Original Article

Dental implants inserted in native bone: Cases series analyses

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ABSTRACT

Background: The concept of osseointegration, i.e., the direct anchorage of endosseous implants made of commercially pure or titanium alloy to the bone caused a breakthrough in oral rehabilitation. The identification of factors for long-term survival and success rate are the main goal of the recent literature. Several variables can influence the final result, and in general they are grouped in surgery-, host-, implant-, and occlusion-related factors.

Materials and Methods: A retrospective analysis on a large series of dental implants was performed to detect those variables influencing the clinical outcome. In the period between January 2007 and December 2009, 157 patients were operated. A total of 429 implants were inserted. Dental implants are reliable devices to be used in oral rehabilitation.

Results: Globally, very few implants were lost at the end of the follow-up period. Slight but significant differences existed among different implants types with regard to peri-implant bone resorption.

Conclusion: A better clinical outcome was revealed for Sweden and Martina global implant.

Key Words: Dental, fixtures, implant, oral, rehabilitation

INTRODUCTION

Pure titanium and titanium alloy are material widely used in orthopedic and dental surgery because of their desirable mechanical properties, chemical stability, and biocompatibility.[1-3] In fact, titanium is used to manufacture joint prosthesis for partial and total joint replacement. Moreover, titanium is also used to produce plates and screws for osteo-synthesis in the case of fractures and dental implants to substitute lost teeth.[1] Several authors have studied different aspects of implants structure during the years.[4-8]

From a general point of view, it is possible to distinguish macro-, mini-, micro-, and nano-design of dental implants. The macro-design is the shape

of the fixture: Some examples are offered by the cylindrical, spiral, and root form of dental implants. Example of mini-design is dimension and shape of threads and neck of dental fixtures. The dimension ranges from 1 to 0.1 mm. The micro-design is the shape of implant surface; an example is provided by the "groves and holes" resulting from surface treatments like machination, acid-etched, and sand-blasted procedures. Finally, the nano-design is determined by the molecular composition of the surface. Usually, macro-and mini-designs provide the mechanical properties of dental implant whereas micro-and nano-designs give the biological properties to the fixtures. Examples are the primary stability and osteoblasts stimulation to producing bone, respectively.[1]

Since the identification of factors for long-term survival (survival rate [SVR], i.e., total implants still in place at the end of the follow-up period) and success rate (SCR, i.e., good clinical and esthetic outcome) are the main goal of the recent literature and several variables can influence the final result, a retrospective analysis on a large series of dental

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implants was performed to detect those variables influencing the clinical outcome.

MATERIALS AND METHODS

Patients

In the period between January 2007 and December 2009, 157 patients were operated. A total of 429 implants were inserted (223 in female and 206 in male). The median age per implant was 52 years (min = 19 years, max = 85 years, SD = 12.17) and the mean implant follow-up was 28 months (min = 11 months, max = 60 months, SD = 9.98).

Subjects were screened according to the following inclusion criteria: Controlled oral hygiene, the absence of any lesions in the oral cavity, sufficient residual bone volume to perform implantology without additional procedures such as bone grafting; in addition, the patients had to agree to participate in a post-operative check-up program.

Exclusion criteria are as follows: Insufficient bone volume, a high degree of bruxism, smoking more than 20 cigarettes/day and excessive consumption of alcohol, localized radiation therapy of the oral cavity, antitumor chemotherapy, liver, blood, and kidney diseases, immunosupressed patients, patients taking corticosteroids, pregnant women, inflammatory, and autoimmune diseases of the oral cavity, poor oral hygiene.

Data collection

Before surgery, radiographic examinations were carried out with the use of orthopantomograph and computer tomography scans. In each patient, peri-implant crestal bone levels were evaluated by calibrated examination of ortopantomograph X-rays. Measurements were recorded before surgery, after surgery, and at the end of the follow-up period. The measurements were carried out mesially and distally to each implant, calculating the distance between the edge of the implant and the most coronal point of contact between the bone and the implant. The bone level recorded just after the surgical insertion of the implant was the reference point for the following measurements. The measurement was rounded off to the nearest 0.1 mm. A peak Scale Loupe with a magnifying factor of seven times and a scale graduated in 0.1 mm was used.

Peri-implant probing was not performed since controversy still existed regarding the correlation between probing depth and implant SCRs.[9]

The implant SVR corresponded to the total number of implant still in place at the end of the follow-up period.

The implant SCR was evaluated according to the following criteria: (1) Absence of persisting pain or dysesthesia; (2) absence of peri-implant infection with suppuration; (3) absence of mobility; and (4) absence of persisting peri-implant bone resorption greater than 1.5 mm during the first year of loading and 0.2 mm/year during the following years.[10]

Implants

A total of 429 implants were inserted in 157 patients: 263 (61.3%) in the mandible and 166 (38.7%) in the maxilla. Types of implant inserted were 60 (14%) 3I (Osseotite; Biomet, Palm Beach, Florida, USA), 37 (14%) SLA1 (Astra Tech AB, Mölndal, Sweden), 59 (13.8%) TiUnite (Nobel Biocare, AB, Goteborg, Sweden), 58 (13.5%) RBM or $CaPO_4$ ceramic-blasted (Lifecore Biomedical S.P.A., Pusiano, Como, Italy), 66 (66%) Global [Figure 1] (Sweden and Martina SPA, Due Carrare, Padova, Italy), 149 (34.7%) Premium [Figure 2] (Sweden and Martina SPA).

