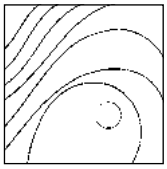
# Immediate Loading of Four or Six Implants in Completely Edentulous Patients



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*In this retrospective study, 44 patients received screw-retained full-arch acrylic resin provisional prostheses connected on 4 or 6 implants in the mandible or maxilla, respectively. With a mean follow-up of 17.6 months, 3 of 205 implants were lost and replaced successfully. Cosmetic fractures were shown in six patients; one abutment loosening, one abutment fracture, and one implant fracture were also observed. Prosthetic fracture was shown in one patient. Marginal bone loss reached two to five threads on 13 implants (6.4%). The results confirmed that immediate loading of 4 mandibular or 6 maxillary implants with an acrylic resin prosthesis for full-arch rehabilitation is a reliable technique in the short- and midterm.* (Int J Periodontics Restorative Dent 2012;32:e1–e9.)

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Immediate or early implant loading for a full-arch restoration is now considered a standard therapeutic option in implant dentistry. Clinical follow-up studies have provided documented and predictable results for the symphysis in particular, with implant survival rates ranging from 96% to 100% for up to 5 years.[1–3] Immediate loading has multiple advantages, including reduction of surgical steps and immediate functional and esthetic rehabilitation. Moreover, in the presence of natural teeth, extraction/implantation with immediate loading avoids use of a provisional removable denture without compromising the survival rate, which may reach 100% for a follow-up of 18 to 42 months.[4] Several protocols for immediate loading of a reduced number of implants at the symphysis have been described.[5–7] Brånemark et al[8] showed that mandibular and maxillary full-arch rehabilitations with four implants had similar implant and prosthetic survival rates at 10 years to rehabilitations with six implants. Chow et al[5] evaluated the immediate loading

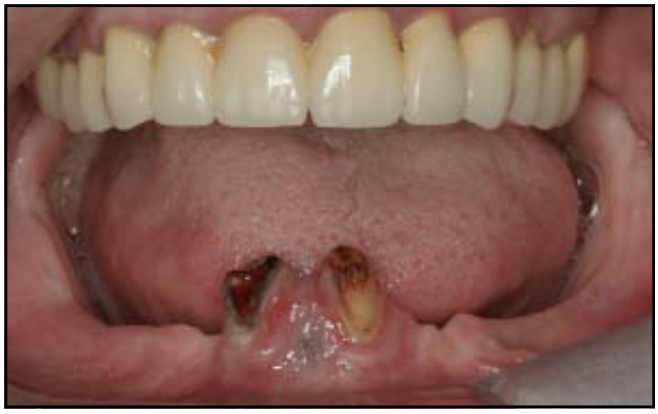

**Fig 1** *A 62-year-old man presented with advanced posterior ridge resorption and two remaining incisal roots in the mandible. The patient had a removable prosthesis.*

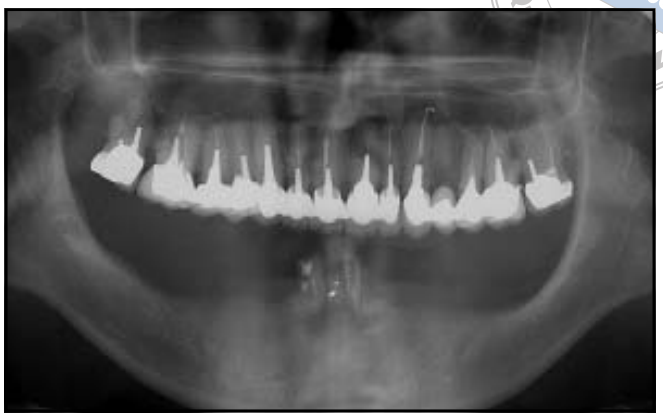

**Fig 2** *Initial panoramic radiograph showing sufficient bone height at the symphysis region.*

of four implants at the symphysis with a success rate of 98% for up to 30 months. Maló et al[6] proposed the "all-on-four" concept for immediate loading of four implants at the symphysis by tilting the most distal implants posteriorly. The survival rate of 176 implants varied between 96% and 98% at 1 year for implants placed in fresh or healed extraction sites, respectively. Tilted implants allow optimal stress distribution along the arch.[9,10] Furthermore, the survival rate of tilted implants is comparable to standard implants.[11–14] According to Eger et al,[15] there are no significant differences between angled abutments that restore the implant inclination and axial abutments after a 3-year follow-up.

