Immediate Loading of Implants with 3-unit Fixed Partial Dentures: A 12-month Clinical Study

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Purpose: *The aim of the present clinical trial was to evaluate the 12-month success rate of titanium dental implants placed in the posterior mandible and immediately loaded with 3-unit fixed partial dentures.* ***Materials and Methods:*** *Patients with missing mandibular premolars and molars were enrolled in this study. To be included in the study, the implants had to show good primary stability. Implant stability was measured with resonance frequency analysis using the Osstell device (Integration Diagnostics). Implants were included in the study when the stability quotient (ISQ) exceeded 62. Clinical measurements, such as width of keratinized tissue, ISQ, and radiographic assessment of peri-implant bone crest levels, were performed at baseline and at the 12-month follow-up. The comparison between the baseline and the 12-month visits was performed with the Student t test for paired data (statistically significant at a level of* $\alpha = 0.05$*).* ***Results:*** *Forty implants with a sandblasted, large grit, acid-etched (SLA) surface (Straumann) were placed in 20 patients. At 12 months, only 1 implant had been lost because of an acute infection. The remaining 39 implants were successful, resulting in a 1-year success rate of 97.5%. Neither peri-implant bone levels, measured radiographically, nor implant stability changed significantly from baseline to the 12-month follow-up (*$P > .05$*).* ***Discussion:*** *The immediate functional loading of implants placed in this case series study resulted in a satisfactory success rate.* ***Conclusion:*** *The findings from this clinical study showed that the placement of SLA transmucosal implants in the mandibular area and their immediate loading with 3-unit fixed partial dentures may be a safe and successful procedure.* (Case Series) Int J Oral Maxillofac Implants 2006;21:914–918

Key words: *immediate loading, partial edentulism, radiologic examinations, success rates*

Titanium dental implants have been successfully used to restore completely and partially edentulous patients over the past 30 years.[1,2] The original surgical protocol required the implants to remain submerged for a healing period of 3 to 6 months. The healing period, which was associated with avoidance of functional loading, was considered necessary to achieve osseointegration.[3,4] Over the years, several studies have reported high success rates with nonsubmerged titanium implants.[5,6] In the last decade, advances in implant surface technology and continuous clinical research have provided clinicians with clinical procedures to address more demanding clinical situations. Some of the original prerequisites for osseointegration have been reassessed to satisfy patient demand for reduced treatment time, improved esthetic outcomes, and increased comfort during healing. New treatment concepts such as immediate implant loading (ie, occlusal loading within 24 hours of implant placement) and early implant loading (occlusal loading 6 to 8 weeks after implant placement) have been proposed to shorten the overall treatment time and to allow the patient to receive a fixed implant-supported prosthesis in the shortest time possible after implant placement.[7,8]

The aim of the present clinical study was to evaluate the 12-month implant success rate of immediately loaded titanium dental implants in the posterior mandible used to support 3-unit fixed partial dentures.

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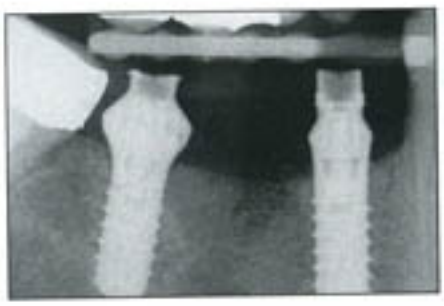

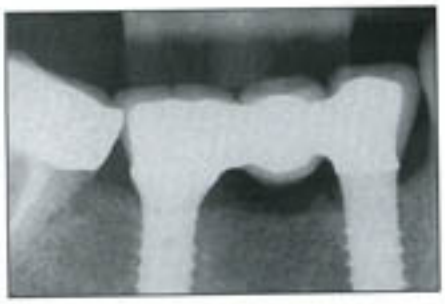

Fig 1 *(left)* Periapical radiograph obtained at the time of immediate prosthetic restoration (baseline) in a standardized manner.

Fig 2 *(right)* Radiograph taken 12 months following implant placement.

MATERIALS AND METHODS

All the patients were recruited to the study based on their need for the restoration of multiple missing mandibular posterior teeth (premolars or molars). Natural teeth adjacent to the area to be restored were required to have a complete occlusal surface and be free from periodontal or endodontic infection. Additional criteria to enter the study were sufficient bone quantity (bone height and width) to allow the placement of implants with a diameter of 4.1 mm and a length of at least 12 mm or a diameter of 4.8 mm and a length of at least 10 mm, an implant stability quotient (ISQ) exceeding 62, an occlusal pattern that allowed for bilateral stability, and a signed written consent form. Exclusion criteria included general health conditions that would jeopardize the bone healing process (eg, diabetes, osteoporosis, blood disorders), severe maxillomandibular space discrepancies, parafunctional habits (bruxism or clenching), drug or alcohol abuse, poor oral hygiene, and local peri-implant bone defects requiring simultaneous bone augmentation procedures during surgery.

