Using Osstell to Monitor Primary Implant Stability: A Clinical Case Report

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Abstract: The increased demand for implants in the dental surgeon's clinical routine, methods and techniques have been created that involve non-invasive quantitative analysis, do not damage the bone-implant interface and objectively measure implant stability, such as resonance frequency analysis. The aim of this case report is to present a clinical case of a patient who came to the Dental School Clinic with a diagnosis of oblique root fracture with an indication for root extraction and immediate implant placement. The Osstell was used as another technique, in addition to the torque wrench, to measure the primary stability of the implant, which showed high stability, proving the importance of using the Osstell in the clinic.

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Introduction

Implant dentistry addresses the growing demand for both partial and complete tooth replacement through biologically based rehabilitation procedures, following the principles of osseointegration as described in the Brånemark protocol (Buser et al., 2000).

Successful treatment with implants is achieved through the process of osseointegration, which can be defined as a direct functional and structural connection between the bone and the implant surface (Branemark, 1983).

Implant stability, characterized by a clinical condition where there is no mobility (Meredith, 1998), and the ability to withstand lateral, rotational and axial loads (Oh and Kim, 2012), can be specified as primary and secondary. Primary stability, considered a fundamental factor for osseointegration, is dependent on the macroscopic characteristics of the implant, such as design and surface, including length, diameter, shape and thread types, as well as surgical technique, mechanical quality and local bone volume (Palarie et al., 2012). To guarantee the osseointegration process, implant stability must be analysed at different times. The ability to measure stability helps the implant dentist decide on the loading of an implant, allows the choice of protocol for each patient and provides adequate documentation for the case (Atsumi et al., 2007).

This analysis can be carried out using a device created by a company based in Gothenburg, Sweden, called Osstell, which monitors implant stability by measuring the resonance of a transducer attached to the implants at any stage of treatment and observation period (Hayashi et al., 2010). Studies have analysed resonance frequency analysis (RFA) in relation to its ability to measure implant stability and have confirmed its usefulness (Winkler et al., 2001). The aim of this study was to report the clinical case of a patient with a fractured root canal requiring extraction and immediate loading, in which Osstell was used to measure the primary stability of the implant friction during implant placement, the homogeneity of the implantation site, and implant factors such as shape conical or cylindrical, diameter, type of surface treatment, length, thread shape, presence of retentive grooves, and surface modifications can influence RFA and insertion torque values (Bannwart et al., 2024).

Case report

A 54-year-old female patient came to the Prosthodontics Postgraduate Clinic at the School of Dentistry with a diagnosis of root fracture of the upper right lateral incisor (Figure 1), which had already been rehabilitated with a cast metal core and full crown (Figure 2). Prior to the surgery to extract the remaining root canal and install the implant, the patient was asked to undergo panoramic complementary radiographic (Figure 3) and laboratory tests in order to assess whether her systemic condition was favourable for the surgical procedure (complete blood count, creatinine, glycemia, urea and coagulation time) (Bannwart et al., 2024).

Figure 1: Intraoral clinical aspect showing alveolus with root remnant.

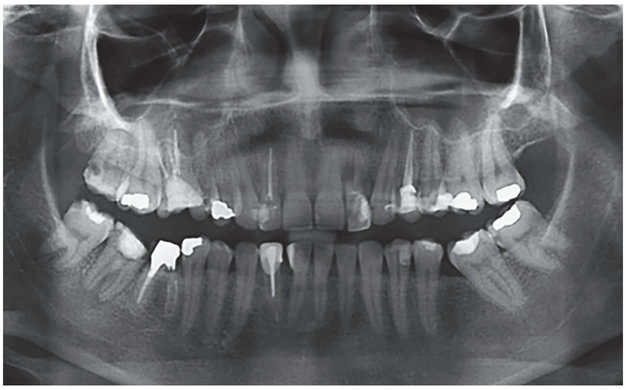

Figure 2: Cast metal core and full crown.