Implant diameter was narrower, equal, and wider than 3.8 mm, in 45 (10.5%), 80 (18.6%), and 304 (70.9%) cases, respectively. Implant lengths was shorter, equal, and longer than 13 mm, in 266 (62%), 129 (30.1%), and 34 (7.9%) cases, respectively. Implants were inserted to replace 47 incisors, 122cuspids, 156 premolars, and 104 molars.

Surgical and prosthetic technique

All patients underwent the same surgical protocol. An antimicrobial prophylaxis was administered with 500 mg Amoxycillin twice daily for 5 days starting 1 h before surgery. Local anesthesia was induced by infiltration with articaine/epinephrine and post-surgical analgesic treatment was performed with 100 mg Nimesulid twice daily for 3 days. Oral hygiene instructions were provided.

After making a crestal incision a mucoperiosteal flap was elevated. No flap was performed in post-extractive cases. Implants were inserted according to the procedures recommended. The implant platform was positioned at the alveolar crest level. Sutures were removed 7 days after surgery. After 16 weeks from implant insertion, the provisional prosthesis was provided and the final restoration was usually delivered within an additional 8 weeks. A total of 56 (13.1%) implants were immediate loaded. A total

Figure 1: Global implant (Sweden)

Figure 2: Premium implant (Sweden)

of 81 implants bore removable dentures whereas 344 carried fixed prosthesis. Five surgeons inserted implants. The number of prosthetic units (i.e., implant/crown ratio) was about 0.7. All patients were included in a strict hygiene recall.

Statistical analysis

Since only 4 out of 429 implants were lost (i.e., SVR = 99.1%) and no statistical differences were detected among the studied variables, no or reduced crestal bone resorption was considered as an indicator of SCR to evaluate the effect of several host-, implant-, and occlusion-related factors.

The difference among the implant abutment junction (IAJ) and the bone crestal level was defined as the IAJ and calculated at the time of operation and during follow-up. ΔIAJ is the difference between the IAJ at the last check-up and the IAJ recorded just after the operation. ΔIAJ medians were stratified according to the variables of interest.

Disease-specific survival curves were calculated according to the product-limit method (Kaplan-Meier algorithm).[11] Time zero was defined as the date of the insertion of the implant. Implants which were still in place were included in the total number at risk of loss only up to the time of their last follow-up. Therefore, the SVR only changed when implant loss occurred. The calculated SVR was the maximum estimate of the true survival curve. Log rank testing was used to compare survival curves generated by stratifications for a variable of interest.

Cox regression analysis was then applied to determine the single contribution of covariates on the SVR. Cox regression analysis compared survival data while taking into account the statistical value of independent variables, such as age and sex, on whether or not an event (i.e., implant loss) probably occurred. If the associated probability was less then 5% ($P < 0.05$), the difference was considered statistically significant. In the process regression analysis, odds ratio, and 95% confidence bounds were calculated. Confidence bounds did not have to include the value «1».[12] Stepwise Cox analysis allowed us to detect the variables most associated with implant survival and/or success.

RESULTS

Since only 4 out of 429 implants were lost (i.e., SVR = 99.1%) no statistical differences were detected among the studied variables.

There were 248 (57.8%) fixtures with a ΔIAJ higher than the cut-off value. Among the investigated variables (i.e., age, gender, tooth replaced, jaws, type of implant, length, diameter, surgeon, type of loading, and prosthesis), only the type of implant had a significant statistical impact on crestal bone resorption using Cox analyses ($P = 0.03$).

The mean peri-implant bone resorption was 3I = 2.1 ± 1.7 mm (60 cases); SLA1 = 1.5 ± 0.7 mm (37 cases); TiUnite = 2.7 ± 1.7 mm (59 cases); resorbable blast media (RBM)=1.9 ± 1.3 mm (58 cases); Global = 1.5 ± 0.6 mm (62 cases); Premium = 2.0 ± 1.4 mm (149 cases). Using univariate analyses (log rank test) Sweden Martina global implant had the best clinical outcome among the studied fixtures.

DISCUSSION

Dental implants are used worldwide for replacing missing teeth also after orthodontic treatment.[13-17] The identification of guidelines for the long-term SVR (i.e., number of implants still in place at the end of the follow-up) and SCR (i.e., good clinical, radiological, and aesthetic outcome) are the main goals of the recent literature. Several variables can influence the final result, but in general they are grouped as (1) surgery-, (2) host-, (3) implant-, (4) bacterial infection-,[18-20] and (5) occlusion-related factors.