All patients were referred to a restorative dentist for a complete presurgical evaluation, including waxup and the fabrication of a surgical template. Each clinical case was evaluated by examining diagnostic casts for the maxillomandibular relationship, periapical and panoramic radiographs, and computerized tomographic scans if needed.

Surgical Protocol

The implants were placed with an atraumatic surgical technique.[9] All surgical procedures were performed with the aid of a custom-made template. Every effort was made to maintain parallelism between the implants and the remaining dentition. Standard Straumann (4.1 mm wide) or wide-body implants (4.8 mm wide) (Straumann, Waldenburg, Switzerland) with a sandblasted, large grit, acid-etched (SLA) surface were placed according to the manufacturer's recommendations. All implants were clinically stable, and the implant stability was confirmed with the resonance frequency analysis (RFA) measurements (Integration Diagnostics, Göteborg, Sweden). The Osstell device was used according to the manufacturer's recommendations.[10,11]

Prosthetic Protocol

Immediately following implant placement, while the patient still under anesthesia, the initial restorative treatment was begun. Two screw-retained transfer copings were connected to the implants. Wound closure was achieved by suture. Subsequently, an impression was taken in a customized impression tray. Healing caps were then placed on the implants. Within 24 hours of implant placement, a temporary screw-retained acrylic resin 3-unit fixed partial denture was connected to the implants. Following incorporation of the provisional restoration, an individualized acrylic resin template was fabricated for each patient to guarantee radiographic reproducibility for the follow-up period. The temporary acrylic resin crown restorations were designed to be placed in occlusal contact. All patients were prescribed 1 g amoxicillin (amoxicillin, Merck Generics, Milan, Italy) twice daily for 5 days and 200 mg ibuprofen (Buscopan, Milan, Italy) as needed. Patients were instructed to rinse twice daily with a chlorhexidine mouthwash (Eburos; Dentsply, Rome, Italy) twice daily for the following 2 weeks. The sutures were removed 7 to 10 days after surgery.

The final implant impression was obtained after 6 months. The definitive abutments were connected to the implants, and lastly, the definitive metal-ceramic restoration was cemented.

Follow-up Evaluation

All patients were placed on a strict follow-up regimen until soft tissue healing was complete. The following clinical parameters were evaluated at the time of implant placement (baseline) and at the 12-month follow-up:

Table 1 Implant Positions and Dimensions (n = 40)

Implant size width × length	Implant position		
	Premolar (20)	Molar (20)	Total
4.1 × 12 mm	16	6	22
4.8 × 10 mm	3	8	11
4.8 × 12 mm	1	6	7

Table 2 Changes of Clinical and Radiographic Parameters Between Baseline and 12-month Follow-up

	Baseline		12 months		
	Mean	SD	Mean	SD	P
DIB					
Mesial	2.4	0.4	2.5	0.4	NS
Distal	2.6	0.6	3.1	0.6	NS
Width of keratinized mucosa					
Midbuccal	2.0	0.5	2.0	0.5	NS
Midlingual	2.4	0.5	2.2	0.6	NS
ISQ	72.0	5.7	74.5	7.3	NS

- Distance between the implant shoulder and the point of bone-to-implant contact (DIB) mesially and distally to the implant on periapical radiographs taken in a standardized manner[6,12] (Figs 1 and 2)
- Width of keratinized mucosa at the midbuccal and midlingual aspects
- Implant stability (ISQ)[10,11]

Data Analysis

Clinical measurements of the 40 implants were calculated for each patient by averaging the readings of each clinical parameter for the implants for each patient, since the intrasubject variation was much lower than the intersubject variation. Subsequently, the means and medians were calculated among the means per patient at baseline and 12 months. The comparison between baseline and 12-month data was performed with the Student *t* test for paired data and was considered statistically significant at the $\alpha = .05$ level.

RESULTS

A total of 20 patients (11 men and 9 women) with an age ranging from 27 to 59 years (mean, 47.2 years) were included in this study. Six patients were smokers and 14 were nonsmokers. A total of 40 dental implants were placed and immediately loaded to support 20 short-span, 3-unit fixed partial dentures. Implant positions and dimensions are reported in Table 1. All the implants were free of complications during the healing phase. During the follow-up period of 12 months, 1 implant was removed 2 months after placement because of an acute infection at the implant site. The failing implant was immediately replaced with a new implant, which was subsequently successful. Throughout the follow-up period of 12 months, none of the 39 remaining implants demonstrated signs of peri-implant infection, and all maintained stability. At the 12-month examination, 39 implants fulfilled the success criteria proposed by Buser and associates,[13] resulting in a short-term success rate of 97.5%.