Figure 3: Panoramic radiograph after crown repositioning.

Pre preparation

At the surgical stage, the patient's vital signs were checked blood pressure and heart rate, followed by antibiotic prophylaxis amoxicillin 1 g one hour before the procedure began.

In accordance with the appropriate biosafety standards, mouth antisepsis was performed, instructing the patient to rinse their mouth for 1 minute with 0.12% chlorhexidine antiseptic solution Periogard (Colgate, São Paulo, Brazil). The patient was then given an extra-mouth antisepsis using polyvinylpyrrolidone and iodine, 9% active iodine (PVPI), the operative field was affixed and infiltrative terminal anesthesia using mepivacaine Mepiadre 100, mepivacaine hydrochloride 2% with epinephrine 1:100,000, Dental Industry, RJ, Brazil (DFL) (Goiato et al., 2016; Bannwart et al., 2024).

Surgical phase

Local anesthesia was applied by infiltration with anesthetic together with vasoconstrictor. When necessary, after incision and syndesmotomy, the surgical bed was prepared by reaming with abundant irrigation with saline solution. A hexagonal Morse cone implant was installed. After completion of the surgical phase, the incised regions were sutured and medications were prescribed using the following protocol: antibiotic, amoxicillin 500 mg–1 gram 1 h before surgery followed postoperatively by one 500 mg tablet every 8 hours for 7 days 6; anti-inflammatory agent, nimesulide one 100 mg tablet 1 h before surgery followed postoperatively by one 150 mg tablet every 12 hours for 3 days (Goiato et al., 2016; Bannwart et al., 2024).

The root remnant had to be extracted and an immediate implant placed (Figure 4).

For the implant, staggered bone milling was carried out under sterile saline irrigation. With the surgical guide in place, the initial drilling was carried out. The pilot drill was used in the socket and then the 3 mm drill in depth. The progressive sequence of cutters followed the manufacturer's instructions according to the type of implant used.

Implant placement

After preparation, the hexagonal Morse cone implant 3.75×13 mm (CMH Biofit DSP Biomedical, Campo Largo, Brazil), implant conical connection for better primary stability in the extracted root region, preventing and preserving the crestal bone (Souza et al., 2021). The implant was installed 1 to 2 mm below the bone crest, favouring aesthetics, and the maximum implant insertion torque was recorded. Installation was carried out using a contra-angle reducer driven by an electric motor with torque control BLM 600 Plus (Driller, São Paulo, Brazil) and a ratchet wrench with a manual torque wrench, which showed a value of 40 N×cm.

Immediately after implant installation, the Osstell® Mentor (Goteborg, Sweden) was used as another technique in addition to the torque wrench, in order to measure the primary stability of the implant. The implant was coupled to a resonance frequency transducer device, SmartPeg™, specific to each type of screw. The Osstell® measuring rod was approached by starting to stimulate the SmartPeg™ by emitting magnetic pulses, causing it to resonate at specific frequencies depending on the implant's level of stability (Figure 5).

Once the insertion torque and implant stability quotient (ISQ) values had been obtained, which represented a high primary stability value, presented an accepted high stability range (ISQ > 70) (Alsaadi et al., 2007), another alternative treatment that could have been carried out was placing the implant with immediate loading, i.e. installing the prosthesis on the implant immediately after installing the implant. However, as this was a research project in which the

Figure 4: Trans-surgical implant placement immediately after root remnant removal.

Figure 5: Measurement of primary implant stability using Osstell, immediately after implant placement.

focus was on measuring the stability of the implant immediately and six months after its installation, we opted to install the removable prosthesis, and finishing simple interrupted sutures were used with 4/0 nylons thread Procare, MedicoCoLtd.

Postoperative care

The patient was then rehabilitated with a temporary removable prosthesis until the implant had osseointegrated. In the post-operative period, the patient was instructed on the necessary post-operative care and medication with antibiotics amoxicillin, anti-inflammatories nimesulide and analgesics paracetamol in case of pain (Goiato et al., 2016; Bannwart et al., 2024).

