Early loading of GMI implants with internal connection and sandblasted acid-etched surface

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ABSTRACT

Introduction: Today, oral implantology constitutes a therapeutic modality in the prosthodontic treatment of patients with partial and total tooth loss. This study reports the evaluation of patients treated by early loading of titanium implants with internal connection and sandblasted acid-etched surface.

Methods: 39 patients with tooth loss were treated with Frontier GMI® sandblasted and acid-etched surface implants. Implants were loaded after a healing load-free period of 6 weeks (mandible) and 8 weeks (maxilla). Clinical findings (implants and prosthodontics) were followed during 1 year.

Results: 111 implants were inserted (50 maxillary, and 61 mandibular) for prosthodontic rehabilitation. 44 implants were inserted in anterior sites and 67 in posterior sites. After 1-year follow-up, clinical results indicate a survival and success rate of implants of 99.1%. One implant was lost during the healing period due to mobility. One case of periimplantitis was reported as late complication after functional loading. Prosthodontic restorations included 30 single crowns, 15 fixed bridges, 5 ball overdentures and 2 fixed total rehabilitations.

Conclusions: Clinical results of this study indicate that prosthodontic rehabilitation supported by internal connection sandblasted and acid-etched titanium implants and early loading can be a successful dental treatment.

KEY WORDS: Dental implants, sandblasted and acid-etched surface, internal connection, early loading, osseointegration, implant dentistry.

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INTRODUCTION

Oral implantology has had a major impact on the dental profession as it is a predictable and successful therapeutic technique in the treatment of patients with partial or total edentulism. In this regard, progress in comprehensive patient diagnosis, treatment planning, basic and advanced surgical techniques and in the various prosthetic options (crowns, bridges, fixed and overdenture restorations) have developed oral implantology until it has become a regular dental treatment (1-6).

Early indications of osseointegrated dental implants and accumulated clinical experience were the result of treatment in totally edentulous patients by inserting some implants and rehabilitation with a full hybrid screw prosthesis (7). Subsequently, implant treatment has been applied to patients with partial and single tooth loss, proving to be a successful alternative to removable and fixed partial dentures in both the maxilla and the mandible (4-6).

Osseointegration as a biological phenomenon was originally described in the classic Brånemark protocol, according to a surgical technique in two phases and a healing period of 3-6 months without functional loading of threaded smooth surface titanium implants (7). In this regard, it was advocated that premature loading could interfere with the bone bonding to the titanium surface of the implant, leading to fibrous encapsulation (8). However, further experimental and clinical research has shown that, using various surgical and prosthetic protocols, early loading *per se* does not prevent osseointegration as long as micromotion is reduced during healing with improved primary stability of the implant (8).

Advances in the macroscopic implant design have led to the introduction of new systems with a more self-tapping macroscopic structure providing increased primary stability (9). Moreover, certain macroscopic changes in the implants, especially in the cervical area, besides increasing primary stability, can help maintain better health of peri-implant bone tissue and retain a more favourable marginal bone level (10).

Furthermore, the development of treated surfaces on the implants shows that a rougher surface (eg. sandblasting and acid etching) promotes osseointegration and reduces healing time, allowing early loading of implants through the corresponding prosthetic restoration (11 -15).

The aim of this study was the clinical evaluation and follow-up of the treatment with early loaded GMI sandblasted and acid-etched surface implants.

PATIENTS AND METHODS

This study was conducted by professors teaching Integrated Adult Dentistry and a Master in Oral Implantology at the University of Seville Faculty of Dentistry.

Prior to the study, patients with severe systemic disorders that could compromise osseo-integration were excluded. The selected patients were adults of both sexes. All patients had partial or total tooth loss. All patients selected for the study were informed of the implant treatment protocol, the surgical and prosthetic aspects, the timing and monitoring of treatment, as well as the possibility of complications and implant loss. The patients gave their authorization for the implant treatment via informed consent. Before the treatment, all the patients were evaluated radiographically, with a panoramic radiography (ortopantomography) and with cone beam computed tomography when required.

Success criteria and implant survival were those recommended by van Steenberghe et al. (16). In this sense, survival was defined as the permanent presence of the implants in their original location even without clinical value or causing adverse effects. The criteria for implant success are detailed in Table 1.