Clinical and radiographic parameters such DIB, width of keratinized mucosa, and ISQ value (resonance frequency analysis) are presented in Table 2.

A comparison of values of DIB, keratinized mucosa width, and ISQ at baseline and at the 12-month follow-up is shown in Table 2. No statistically significant differences were found for the parameters measured. All the patients reported that the temporary restoration was esthetically acceptable. No technical complications such as screw loosening, resin fracture, or pain during chewing were registered during the observation period.

DISCUSSION

Immediate loading of dental implants offers several advantages to both the clinician and the patient, such as reduced number of appointments, reduced healing time, elimination of the need for removable temporary dentures during healing, and above all increased comfort for the patient with immediate fixed restorations. The compatibility of immediate and early loading with implant osseointegration and long-term success has been investigated in animal[14–16] and human studies[17–19] with positive but sometimes controversial results.

Deporter and coworkers[14] loaded conical cylinder implants immediately after placement; after 4 weeks, bone ingrowth without fibrous encapsulation had reached a certain level, but no further increase was observed between 4 and 8 weeks. In a histologic study in monkeys, Piattelli and colleagues[16] compared the amount of bone apposition around screw-type implants loaded after 30 days with nonloaded implants and reported similar amounts and patterns of bone apposition. Chiapasco and Gatti[18] recently

published a prospective study on 82 patients with edentulous mandibles rehabilitated with implant-supported overdentures delivered immediately after implant placement. Three hundred twenty-eight screw-type implants (4 implants per patient) were placed in the interforaminal area of the mental symphysis. Of 328 implants placed, 296 were followed to 62 months. Seven implants were removed; another 18 integrated but did not fulfill the success criteria. The cumulative survival and success rates of implants were 96.1% and 88.2%, respectively.

Glauser and associates[20] placed 104 Brånemark System MkIV TiUnite implants which were immediate occlusally loaded in 38 patients. Of these, 20 were single-tooth restorations, 30 were fixed partial dentures, and 1 was a complete fixed mandibular restoration. The authors reported a cumulative implant success rate of 97.1% after 1 year of prosthetic loading. The mean marginal bone resorption after 1 year of loading was 1.2 ± 0.9 mm. Cornelini and associates[21] placed 30 Straumann dental implants with a SLA surface in 30 patients with a missing mandibular molar and immediately restored them. The implants were included in the study only if the ISQ exceeded 62. At 12 months, only 1 implant had been lost because of acute infection. Radiographic as well as clinical examination confirmed the clinical success of all remaining implants, resulting in a 12-month success rate of 96.7%. Interestingly, implant stability measured with RFA did not increase significantly from baseline to the 12-month follow-up ($P > .05$) in either that study or the present one.

The results of the studies reviewed should be interpreted with caution, since they vary widely with respect to important determinants of implant success such as inclusion/exclusion criteria for patient selection, area of implant placement (maxilla versus mandible), and loading protocol.

The results of the present study indicated that immediate loading of dental implants with 3-unit fixed partial dentures in the posterior mandible can be a safe and predictable procedure. Only 1 implant was lost during the study period, whereas 39 of 40 implants were clinically successful and met the success criteria. This resulted in an implant success rate of 97.5% after 12 months of follow-up. The implant failure caused prosthesis failure; consequently, the prosthesis survival rate was 95%.

These results are in accordance with other studies on the use of immediately loaded implants to support overdentures in completely edentulous patients[22–24] and the use of immediately loaded implants to support single crowns for single tooth replacement.[25–28]

In the present study, all implants were placed in the posterior area of the mandible to replace premolars or molars. To evaluate the primary stability of implants, resonance frequency analysis was performed with the Osstell device. This non-invasive, objective, reliable method allows the clinician to measure the primary stability of implants at the time of placement and the continuing stability of the implants during the different stages of healing.[10,11] It has been demonstrated that RFA values are consistent with other measurements of primary stability, such as manual assessment[10] and "true cutting resistance."[29]

The present study confirmed that transmucosal dental implants with good primary stability measured according to the RFA principles can be successfully loaded to support 3-unit dental prostheses. Furthermore, the immediately loaded implants showed stability of the marginal bone level.

Further clinical trials with larger sample sizes and longer follow-up periods are needed to demonstrate the long-term success of this clinical approach.

CONCLUSIONS

The results of the present short-term study showed that immediate loading of dental implants placed in the posterior area of the mandible that achieved primary stability at a minimum of 62 ISQ can be a successful procedure, if strict inclusion criteria are respected. This approach has the potential to become a valuable alternative to the concept of early implant loading.

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