. In addition, a significant positive correlation was also found between the voxel values and the ITVs. From the multiple regression analysis, the thickness of the cortical bone and the voxel values had a positive influence on the ITVs and the ISQ values.[34]

Ostman et al [34] found higher ISQ values for wide platform implants compared to normal/narrow platform implants in men and women, mandibular and maxillary, and placement surgery. Similarly, in the current study, higher initial implant stability scores were observed in mandibular, male, elderly patients, and large-diameter implants.
Although various diagnosis analyses have been employed and several research and development projects have been already made to quantify implant stability at various times.
The benefits of measuring implant stability are more accurate determination of crown loading or unloading timing, selection of appropriate protocols for implant loading, and increased confidence between patients and practitioners.

Conclusion

The level of predictability and high success rate of current implant treatments provides a rationale for re-evaluation of long-established surgical and prosthetic guidelines. With the

trend to shorten treatment times and reduce patient discomfort, immediate loading of implants is emerging as an alternative approach. Certain standards and guidelines must be followed to avoid unnecessary mistakes. The primary stability of the implant is an important factor to consider before attempting immediate loading of the implant and is also important in considering the long-term success of implant treatment. Therefore, noninvasive diagnostic techniques for clinical assessment of implant stability and osseointegration are needed. Although RFA is widely used in clinical studies as a parameter to monitor implant stability, there is still much controversy about its reliability.In conclusion, RFA may serve as a non-invasive diagnostic tool. Proof of implant stability of dental implants during the healing phase and regular aftercare after treatment.

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