Surgery

An hour before surgery, patients began a preventive antibiotic regimen (amoxicillin + clavulanate) for one week. All patients received local anesthesia. All implants used in this study

TABLE 1.- DISTRIBUTION OF IMPLANTS BY LOCATION

	Implants		
	Front	**Back**	**Total**
Maxilla	21	29	50
Mandible	23	38	61
Total	44	67	111

were Frontier® (Global Medical Implants, Barcelona, Spain) with internal threaded connection and sandblasted and etched surface. All implants were stable after insertion. Site

preparation and insertion of the implants was performed according to the standard protocol with consecutive conventional cutters from smallest to largest diameter, at a constant speed of 800 rpm. One week later, sutures were removed and patients were advised to rinse daily with chlorhexidine for the first 30 days (Figures 1-4).

Prosthodontics

At 6 weeks (in mandible) and 8 weeks (in maxilla) after insertion of the implants, functional early loading of the implants was performed by placing the appropriate implant prosthesis (Figures 5 and 6). The clinical follow-up time after the functional implant loading time was 12 months.

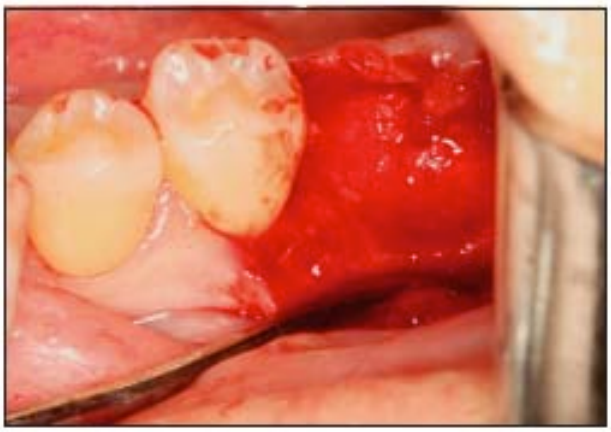

Fig. 1: *Flap surgery for implant insertion replacing the lower left first molar.*

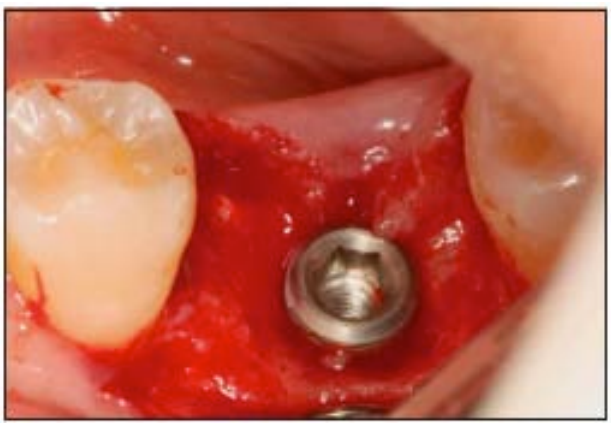

Fig. 2: *Clinical appearance of internal connection implant inserted.*

Statistical Analysis

Descriptive statistics of the clinical findings of the study were carried out with reference to the patients' demographic variables, survival, success, complications and loss of implants as well as any prosthetic restorations made.

RESULTS

Patients

39 patients with tooth loss (21 men and 18 women) participated in the study with a mean age of 45.3 years (range: 25-73 years); 6 patients (15.4%) were edentulous; 7 patients (18%) had some kind of controlled systemic disease (hypertension, diabetes); 8 patients (20.5%) were smokers.

Implants

A total of 111 Frontier GMI® implants were inserted into the corresponding 39 patients; 50 implants (45%) were inserted in the upper jaw and 61 implants (55%) in the lower jaw; 44 implants (39.6%) were inserted in the anterior region (incisor and canine replacement) and 67 implants (60.4%) in the posterior region (premolar and molar replacement) (Table 1).

Fifty nine implants (53.2%) were submerged (double surgery), while 52 implants (46.8%) were non-submerged (single surgery); 102 implants (92.8%) were inserted by basic implant surgery, while 8 implants (7.2%) were inserted using complex techniques (osteotomes, grafts, GBR).