The aim of this retrospective study was to evaluate immediate loading using the "all-on-four" and "all-on-six" concepts of four implants in the mandible and six implants in the maxilla using an acrylic prosthesis consisting of 12 teeth.

## Method and materials

### *Design and experimental plan*

This retrospective study evaluated the implant and prosthetic survival rates as well as the satisfaction in patients referred for full-arch maxillary or mandibular rehabilitation using the "all-on-four" or "all-on-six" concept.[6,7]

Men and women older than 18 years of age with favorable medical conditions for dental implantation were treated between September 2004 and May 2005. The maxilla or mandible had to be fully edentulous or in preparation for full extraction and without major bone pathology. Patients had to have a favorable occlusal context (restriction to Angle Class I and II). Patients were in overall good anatomical and psychologic conditions.

All patients were informed about the surgical technique and instructed on food intake and masticatory precautions, ie, avoiding hard foods to prevent mechanical stress during the 6 weeks following placement of the implants. Semi-liquid food was encouraged.

### *Implant placement and prostheses*

Implant surgery was performed by two investigators according to the protocol described by Maló et al[6,7] using Brånemark TiUnite implants (Nobel Biocare). The surgical and prosthetic steps are illustrated in the treatment of an edentulous mandible (Figs 1 and 2). The most posterior implants were tilted distally to improve implant distribution and to avoid the mental foramen (Fig 3). Multiunit abutments (MUAs; Nobel Biocare) were placed immediately the day of surgery. Straight abutments or 17-degree angled abutments could be chosen for anterior implants, and 17- or 30-degree angled abutments could be selected for posterior implants. The prosthetic portion was accomplished by the patients' dental practitioners.

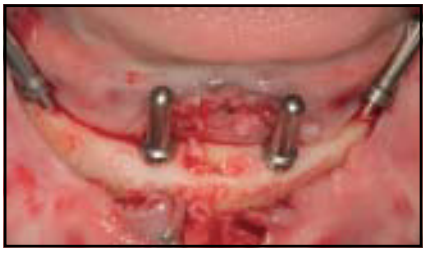

**Fig 3** (left) *The remaining incisor roots were extracted, the alveolar ridge was leveled, and the implant sites were prepared. Direction indicators show the tilting of the most distal implants.*

**Fig 4** (right) *Titanium provisional copings were connected to the MUAs through the patient's removable prosthesis.*

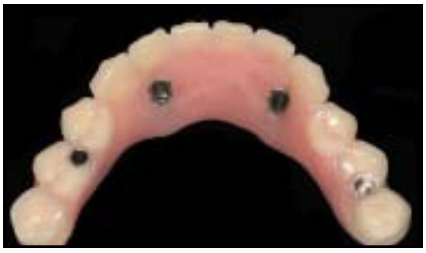

**Fig 5** (left) *The removable prosthesis was converted to an immediate acrylic resin FPD by the laboratory technician in a few hours. Note the optimized implant distribution. Prosthetic screws were then tightened to 15 Ncm.*

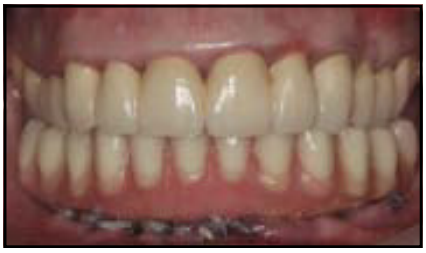

**Fig 6** (right) *Clinical view just before suture removal at 1 week after implant placement.*

**Fig 7** (left) *Composite teeth (Cerapearl, Klema Dental Produkte) applied over a Procera titanium framework (Nobel Biocare). Acrylic resin gingiva was used to compensate for bone resorption.*

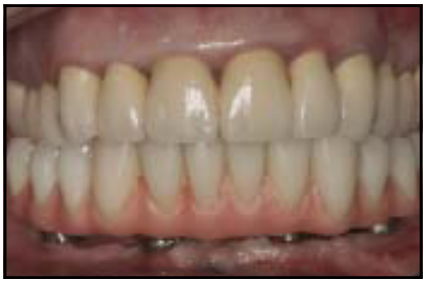

**Fig 8** (right) *Clinical view indicating sufficient space between the FPD and gingiva to allow for adequate oral hygiene maintenance. The patient's initial occlusal scheme was adopted for final occlusion.*

