Title: IMMEDIATE IMPLANT LOADING: A COMPARISON OF TRABECULAR METAL AND TAPERED SCREW-VENT DENTAL IMPLANTS.

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ABSTRACT

Aims: The aim of the present study is to compare osteointegration and marginal bone loss of immediately loaded Trabecular Metal® and Tapered Screw-Vent® Dental Implants(Zimmer Dental Inc., Carlsbad, CA, USA).

Methods: Eighty-seven (87) patients were selected and randomly divided into Group A and Group B. Twenty-six (26) patients were enrolled in Group A, and were rehabilitated using Zimmer Trabecular Metal Dental Implants®. Sixty-one (61) patients were enrolled in Group B, and were rehabilitated using Zimmer Tapered Screw-Vent Dental Implants®.

Results: The mean value of marginal bone loss after one year was 0.44+0.40 mm for Group A and 0.95+0.62 mm for Group B (p<.003). Mean marginal bone loss after 18 months was 0.46+0.42 mm for group A and 0.97+0.65 mm for group B (p<.003). No TM implant was lost (Group A), whereas one TSV implant (Group B) was lost before osseointegration and was not included in the statistical analysis.

Conclusion: Both Trabecular Metal and Tapered Screw-Vent dental implants showed satisfying levels of osteointegration and marginal bone loss; however, statistical analysis revealed a value significantly lower of marginal bone loss for TM. Thus, it may be deduced that when implants are immediately loaded, the average loss of marginal bone around the TM implants is lower than that of the Tapered Screw-Vent implants.

INTRODUCTION

Compared to all other dental disciplines, implant dentistry has rapidly evolved, with progressive innovations, mainly in terms of development of new implant systems and the introduction of new surgical techniques (1, 2, 3, 4). Formation of a direct bone to implant contact is the main success criteria in implant dentistry.

Porous surface coating should enhance integration, by allowing bone growth inside the pores (5, 6); however, the number and size of the pores that can be obtained on the surface of the implant determine the quality and quantity of the bone growth. Histological studies showed that while a pore size of ̴ 100 μm is adequate for bone ingrowth (7), osteon formation inside a porous material needs ̴ 150 μm pores (8), while pores greater than ̴ 300 μm are required to support vascularized bone ingrowth (9).

Difficulties, however, were encountered in trying to get regular pores of predetermined dimensions. To overcome this obstacle, orthopedic researchers developed a highly porous tantalum trabecular material (PTTM) (Trabecular Metal Material, Zimmer TMT, Parsippany, NJ, USA) that simulated the trabecular structure (10–17) and more closely resembled the elastic modulus (2.5–3.9 GPa) of both cancellous (6.8 GPa) and cortical (13–17 GPa) bone than titanium (106– 115 GPa), cobalt chromium (210 GPa), or stainless steel (230 GPa) surgical metals used for orthopedic implants.(17–20). PTTM showed a bone-like three dimensional architecture (17, 21), interconnected porosity up to 80% (12, 13, 16, 17, 22, 23) and osteoconductive properties (12, 13, 16, 17, 22).

Since 1997, PTTM has been used for hip, knee, and spine reconstruction (12-14, 16-18). In recent years, PTTM was applied to the midsection of root-form, threaded, titanium alloy dental implants to create a three-dimensional, peri-implant bone ingrowth scaffold (24). The porosity of Trabecular Metal Material not only significantly increases the surface available for bone formation, but also allows angiogenesis and bone formation inside the pores (8, 10, 24, 25): the average pore size of Trabecular Metal Material is ̴550 µm, adequate for blood vessel formation and osseoincorporation (24, 26). The term osseoincorporation indicates the combination of osseointegration/bone ongrowth (bone to implant contact, BIC) and bone ingrowth within the porous material.

 In his initial studies on osseointegration, Branemark identified in titanium and tantalum the most suitable materials for implant manufacturing (27). Tantalum demonstrated a high biocompatibility and resistance to corrosion (28-32); however, the difficulty in working this material limited its use (33) and titanium was preferred.

