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Peri-implant bone loss around platform-switched Morse taper connection implants: a prospective 60-month follow-up study

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Abstract. The aim of this study was to measure the crestal bone level changes at 60 months of follow-up and to evaluate the influence of biologically relevant, anatomical, and implant-related variables. A prospective study design was used. STROBE guidelines were followed. A total of 576 implants were inserted in 270 patients needing an implant-supported, partial, fixed dental prosthesis or a single crown. Standardized peri-apical radiographs were obtained at 2 months (time of implant–abutment connection and prosthetic loading) and 60 months of follow-up. Descriptive statistics were used and inter- and intra-examiner reliability determined. A mixed model was used to evaluate the predictor variables. The correlation among multiple implants inserted in a single patient was considered. Significance was assessed using the type 3 test. Sensitivity analyses, least-squares means analyses, *t*-tests, and χ^2 tests were also conducted. The statistical analysis was performed at the implant level; $P < 0.05$ indicated statistical significance. At the 60-month follow-up, the mean marginal bone remodelling was -0.59 ± 1.34 mm (range -5.70 to 3.65 mm). Marginal bone loss was significantly influenced by implant depth, implant location, and the interactions implant depth × jaw, implant location × timing of implant placement, and jaw × implant diameter. At the 60-month follow-up, a low mean marginal bone loss was found, which was significantly higher with subcrestal implants and anterior implants.

Key words: bone loss; dental implant–abutment design; dental radiography; prospective studies; dental implant platform switching.

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The replacement of missing teeth with implant-supported restorations has become an accepted treatment modality for partially and totally edentulous patients.[1] A stable and aesthetic implant restoration can be achieved only through careful consideration of the biological principles of peri-implant hard and soft tissue healing, as well as the selection of an appropriate implant type and position.[1] Understanding the biological rationale for the bone remodelling and the specifics of these changes is paramount to predicting the stability and the location of the gingival margin.[1,2]

Marginal bone loss originates from a combination of mechanical and biological factors,[3] and factors hypothesized to be associated with marginal bone loss include the surgical trauma to the periosteum and bone,[4] size of the microgap between the implant and the abutment,[5] bacterial colonization of the implant sulcus,[6] the biological width,[7] and the biomechanical factors related to loading.[8] Marginal bone loss with implants seems to be unavoidable, especially after abutment connection, and minimal or no marginal bone loss after an implant–abutment connection is considered to be an indicator of the long-term success of implant restoration.[9] Over recent years, modifications have been made to the implant–abutment connection to prevent or reduce marginal bone loss. Accordingly, supracrestal implants with Morse taper connections, or one-piece implants, have been proposed as suitable alternatives.[9]

The primary aim of this study was to measure the mesial and distal bone levels at the time of implant–abutment connection and prosthetic loading (2 months after implant insertion) and at the 60-month follow-up to determine the changes in marginal bone level when a platform-switched Morse taper connection implant is used. A secondary aim was to identify the variables associated with increased rates of marginal bone loss.

It was hypothesized that peri-implant bone loss would already be present after the implant–abutment connection. Furthermore, it was hypothesized that there would be at least one variable associated with increased rates of peri-implant bone loss that the clinician could modify to improve the outcome.

Materials and methods

This prospective cohort study was conducted in the Department of Oral and Maxillofacial Sciences of ''Sapienza'' University of Rome, Italy, between February 2008 and February 2014. The STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines for prospective cohort studies were followed. This clinical investigation was performed in accordance with the ethical principles of the World Medical Association Declaration of Helsinki and the laws of Italy. The clinical investigation was undertaken after informing the patients of the content, risks, and benefits of the study and after obtaining the written consent of each participant. The investigation was independently reviewed and approved by the local ethics committee.

The main inclusion criteria were the following: systemically healthy patients aged between 18 and 85 years, in need of an implant-supported, partial, fixed dental prosthesis (FDP) or a single crown (SC). Furthermore, a sufficient bone volume for implants of at least 3.5 mm in diameter and with a minimum length of 10 mm was required in the prospective implant region. The patients were in a stable occlusal relationship with no parafunctional habits (clenching and/or bruxism) and the implant sites were free of infection and/or tooth remnants.

Exclusion criteria were alcohol or drug abuse; smoking more than 10 cigarettes per day; general health conditions that would preclude a surgical procedure, such as infectious diseases, heart or circulatory system diseases, metabolic diseases, bone metabolism disorders, disturbances of the hematopoietic system, haematological disorders, wound healing disturbances, disorders of the endocrine system, and pregnancy. Local contraindications included tumours or ulcers. In addition, reasons to believe that the treatment might have a negative effect on the patient's psychological situation were also considered criteria for exclusion. The need for extended bone augmentation before implant installation was also an exclusion criterion.

The level of the marginal bone was recorded at the time of implant–abutment connection and prosthetic loading, i.e. 2 months after implant insertion (T0), and at the 60-month follow-up (T1) using standardized peri-apical radiographs. The areas of implantation were evaluated with panoramic and intraoral peri-apical radiographs. Computed tomography (CT) was required only in cases of diagnostic doubt. The lengths and the diameters of the implants were selected according to the available bone.

All patients were treated with two-stage implant surgery, and a temporary acrylic resin restoration was delivered 2 months after implant insertion. The abutment was placed chair-side by the operator, milled and refined if necessary. After placement, the abutment was not removed. The impression was made from the abutment level, and delivery of the final metal–ceramic restoration occurred at the 6-month follow-up. The dental prostheses were conventionally cemented using glass ionomer cement (Ketac Cem; 3M Espe, Neuss, Germany). Any cement remnants were completely removed. If any mucositis or peri-implantitis did occur, the affected implants were included in recalls for special care. If this treatment resulted in persistent inflammation or showed initial mobility, it was considered unsuccessful and the implants were removed.

A two-piece cylindrical implant made from Ti–6Al–4V titanium alloy (grade 5) was used (Fig. 1). This implant (Osseothread; ImplaDent, Formia, Italy) is characterized by a modified sand-blasted/acid-etched titanium surface (SLA), extended onto the implant shoulder, and by a Morse taper connection (Fig. 2). The abutments had a smaller diameter than their respective implant platform (platform-switching) (Fig. 1). The implant lengths available were 10, 12, and 14 mm and the diameters were 3.5, 4.2, 4.8, 5.5, and 6.5 mm.

Antibiotic therapy (1 g amoxicillin) was prescribed 1 h before the intervention and twice a day for 5 days. Patients underwent local anaesthesia by infiltration of mepivacaine (20 mg/ml) associated with adrenaline 1:100,000. Pain was controlled with ibuprofen. All implants were inserted in a submerged mode. The flap design for the placement of the implants was an envelope full-thickness flap. A distance of at least 2 mm from the neighbouring teeth was taken. Each implant had a minimum thickness of 2 mm of surrounding bone. In no case was a temporary removable prosthesis used, in order to avoid hampering the healing process.

The level of the marginal bone was recorded by taking standardized radiographs. Peri-apical radiographs were obtained with the use of the long-cone parallel technique and the Rinn XPC film holding system (Dentsply Rinn, Elgin, IL, USA). Care was taken to align the X-ray film in the film holder parallel to the long axis of the implants. Digital radiographs were stored using a digital intraoral imaging system (DenOptix QST Digital X-ray Phosphor Plate System; Gendex, Hatfield, PA, USA). The stored images were displayed on a monitor and direct measurements were performed using dental imaging software (VixWinPRO; Gendex). Linear measurements from the implant

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