Impression copings for the open tray technique or provisional titanium copings were placed, and the flap was sutured (Fig 4). Impressions and maxillomandibular relations were obtained using the patient's complete denture or its replica. Denture stability was checked initially. When titanium provisional copings were used, they were fixed with acrylic resin through the patient's complete denture. This removable prosthesis served as a fixed prosthetic basis after conversion in the laboratory (Fig 5). A screw-retained full-arch acrylic prosthesis was connected on four or six implants a few hours after surgery or within the following 2 days.

The patient had to visit his or her dental practitioner 1 week, 2 weeks, 1 month, and 3 months after denture insertion for occlusal adjustment. A visit was scheduled at the surgical center 1 week after implant placement for suture removal (Fig 6), at 4 months postrestoration, at definitive prosthesis insertion, and every year thereafter. At 4 months, a panoramic radiograph was taken, and the provisional fixed partial denture (FPD) was removed to check implant osseointegration. All abutments were retightened to 15 or 35 Ncm for angled or straight abutments, respectively. The definitive FPD was produced, which consisted of a veneer FPD (ceramic buildup on a gold alloy base) or composite teeth applied on a titanium base (Fig 7) manufactured using computer-aided design/computer-assisted manufacturing technology. The definitive prosthesis was tightened to 15 Ncm (Fig 8). Crestal bone level was monitored using panoramic radiographs at implant insertion, 4 months postrestoration, definitive prosthesis placement, and every year thereafter (Fig 9).

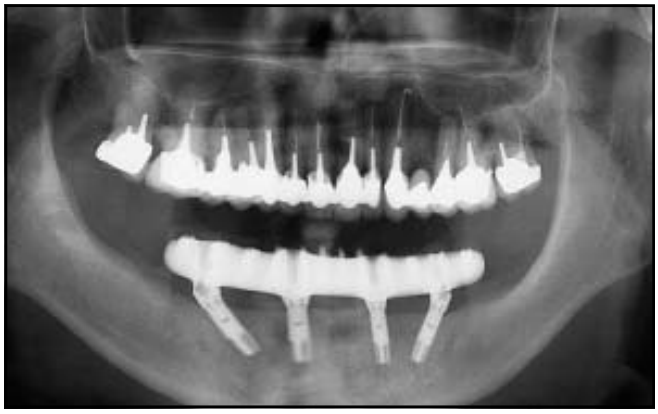

**Fig 9** *Panoramic radiograph at 12 months after implant placement showing the definitive FPD. Note the crestal bone stability.*

*Assessments*

Implant survival, prosthesis stability, marginal bone loss at the implant-abutment junction in mesial and distal sites, and treatment complications were determined at the last follow-up visit. Patients' satisfaction with esthetics, chewing, and comfort were recorded on a visual analog scale (0 to 10) before intervention and at the last follow-up visit.

*Data management and statistics*

Data including questionnaires were directly recorded in Excel (Microsoft) files by the principal investigator. Implant survival was assessed after removing the prosthesis. Success was defined as fulfilling all of the following criteria: clinically immobile implant, no pain or sign of infection of the bone and peri-implant soft tissues, no peri-implant radiolucency, and no paresthesia or neuropathy. Pain or infection disappearing for any reason was classified as a complication, not as implant failure. Prosthetic survival rates were calculated for all prostheses placed, even in cases of implant failure.

## Results

*Patient and implant characteristics*

Forty-four patients (32 women, 12 men) between 51 and 94 years of age (mean, 70 years) were treated for full-arch rehabilitation. Ten patients (23%) were current smokers. A total of 202 implants were placed in the mandible (n = 124) and maxilla (n = 78). The "all-on-6" maxillary restoration was performed in 13 (30%) patients, and the "all-on-4" mandibular restoration in 31 patients (70%). Of the 202 implants, 24 (12%) were placed in fresh extraction sites in 7 patients (16 mandibular implants, 8 maxillary implants). In addition, 3 implants were replaced during the follow-up because of implant loss (1 maxillary implant, 2 mandibular implants). Thus, a total of 205 implants were placed during this study.