Of the implants used, 6 were Ø 3.3 mm; 45 were Ø 3.75 mm; 42 were Ø 4.25 mm and 18 were Ø4.75 mm. Regarding length, 83 implants of 11.5 mm were inserted, 26 of 10 mm and 2 of 8 mm (Table 2). All implants were inserted in a deferred load, a minimum of 6 months after tooth extraction.

An immediate complication was: an implant (0.9%) was moving upon clinical examination during the functional load-free healing phase and was removed. Late complications included a case of periimplantitis that was treated with bone regeneration. There was no implant loss after functional loading thanks to an appropriate prosthetic restoration during clinical follow-up.

Fig. 3: *Clinical appearance of the suture around the implant.*

TABLE 2.-DISTRIBUTION ACCORDING TO IMPLANT DIAMETER AND LENGTH

Diameter	Length			Total
	8 mm	10 mm	11.5 mm	
3.30 mm	-	2 impl.	4 impl.	6 impl.
3.75 mm	-	8 impl.	37 impl.	45 impl.
4.25 mm	-	7 impl.	35 impl	42 impl.
4.75 mm	2 impl.	9 impl.	7 impl.	18 impl.
Total	2 impl.	26 impl	83 impl.	111 impl.

Implant Prosthetics

52 prostheses were applied to 39 patients.30 single crowns (57.7%), 15 fixed partial dentures (28.9%), 5 ball-retained overdentures (9.6%) and 2 totally fixed restorations (3.8%). Of the 47 fixed prostheses, 28 (59.6%) were cemented and the rest, 19 (40.4%), were screwed.

DISCUSSION

The main objective of this study was to obtain a good osseointegration of implants with sandblasted and etched surface and to achieve good functional and aesthetic results through loading with the corresponding prostheses. In this sense, clinical findings in this study indicate a success rate of 99.1%, confirming the efficacy of early loading of dental implants used with a suitable macroscopic design and sandblasted and etched surface, inserted in one or two surgeries, in patients with partial and total tooth loss. In this paper, one-year results are presented, but the goal is long-term clinical monitoring of patients.

In the present study, 53.2% of the implants were submerged (2 phases) while 46.8% of the implants were non-submerged (one phase) form, showing that both techniques had a high success rate (98.3% vs 100%). Although double surgery was recommended in the classic protocol of the

Fig. 4: *Clinical appearance at 6 weeks. Note the good condition of the soft tissues around the healing cap.*

Fig. 5: *Clinical appearance at 6 weeks. Note the good condition of the soft tissue around the implant.*

Fig. 6: *Clinical appearance of the crown cemented on the internal connection implant.*

Swedish Brånemark group (7) for osseo-integration of implants, the experience gained mainly by the Swiss school, shows that the non-submerged technique (single surgery) provides also a good tissue response of bone and soft tissues (17,18). The clinical evaluation and long-term monitoring of both techniques (submerged, 2 stages and non-submerged, 1 stage) indicate that the functional and aesthetic results with different implant systems are very acceptable (19,20). In fact, we have compared the clinical outcomes of Brånemark implants inserted with both procedures (1 or 2 surgical stages) without differences in the survival and success rates, which indicates that both techniques are equally predictable (21).

The present study shows the clinical findings of the use of implants in both jaws; Thus, of the 111 implants placed, 55% were inserted in the mandible and 45% in the maxilla. This distinction is based primarily on the fact that past experience indicates that the survival and success rates of implants is lower in the maxilla than in the mandible. However, in this study implant loss was minimal and bore no relation to the maxillary or mandibular location. Furthermore, in this study, most patients had single or partial losses, and the presence of adjacent natural teeth with implants can help prevent or delay alveolar resorption and contribute to occlusal protection compared to implants inserted for rehabilitation of totally edentulous segments (22-24).

This study describes the clinical results regarding the use of implants in the anterior (incisors and canines) and posterior (premolars and molars) region. Thus, of the 111 implants placed, 60.4% were inserted in the posterior region and 39.6% in the anterior region. The posterior region is ideal for assessing the success rate of implants because it is subject to greater masticatory forces where parafunctional occlusal loads are more concentrated (15,22,23). So, wider diameter implants can be an alternative as they get more titanium-bone interface and are more resistant than standard implants and they also favour a good aesthetic emergence profile (25). In the anterior region, the aesthetic factor is very important because implants can replace front teeth that have been lost through trauma, endodontic failure or advanced periodontal disease. In these cases, implants represent the best current therapeutic solution because implant crowns offer good function and aesthetics, and the patient's response to treatment is very positive (26).