Discussion

To ensure the osseointegration process, implant stability must be analysed at different times. The ability to measure stability helps the implant dentist decide on the loading of an implant, allows the choice of protocol for each patient and provides adequate documentation for the case (Atsumi et al., 2007).

The limitation of methods for verifying implant osseointegration, such as histological analysis, radiography and percussion tests due to their low degree of accuracy has led to the development of a non-invasive, clinically applicable diagnostic test which does not damage the bone-implant interface, is easy to use and reliable. In the resonance frequency analysis RFA method, a SmartPeg sensor is connected to the implant and then the tip of the device is held close to the sensor in the mesial, distal, buccal and lingual directions, while electromagnetic pulses are emitted. The description of RFA method and ISQ scale is repeated twice, which affects readability. RFA is a non-invasive way to evaluate implant stability. A SmartPeg™ is attached to the implant, and electromagnetic pulses are emitted from the Osstell device in various directions. The resonance frequency is then converted into ISQ value ranging from 1 to 100. According to the manufacturer, values above 70 indicate high stability, 60–69 medium stability, and below 60 low stability (Alsaadi et al., 2007).

No correlation was observed between insertion torque and ISQ, so we can say that they are independent methods that indicate two different characteristics of primary stability. The ISQ can indicate resistance to bending loads and the insertion torque can indicate resistance to shear forces (Souza et al., 2021).

The RFA technique provides clinically important information regarding the state of the bone-implant interface at any stage after implant placement. It can be used as an additional parameter for decision-making during treatment and all implant follow-up. Studies have analysed RFA in relation to its ability to measure implant stability and have affirmed its usefulness (Winkler et al., 2001).

Insertion torque values ranging from 30 to 40 N×cm represent good primary stability and are defined as limits for immediate loading (Souza et al., 2021).

In the study by Souza et al. (2021), 25 patients (average age 50 ± 9 years) received implants, most of which were placed in bone types I and III. One failure was reported in a type III bone site, while implants placed in type II bone showed successful osseointegration after six months.

In the resonance frequency analysis RFA method, a SmartPeg sensor is connected to the implant and then the tip of the device is held close to the sensor in the mesial, distal, buccal and lingual directions, while electromagnetic pulses are emitted. Subsequently, the resonance frequency values are automatically converted to a scale called ISQ and shown on the device's display, where the values range from 1 to 100. The device manufacturer states that ISQ greater than 70 represents high stability, ISQ between 60 and 69, medium stability and ISQ less than 60 is considered low stability. Therefore, the higher the ISQ, the greater the stability of the implant (Alsaadi et al., 2007).

No correlation was observed between insertion torque and ISQ, so we can say that they are independent methods that indicate two different characteristics of primary stability. The ISQ can indicate resistance to bending loads and the insertion torque can indicate resistance to shear forces (Choi et al., 2014; Souza et al., 2021).

Based on previously conducted studies, the RFA device has been widely used in clinical studies to assess implant stability, although it also has limitations due to the need for a specific transducer that is not available for all implant systems, in addition to difficulties in use in prostheses cemented with implants (Choi et al., 2014).

Implant design is essential to achieve stability. The external and superficial geometry of the screw is designed to promote a larger surface area of contact between bone and implant, which induces greater bone growth and load distribution, favouring superficial anchorage and offering resistance to insertion torques (Souza et al., 2021).

The advantage of using the Osstell device to analyse resonance frequency is that it can be measured at any stage of rehabilitation (Andreotti et al., 2017). In this way, it can be assessed at the time of implant installation, during the trans operative period, or even at the stage of prosthesis installation or after its

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installation. The Osstell device allows implantologists to obtain clinically important and indispensable information about the stability of the bone-implant interface at any stage after implant placement.

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