Table 1 shows the lengths and diameters of the implants placed. The most frequently chosen lengths were 13 or 15 mm (92% of implants), and the most frequently chosen diameter was 4 mm (185 implants, 90%), ensuring optimal primary stability.

Follow-up ranged between 3 and 56 months, with a mean follow-up of 17.6 months. Twenty-six patients (121 implants, 60%) were followed for at least 13 months, and 11 patients (47 implants, 23%) for at least 25 months (Table 2).

*Implant and prosthetic survival rates*

Three of 205 implants placed were lost during the study. One implant loss was noted at the 6-month control appointment. This occurred in

**Table 1** Distribution of implants according to length and diameter

| | Diameter (mm) | | | | |
|---|---|---|---|---|---|
| Length (mm) | 3.35 | 3.75 | 4 | 5 | Total (%) |
| 10 | 0 | 0 | 3 | 0 | 3 (1) |
| 11.5 | 0 | 0 | 11 | 2 | 13 (6) |
| 13 | 2 | 11 | 72 | 1 | 86 (42) |
| 15 | 0 | 4 | 99 | 0 | 103 (50) |
| Total (%) | 2 (1) | 15 (7) | 185 (90) | 3 (1) | 205 (100) |

**Table 2** Patient and implant follow-up

| | Follow-up (mo) | | | | | |
|---|---|---|---|---|---|---|
| | 3–6 | 7–12 | 13–18 | 19–24 | 25–36 | 37–56 |
| No. of patients | 11 | 7 | 9 | 6 | 8 | 3 |
| No. of implants | 48 | 32 | 44 | 30 | 31† | 15‡ |
| Implants replaced* | 1† | 0 | 0 | 0 | 1‡ | 0 |
| Implants evaluated (%) | 49 (24) | 32 (16) | 44 (22) | 30 (15) | 32 (16) | 15 (7) |

*In all, 3 implants were lost in 2 patients. Two implants were lost consecutively in the same site.
†Patient had 4 implants and showed an implant fracture at 21 months of follow-up. The implant was replaced immediately. At the 3-month control, the replaced implant failed to osseointegrate and was successfully replaced 3 months later. This implant had a 3-month follow-up, while the 3 others had 30-month follow-ups.
‡Patient lost 1 of 6 implants. The replaced implant follow-up was 34 months, while the other 5 implants had a 44-month follow-up.

a 61-year-old female smoker undergoing hormonal replacement therapy. She was included for maxillary arch rehabilitation using the "all-on-6" procedure. A peri-implant graft at the location of the lost implant was then performed. The length and diameter of the implant selected were 15 and 4 mm, respectively. Replacement of this implant was successful. Another patient complained of prosthesis mobility at 21 months after implant placement. The acrylic resin at the mandibular left second premolar site was obviously fractured, and the panoramic radiograph revealed implant fracture at that location. The implant was retrieved and immediately replaced with a 4 × 13-mm implant and a 30-degree angulated abutment without immediate loading. At the 3-month control visit, the replaced implant had failed to osseointegrate and was retrieved. After 3 months of site healing, a 4 × 13-mm implant was placed, and a 30-degree angled MUA was torqued to 15 Ncm. Three months later, osseointegration was judged successful. There was one other acrylic resin failure in this patient during the follow-up; immediate acrylic resin should be replaced by a veneer FPD during the first year after the first 4 months of healing. The implant survival rate was 98.5% (202 of 205 implants), and the prosthetic survival rate was 97.7% (43 of 44 patients).

**Table 3 No. of complications**

| | | |
|---|---|---|
| Abutment loosening (per successful implant) | 1/202 | 0.5% |
| Cosmetic fracture (per prosthesis) | 6/44 | 13.6% |
| Prosthetic fracture (per prosthesis) | 1/44 | 2.3% |
| Abutment fracture (per implant) | 1/205 | 0.5% |
| Osseointegration failure (per implant) | 2/205 | 1.0% |
| Implant fracture (per implant) | 1/205 | 0.5% |

*Prosthetic complications*

Minor prosthetic complications were observed at the follow-up visits (Table 3). Six patients (13.6%) had cosmetic fractures. One abutment loosening was observed in one implant and one abutment fracture in another implant.

*Bone loss*

Marginal bone loss was observed using panoramic radiographs (Table 4). Ninety-five of 202 implants (47.0%) exhibited no marginal bone loss, 94 implants (46.5%) presented bone recession reaching the first thread, and 13 implants (6.5%) showed bone loss of 2 to 5 threads. Most of the bone loss was observed during the first year of follow-up.