Our results demonstrated that implant type had a statistical significant impact on SCR but not on SVR. Micro-design (i.e., surface) was relevant for implant biological proprieties which became relevant in the late post-surgical period. Macro-design (i.e., conical or cylindrical shape) is essential formechanical proprieties (i.e., primary stability) which are of paramount importance in the immediate post-surgical period. Since our results demonstrate some effect on the late follow-up period (i.e., SCR), our data suggest that implant surface can determine difference in clinical outcome.

Double-etched implants (i.e., DEIs, 3I implants) are fixtures which are used worldwide. They are characterized by an osseotite surface which is etched using a double-acid technique with HCl and H_2SO_4resulting in a non-machined roughened implant.[21] Several reports are available regarding the used of DEIs in native bone.[21,22]All the studies have demonstrated high SVR and SCR.

The RBM surface (also named $CaPO_4$-blasted implants) is roughened with the use of biocompatible calcium phosphate ceramic medium, which is fully resorbable, permitting its removal after manufacture. The result is a clean, textured, and pure titanium surface. The roughening process does not involve acid etched; thus RBM implant surfaces is, by definition, free from acid-etching residues. It is also susceptible to the titanium grain boundary degradation that can occur during aggressive acid-etching procedures.[23] Studies[24] have reported high SVR after 50 months of 1077 implants placed in 348 patients: 950 in the mandible and 127in the maxilla. Seven failures, all in the mandible, occurred before second-stage surgery was performed.

A moderately rough surface implant TiUnite (Nobel Biocare) was introduced in 2000.[25] TiUnite is a high crystalline and phosphate-enriched titanium oxide characterized by a micro-structurated surface with open pores in the low micrometer range. The TiUnite implant surface has been repeatedly proven to give an enhanced bone response and greater amount of bone during healing when compared with machined implant surfaces.[26] The enhanced bone response to TiUnite results in faster and stronger osteointegration and thereby better maintenance of the implant stability when compared with machined titanium implants. When placed in soft bone and immediately loaded, the enhanced osseointegration of Nobel BiocareTiUnite implants results in higher SCR. These claims are supported by extensive researches.[27] Vaden Bogaerde, *et al.*,[28] demonstrated that the use of oxidized titanium implants for early functional loading in the maxilla and in the prosthesis or mandible resulted in an higher implant SVR and favorable marginal bone level during a follow-up of 18 months.

Astra-Tech (Astra Tech Dental Implants; Astra Tech AB, Mölndal, Sweden) produces a TiO2-blasted surface. Gotfredsen *et al.*,[29] performed a prospective 5-year study of fixed partial prostheses supported by implants with machined and TiO2-blasted surface. A total of 133 implants were placed in 50 patients. Each fixed partial prosthesis was supported by atleast1 machined and 1 TiO2-blasted implant. The implant-supported fixed partial prostheses (ISFPP) were fabricated within 2 months after post-operative healing. A total of 52 ISFPP (17 maxillary, 35 mandibular) were inserted. The patients were clinically examined once a year for 5 years. At the annual follow-up, biological as well as technical complications were recorded. Of the 133 implants placed, 3 were reported as failed after 5 years of follow-up, resulting in an overall cumulative SVR of 97.6%. The cumulative implant SVRs were 100% for the TiO2-blasted implants and 95.1% for the machined implants. No significant difference in survival was, however, found between the machined and TiO2-blasted implants after 5 years. The mean marginal bone loss in the maxilla was 0.21 ± 0.83 mm (SD) for the machined implants and 0.51 ± 1.11 mm (SD) for the TiO2-blasted implants during the 5-year observation period. In the mandible, the mean marginal loss was 0.22 ± 1.13 mm for the machined implants and 0.52 ± 1.07 mm for the TiO2-blasted implants from baseline to the 5-year examination. No significant difference in marginal bone loss between the two surface groups was found during the 5-year observation period.

The global implants has a Zirconium sand-blasted acid-etched titanium surface. In the previous study using DNA (Deoxyribonucleic acid) microarray containing 19,200 genes, we identified osteoblast-like cells line (MG-63, Human osteosarcoma cell line) on new implant surface (nanoPORE, Out-Link, Sweden and Martina, Due Carrare, Padova, Italy), wherein expressions of several genes were significantly down-regulated. The differentially expressed genes cover a broad range of functional activities: (1) Immunity, (2) vesicular transport, (3) apoptosis, and (4) cell cycle regulation. It was possible to verify the activation of some genes related to bone formation.[30]

In a preliminary report, it was demonstrated that Sweden and Martina implants can be successfully used in grafted bone.[31] Here, in a larger series, it is demonstrated that Sweden and Martina implants have a very high SVR and SCR rate. They give a small but significant advantage with regard to peri-implant bone resorption.

CONCLUSIONS

The present study revealed a better clinical outcome for Sweden and Martina global implant.

ACKNOWLEDGMENTS

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