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Clinical analysis of the stability of dental implants after preparation of the site by conventional drilling or piezosurgery

Ulisses Tavares da Silva Neto [a], Julio Cesar Joly [b], Sergio Alexandre Gehrke [c,*]

[a] *Postgraduate Program in Implantology of APCD, Jundiaí and Osasco, Brazil*
[b] *São Leopoldo Mandic University, Campinas, Brazil*
[c] *Catholic University of Uruguay, Montevideo, Uruguay*

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Abstract

We used resonance frequency analysis to evaluate the implant stability quotient (ISQ) of dental implants that were installed in sites prepared by either conventional drilling or piezoelectric tips. We studied 30 patients with bilateral edentulous areas in the maxillary premolar region who were randomised to have the implant inserted with conventional drilling, or with piezoelectric surgery. The stability of each implant was measured by resonance frequency analysis immediately after placement to assess the immediate stability (time 1) and again at 90 days (time 2) and 150 days (time 3). In the conventional group the mean (SD) ISQ for time 1 was 69.1 (6.1) (95% CI 52.4–77.3); for time 2, 70.7 (5.7) (95% CI 60.4–82.8); and for time 3, 71.7 (4.5) (95% CI 64.2–79.2). In the piezosurgery group the corresponding values were: 77.5 (4.6) (95% CI 71.1–84.3) for time 1, 77.0 (4.2) (95% CI, 69.7–85.2) for time 2, and 79.1 (3.1) (95% CI 74.5–87.3) for time 3. The results showed significant increases in the ISQ values for the piezosurgery group at each time point ($p = 0.04$). The stability of implants placed using the piezoelectric method was greater than that of implants placed using the conventional technique.

Keywords: Implant stability; Resonance frequency analysis; Piezosurgery; Conventional drilling; Implant osteotomies

Introduction

Improvements in the bioengineering, geometry, and surfaces of implants, together with the advent of minimally invasive surgical techniques with increased tissue preservation, have changed the method of placement of dental implants, and allowed clinicians to obtain better results.

Stability is a prerequisite for the long-term clinical success of implants, and it depends on the quantity and quality of local bone, the design of the implant, and the surgical technique used (subinstrumentation or overinstrumentation).[1] The changes during tissue healing, such as resorption of bone and integration of the bone–implant interface, can govern the degree of secondary stability of the implant. Obviously the healing process will be affected by the morphology of the bone including the trabecular pattern, the density, and the degree of maturation.[2]

Rotary drills are efficient but they have several disadvantages, including the generation of debris and chips (which can spread and produce foreign-body reactions), the creation of substantial haematomata at the drilling site, the production of heat, difficulties in attaining geometrical accuracy, and wobbling.[3–5] Osteotomies designed to prepare the bony bed for placement of an implant generate heat, mainly from the high pressure manual movements and the speed of the rotary instrumentation that is required to achieve more

* Corresponding author at: Rua Dr. Bozano, 571, 97015-001 Santa Maria (RS), Brazil. Tel.: +55 55 3222 7253; fax: +55 55 3222 7253.
E-mail addresses: bioface@bioface.com.br (U.T. da Silva Neto), bio-tecnos@bio-tecnos.com (J.C. Joly), Sergio.gehrke@hotmail.com (S.A. Gehrke).

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efficient cutting. If it is not controlled this heat can lead to osteonecrosis.[5,6] A more recent option is piezosurgery (rather than traditional drills) for osteotomy.

Piezosurgery (piezoelectric bone surgery) is a promising, precise, bone-cutting system that is based on ultrasonic microvibrations and spares soft tissue. This allows for the selective cutting of bone, and causes minimal trauma at the time of the operation[7] because any cuts are micrometric and selective, and most damage is limited to the surrounding tissues.[8,9] Not only is this technique clinically effective, but histological and histomorphometric observation of postoperative wound healing and formation of bone in experimental animal models has indicated that the response of tissue is more favourable after piezosurgery[10] than after conventional bone-cutting techniques with diamond or carbide rotary instruments.[11]

The aim of this study was to evaluate in a randomised controlled clinical study the stability of implants placed in osteotomies made with conventional drilling or with the piezoelectric method at 3 different time points: immediately afterwards, and 90 days and 150 days after implantation.