Implantation in fresh extraction sockets seems not to influence bone loss (bone loss in 16 of 24 implants; 12 implants reached the first thread, 1 implant reached 2 threads, 2 implants reached 3 threads, and 1 implant reached 5 threads).

*Patient satisfaction*

Patient satisfaction was determined in 40 of 44 patients. Overall, patients were satisfied to very satisfied with the procedure. They described significant improvements in esthetics, chewing ability, and overall comfort (Table 5). Pain, swelling, and hematoma were unpleasant for 20.0%, 32.5%, and 52.5% of patients, respectively. All patients except one declared they would recommend or strongly recommend this treatment to other people.

## Discussion

This retrospective study confirmed that immediate loading of fixed provisional acrylic resin prostheses, using four mandibular or six maxillary implants, is a reliable technique for full-arch rehabilitation. The surgical and prosthetic procedures used were based on the protocol previously published by Maló et al for immediate rehabilitation of completely edentulous arches.[6,7] With a mean follow-up of 17.6 months, the implant success rate was 98.5%, and the prosthetic success rate was 97.7%. Few prosthetic complications were observed. Overall, the esthetic and functional outcomes were good to very good, as assessed by the patients. There was no significant bone loss except in one patient.

These success rates are in line with the data published by Maló et al[6,7] with 4 maxillary implants supporting fixed, full-arch acrylic resin prostheses in the mandible (cumulative survival rate, 97% up to 3 years) and maxilla (1-year cumulative survival rate, 98%). Chow et al[5] reported 2 of 123 implants failed in the mandible using immediate loading of a fixed provisional prosthesis with a minimal number of implants during a follow-up of 3 to 30 months, ie, a cumulative survival rate of 98%. The prosthetic survival rate in the studies by Maló et al[6,7] was 100%, indicating that despite implant failure, all provisional acrylic resin prostheses may survive on the remaining implants.

**Table 4** Bone loss: Number of implants and observations according to follow-up

| No. of exposed threads | Duration of follow-up (mo) | | | | | | Total (%) |
|---|---|---|---|---|---|---|---|
| | 3–6 | 7–12 | 13–18 | 19–24 | 25–36 | 37–56 | |
| 0 | 9 | 16 | 30 | 11 | 16 | 13 | 95 (47.0) |
| 1 | 40 | 16 | 14 | 12 | 11 | 1 | 94 (46.5) |
| 2 | 0 | 0 | 0 | 1 | 3 | 0 | 4 (2.0) |
| 3 | 0 | 0 | 0 | 0 | 3 | 2 | 5 (2.4) |
| 4 | 0 | 0 | 0 | 0 | 2 | 0 | 2 (1.0) |
| 5 | 0 | 0 | 0 | 0 | 2 | 0 | 2 (1.0) |
| Total (%) | 49 (24.3) | 32 (15.8) | 44 (21.8) | 24 (11.9) | 37 (18.3) | 16 (7.9) | 202 (100) |

**Table 5** Patient satisfaction, as measured on a visual analog scale*

| | Mean score (range) | |
|---|---|---|
| | Before | After |
| Esthetics | 3.6 (1–9) | 8.5 (5–10) |
| Mastication | 3.0 (0–9) | 8.3 (6–10) |
| Comfort | 2.8 (0–8) | 8.8 (5–10) |

*Scores ranged from 0 (not at all satisfied) to 10 (very satisfied).

In the present study, 3 of 205 implants were lost. One implant failure occurred approximately 6 months after immediate loading in a patient treated for a maxillary restoration. This implant was placed near the extraction site of an impacted canine. The loss of this implant was a result of osseointegration failure. In another patient, one posterior implant was fractured after an acrylic fracture that had lasted for several weeks. The patient delayed veneer placement, and the immediate acrylic resin degraded over time until it fractured 21 months later. The lost implant was separately loaded for several weeks and finally fractured. The first implant replacement failed because of lack of osseointegration but was replaced successfully.