In the 90’s a process of deposition of vapor using tantalum overcame the manufacturing limits. Trabecular metal material is nowadays produced by coating a vitreous carbon skeleton (2% of TM) with tantalum (98% of TM) via a chemical vapor deposition process (10, 11, 13): the result is a nanotextured, osteoconductive framework (20) of three dimensional, dodecahedron-shaped interconnected pores (10, 11, 13, 14, 19). The pores are large enough to allow bone ingrowth and blood vessel formation.

Two preclinical studies on PTTM documented bone growth inside the porous tantalum structures (18, 22, 34). In the first study, histologic analysis detected regions of contact between bone and implant increasing with time and evidence of Haversian remodelling within the pores at later stages. Mechanical tests at four weeks indicated a minimum shear fixation strength of 18.5 MPa, substantially higher than that obtained with other porous materials with a lower volumetric porosity (18, 22).

In the second study, 22 PTTM acetabular implants were studied in a canine model for a period of 6 months. Histology, radiography, and electron microscopy revealed stable bone-implant interfaces in all 22 implants. All histologic sections presented areas of bone ingrowth. The depth of bone ingrowth ranged from 0.2 mm to 2 mm. The mean bone ingrowth for all sections was 16.8%. In the peripheral regions, where bone-implant contact was most consistent, bone ingrowth averaged 25.1%. (18, 34).

The aim of the present study is to clinically and radiographically evaluate osteointegration and marginal bone loss of immediately loaded Trabecular Metal Dental Implants® (Zimmer Dental Inc., Carlsbad, CA, USA) 18 months after insertion in partially edentulous patients.

MATERIALS AND METHODS

The study was conducted in the Head and Neck Department of “Sapienza” University of Rome, and was open to all patients who met specific inclusion and exclusion criteria (Table I) and provided signed informed consent, according to the World Medical Association’s Declaration of Helsinki.

The Authors selected eighty-seven (87) patients, aged from 24 to 72 years (mean age 51), and randomly divided them into Group A (study group) and Group B (control group).

Twenty-seven (27) patients, aged from 24 to 68 years, with an average of 49 years old, were enrolled in Group A, and were rehabilitated using Zimmer Trabecular Metal Dental Implants. Each patient was treated with one implant. 15 implants were placed in the mandible and 11 in the maxilla. The sizes of the implants were the following: 4.7 x 11.5 mm (1 implants); 4.1 x 13 mm (1 implant); 4.1 x 11,5 mm (3 implants); 4.1 x 10 mm (9 implants); 3.7 x 11.5 mm (5 implants); 3.7 x 10 mm (7 implants).

Sixty-one (61) patients, aged from 26 to 72 (mean age 54) were enrolled in Group B, and were rehabilitated using Zimmer Tapered Screw-Vent Dental Implants. Each patient was treated with one implant. 37 implants were placed in the mandible and 24 in the maxilla. The sizes of the implants were the following: 4.7 x 11.5 mm (2 implants); 4.1 x 13 mm (3 implants); 4.1 x 11.5 mm (5 implants); 4.1 x 10 mm (15 implants); 3.7 x 11.5 mm (20 implants); 3.7 x 10 mm (21 implants).

One hour before surgery, patients were administered oral prophylactic antibiotics, either amoxicillin (2 g) or clindamycin (600 mg). All implants were inserted under local anesthesia and after flap incision and elevation (fig. 1). Implant insertion torque, measured in newton-centimeters (N/cm), and resonance frequency analysis (RFA) values, measured in implant stability quotient (ISQ) value were recorded at implant placement.

Within 48 hours of implant placement, an abutment was interlocked to the implant, and a temporary prosthesis was cemented to the abutment using a provisional luting cement. Occlusion of the restoration was adjusted so that crown did not come into contact with the opposing tooth in both intercuspal and lateral excursive movements. The provisional crown was left in place for about 7 to 14 days to allow soft tissues healing. Subsequently, if the implant appeared clinically stable, definitive ceramo-metal prosthesis was cemented onto the final abutment and the restoration was placed in occlusion (fig. 2). Follow-up examinations were performed at 1, 3, 6, 12 and 18 months, for clinical monitoring and annual hygiene prophylaxis.