Patients and methods

Thirty patients (24 women and 6 men aged between 20 and 60 years) were selected for this study, which was approved by the Ethics and Research Committee of São Leopoldo Mandic University (Campinas, Brazil). All patients were informed of the nature of the study and gave written consent to participation according to the Helsinki Declaration of 1994.

The inclusion criteria included the patient' current stable medical condition, the ability to withstand the stress of a dental implant, and the request for implants in the maxillary premolar area. Included patients were required to have had at least 6 months of healing without any grafting at the time of, or after, the extractions. Patients with unstable systemic conditions such as diabetes, hypertension, or osteoporosis; patients with oral disease in their soft or hard tissues; and patients with harmful oral habits such as bruxism and smoking, were not included. Exclusion criteria also included the presence of uncontrolled or untreated periodontal disease, insufficient bony volume to insert implants without augmentation procedures (a crest of at least 13 mm in height and 5 mm in width was required) and an insufficient mesiodistal space.

Surgical technique

Patients were given amoxicillin 875 mg orally twice a day for 5 days, and the initial dose of 2 g was given 2 h before operation. All procedures were done under local anaesthesia with 2% articaíne (Dfl Ltda, Rio de Janeiro, Brazil), as day cases by the same surgeon, who was familiar with both traditional and piezoelectric surgical techniques.

A full-thickness mucoperiostal flap was raised, and the underlying alveolar bone exposed for osteotomy. The adjacent implant sites were prepared in each patient during the same operation. At the control site the osteotomies were made using the conventional drilling method (according to the manufacturer's instructions), while in the test site the osteotomies were produced using piezoelectric surgery. Sixty-eight conical implants ($n = 34$ in each group), with a double-sandblasted and acid-treated surface and a Morse taper connection (Neodent, Curitiba, Brazil) were inserted. Implants were always inserted on one side for the conventional drilling and on the opposite side for the piezoelectric method, selected randomly. All implants were 3.5 mm in diameter and 13 mm long. The torque of the implants was limited to 55 Nm.

For implants placed by conventional techniques we used stainless steel and diamond piezoelectric tips with diameters of 2 mm, 2.5 mm, and 3 mm (Fig. 1A) with a piezosonic device (Driller, São Paulo, Brazil) and external irrigation with 0.9%saline solution. In the piezosurgery group we used a motor Kavo Concept (KaVo Dental GmbH, Biberach, Germany) and counter angle Kavo with a 27:1 reduction and an external irrigation with 0.9% saline solution. All implants were installed with the use of surgical guides, and the wounds were sutured. Ketoprofen 200 mg/day and paracetamol 750 mg 3 times a day were given for pain relief for 3 days postoperatively. All implants were submerged for 90 days, and with the healing abutment for 150 days. Restorative procedures were done during the 90 and 150 days.

Implants were inserted to analyse the resonance frequency in both sides using the Ostell™ Mentor (Integration Diagnostics AB, Göteborg, Sweden) for the measurements of resonance frequency analysis. A Smartpeg™ (Integration Diagnostics AB, Göteborg, Sweden) was screwed into each implant and tightened to approximately 5 Ncm. The transducer probe was aimed at the small magnet at the top of the Smartpeg at a distance of 2 or 3 mm and held stable during the pulsing until the instrument beeped and displayed the ISQ value. The ISQ values were measured during the operation (time 1), at 90 days (time 2), and at 150 days (time 3) postoperatively (Fig. 2). The measurements were taken twice in the buccolingual direction and twice in the mesiodistal direction.[12] The mean of the 2 measurements from each direction was regarded as the representative ISQ in that direction. The higher values of buccolingual and mesiodistal ISQ were used to generate a mean value, and all values were recorded. In addition, each implant was evaluated at all visits for mobility, pain, and signs of infection.

Statistical analysis

The outcomes were analysed longitudinally within the same group using the analysis of variance (ANOVA) test for repeated measures. The significance of differences between the 2 groups was assessed using Student's t test for unpaired samples (R Software version 2.6.2, R Foundation for