All patients included in this study were apparently in good anatomical and psychologic conditions. A favorable occlusal context was required. Otherwise, patients with uncontrolled diabetes, immunodepressed patients, or pregnant women were excluded from the rehabilitation procedure. In other reports, implant loss mainly occurred during the first 6 months after loading. The cause of failure is generally related to the patients' conditions (bruxism, excessive bone resorption). Bone quality is a prerequisite for initial implant stability, and thereby for immediate function. In this study, all implants were placed at the symphysis or the premaxilla, where bone is frequently found in

sufficient quantity and good quality. Infection, particularly in fresh sockets, may also be responsible for implant failure. In this study, 24 of 205 (11.7%) implants were placed in extraction sites. None of these implants were lost. This supports other published results[5–7] suggesting that immediate extraction/implantation in fresh extraction sites is not more sensitive to early implant loss.

No postsurgery complications were reported, and only one problem with prosthetic stability was noted during the follow-up. Six patients (13.6%) needed additional prosthodontic treatment as a result of cosmetic fractures. In addition, one abutment loosening was reported in one patient, and one abutment fracture in another. This confirmed that acrylic resin prostheses placed within a few hours after surgery for immediate loading on tilted implants can be used efficiently in the short term with limited associated fractures. The distal position of posterior implants probably resulted in reduced mechanical stress to the prosthesis.

The only peri-implant problem recorded during the study was paresthesia in one patient. Otherwise, there was no inflammation, infection, or pain reported at the clinical examination. This confirmed previous results suggesting that angled abutments do not necessarily promote peri-implant mucosal or osseous problems.[11]

Although marginal bone loss was observed in approximately half of all implants, it was limited to the first thread in more than 90% of cases. Of note, however, is that bone loss was mainly related to one patient: A 50-year-old male smoker (one to five cigarettes per day) treated for a mandibular restoration, with an implant of 4-mm diameter and 15-mm length, had five mesial threads exposed 1 year after loading. Other studies also reported minimal marginal bone loss after 1 to 3 years of follow-up.[5–7] In this study, immediate implant placement after extraction seems to not influence bone loss.

The questions raised by the immediate loading procedure essentially concerned the impact of tilting on the biomechanical strength of the implants, the reliability of angled abutments, and the number of implants in completely edentulous patients.

Laboratory experiments and theroretic calculations suggest that tilted implants may increase the stress to bone while remaining within physiologic limits.[16,17] These studies were performed on single implants. During loading, a tilted single implant may be subjected to bending and shearing stresses, leading to increased marginal bone stress. However, when the implant is part of a full-arch prosthetic restoration, the distribution of the implants and rigidity of the prosthesis should likely reduce the bending of the implant.[13] There are many advantages for posterior implant tilting in distal regions of the mandible or maxilla, including short cantilever length and better implant distribution for optimal prosthetic support. Tilting implants allows the avoidance of anatomical landmarks, such as the mandibular foramina and maxillary sinuses. The possibility of using longer implants also allows for good cortical anchorage. This reduced the maximum cantilever length to one tooth, resulting in reduced mechanical stress to the prosthesis.[13]

Angled abutments are used to redirect the screw access channels for implants that were unfavorably inclined. Experimental measurements carried out by Hoshi et al[18] suggest that the mechanical properties of angled abutments are improved compared with standard abutments. The stress values in the implant components for angled abutments (17 degrees to the vertical) placed in the mandibular posterior region were reduced by 30% in comparison with standard abutments. Cyclic loading tests showed that the release torque of the screw was significantly greater for angled abutments than for standard abutments. This confirmed previous studies suggesting no relevant physiologic or clinical differences between angled and standard abutments in terms of implant mobility, peri-implant mucosal parameters, and implant or prosthetic success rates.[11,15]

The use of 4 implants is considered an optimal number for full-arch prostheses.[19] As suggested in previous prospective and retrospective studies, increasing the number of implants does not necessarily improve implant predictability or create a better stress

distribution.[8] In addition, prosthesis adaptation is often rendered difficult. Experimentally, using software modeling,[10] it was demonstrated that the pattern of stress distribution using 4 implants (2 implants in the canine region and 2 implants in the second molar region) and that using 14 implants were similar for optimal occlusal support. The reduced number of implants is also in line with the goal of reducing the cost of treatment.

## Conclusion

This retrospective study confirmed that immediate loading of four mandibular or six maxillary implants using an acrylic resin prosthesis for full-arch rehabilitation is a reliable technique in the short- and midterm. Long-term follow-up is necessary to confirm the results of this procedure.

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