Periapical radiographs were performed for each implant at provisionalization (baseline) (fig. 3) and after 6, 12 and 18 months of functioning, using a Rinn’s XCP (Extension Cone Paralleling) film holding system (fig. 4). Bone levels were measured by calculating the distance from the implant shoulder to the first bone-to-implant contact. Both mesial and distal measurements were made on each periapical radiograph.

RESULTS AND DISCUSSION

The total number of implants inserted was 87; one Tapered Screw-Vent implant (Group B) was lost before osseointegration and was not included in the statistical analysis, whereas no implant was lost in the Group A (TM). Marginal bone loss was measured on the periapical radiographs after 12 and 18 months. Data were analyzed by descriptive statistics and Student's t-test.

The mean value of marginal bone loss after one year was 0.44+0.40 mm for TM implants (Group A) and 0.95+0.62 mm for Tapered Screw-Vent implants (Group B) (p<.003). Mean marginal bone loss after 18 months was 0.46+0.42 mm for Group A and 0.97+0.65 mm for Group B (p<.003) (Table II).

Hence, data proved to be statistically significant. Therefore, it may be deduced that when implants are immediately loaded, the average loss of marginal bone around the TM implants is lower than that of the Tapered Screw-Vent implants.

These findings are in accordance with previous studies on Zimmer TM and Tapered Screw-Vent implants (35).

Osseointegrated dental implants have traditionally been placed in accordance with a 2-stage protocol: implants were submerged and left to heal for a period of 3-4 months in the mandible and 6-8 months in the maxillae. Attempts to early load the implants were associated with increased failure rates (36). This practice is based on the assumption that the implant micro-movements, caused by the functional forces exerted during wound healing, can induce the formation of fibrous tissue around the implant, rather than bone, leading to clinical failure (37). Early or immediate implant loading is now a common procedure, particularly in mandibles with good bone quality (38). A Cochrane systematic review of randomized controlled clinical trials, assessing timing for dental implant loading, suggested that immediately loaded implants, in selected cases, can be just as effective as those loaded after a conventional healing time (39).

Several parameters, such as implant surface and design, implant diameter and length, bone quality and surgical procedures, influence the primary stability of dental implants (40, 41, 42, 43). The decision to immediately load the implant or not is largely based on its primary stability. Resonance frequency analysis technique is a viable means for accurately evaluating implant stability (44). Furthermore, the possibility of repeating the measurements over time makes it possible to intercept any changes in implant stability during loading. Implants with loss of stability due to an overload can thus be detected before failure occurs.

The possibility of loading the implants immediately after their insertion is a major advantage for patients, because the treatment period may be significantly reduced, and the aesthetic result may be achieved forthwith.

An implant is considered successful when the marginal bone loss is less than 1.5 mm in the first year after loading and less than 0.2 mm / year in the following years (45). The maintenance of bone tissue around implants is the most important factor in determining long-term implant success, and progressive bone loss dramatically reduces the chances of survival of dental implants (46). Among the causes that may lead to marginal bone loss surgical trauma, incongruous occlusal forces, bacterial colonization of the implant-abutment gap and an unsuitable implant design should be mentioned (47). All these factors should be considered when planning implant rehabilitation.

Zimmer TM implants have rather parallel walls in their central area, because a conical shape would not allow incorporation of the tantalum body to the implant. This could be considered a serious disadvantage, as when a tapered implant is inserted into a straight, under-prepared osteotomy, the bone is compressed, with a consequent improvement in primary stability; this obviously cannot happen with a cylindrical implant. This could be a limitation especially in the rehabilitation of the upper jaw, where there is a lower bone density (48). Nevertheless, in our study, the tantalum body was found to give the implant an optimal primary and secondary stability.

CONCLUSIONS

Immediate loading is a safe and efficacious procedure when measured in terms of implant survival. It reduces treatment time and patient discomfort, while ensuring a high predictability and good aesthetic results. Within the limitations of this study, it is possible to assert that immediate loading of Zimmer TM implants gives satisfying results in terms of success and marginal bone loss.

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