In this study, implants lengths went from 8 to 11.5 mm and their diameters were 3.30 mm - 4.75 mm, although most of the implants had standard macroscopic characteristics (Table 2). Thus, the macroscopic structure of the implant is also related to successful treatment (9,10). In fact, the length of the implant may affect treatment success rate, i.e., a longer dental implant offers a larger contact area, thereby enhancing the bone-implant contact ratio; for example, a 10 mm implant offers 30% more contact area compared to a 7 mm implant (27). Osseointegration also affects the diameter of the dental implant. As with the length, a larger diameter implant ensures a more contact surface with the bone, thereby providing a better biomechanical response. Studies indicate that the increase in diameter has a more positive influence on implant integration than increasing its length, but cannot compensate for the lack of length of short implants (27).

In addition to bone quality and surgical technique, the macroscopic design of the implant is also very important to achieve good primary stability after surgery (9). The self-tapping tapered design capacity and can provide a good anchorage in the alveolar bone offering a good bone-implant contact after milling (9). The incorporation of smaller coils in the cervical area, such as those on the implants inserted in this study has shown an increased resistance to axial forces, which helps to preserve the peri-implant marginal bone (10).

This study evaluated the clinical results of the use of implants with a sandblasted and etched surface. Experience with rough surface implants in the treatment of tooth loss confirms a high success rate for implant treatment with highly predictable results in the medium and long term with this type of surface (28,29). Clearly, a therapeutic dental implant is directly dependant on the contact surface between bone and implant (7). Thus, the addition of a surface treated to increase its roughness can provide bonding between the implant surface and the bone improving clinical outcomes (28,29). In this regard, several studies confirm that osseointegration can be facilitated by the use of implants with a rough surface created by the action of sandblasting and acid etching, which shows that there is a good response from host tissues, leading to a high rate of success (30,31). Moreover, implants with sandblasted and etched surfaces achieve better clinical results than implants with a polished surface in conditions of poor bone quality or in bone regeneration techniques with biomaterials, since the treated surface of the implant can optimize the biological response of the bone (32).

In the present study, during the healing period, one implant showed mobility and was removed. These early failures may be caused by factors related to the surgical procedure, such as overheating of the bed or the lack of primary stability that prevents proper bonding between the implant surface and the bone (33). Subsequently, there was a case of periimplantitis as a late complication that was successfully treated with guided bone regeneration (34). After the prosthetic phase was performed, the results showed a 100% success rate of implants in the 12 months after the early functional load.

Early loading is one of the most important aspects assessed in this study. Although at the beginning of oral implantology a functional load-free healing time of 3-6 months was advocated, currently early loading represents an advance in the development of implantology protocols since it reduces the waiting time, benefiting patients with different kinds of tooth loss (12-15). Early loading protocols have been developed as they improve the surgical aspects of the implant. Thus, macroscopic design and surface roughness have been used to establish good bone to implant contact and rapid osseointegration (12-15).

From a prosthetic point of view, early loading has been used in different studies involving all types of implant restorations, such as single crowns, fixed bridges, total restorations and overdentures (6,13,15,17). Early loading has improved with the new internal connections that achieve an excellent fixation and transmission of forces to the implant abutments, reducing functional waiting time (35,36). These clinical findings are confirmed in this study, where the implants used had an internal connection for attachment to the corresponding prosthetic abutments. The internal connection was a major breakthrough in the functional and aesthetic clinical outcomes of prosthetic implants, since they improve the biomechanical response to stress, reduce bacterial contamination of the implant-abutment junction and provide a good seal for excellent aesthetics (35,36).

CONCLUSIONS

Oral rehabilitation with implant-supported prostheses has become an everyday dental treatment. A prerequisite for the success of this therapy is to achieve and maintain osseointegration of implants. In this regard, the use of surgical techniques with an appropriate macroscopic implant design to achieve good surgical stability and a sandblasted and etched surface to achieve an acceptable level of osseointegration, followed by restoration with the necessary prosthesis through early loading protocols, represents a successful treatment that satisfies patients positively improving their oral quality of life.

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