Immediate function with fixed implant-supported maxillary dentures: A 12-month pilot study

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Statement of problem. Immediate occlusal loading of dental implants in the edentulous mandible has proven to be an effective, reliable, and predictable procedure. There is little long-term data available on similar treatments in the edentulous maxilla.

Purpose. The purpose of this study was to evaluate the 12-month implant survival after immediate loading of 4 to 6 implants with fixed screw-retained prostheses in edentulous maxillae.

Material and methods. Twenty-one patients, edentulous or with remaining teeth to be extracted in the maxilla, received 4 to 6 implants (n=111). The patients were restored with screw-retained fixed provisional prostheses supported by palladium-alloy frameworks within 24 hours after surgery. Insertion torques for implants were at least 40 Ncm. Implants, grouped as tapered or cylindrical screws, were placed in healed bone or extraction sockets. Implants were also classified as either vertical or off-angle. Definitive prostheses were placed after a mean healing time of 18 weeks. Radiographic examinations were made at the time of placement of provisional prostheses and 12 months later. Between-groups bone resorption was compared using 2-way ANOVA (α=.05).

Results. The mean follow-up time for all of the patients was 20 months (range, 13 to 28 months). The cumulative implant survival rate at the 12-month follow-up visits (after surgery) was 92.8%; the prostheses survival rate was 100%. No significant differences were found between the survival of tapered or cylindrical screw-type implants placed in postextraction sockets versus those in healed edentulous sites or between vertical and off-angle placed implants. Eight implants failed during the first 3 months, 5 of which were the most distal implants. The mean reduction in marginal bone height over the 12-month observation period was 0.84 mm (CI 95%; 0.68-0.99 mm).

Conclusions. In this study with 12-month follow-up, 4 to 6 implants were sufficient to successfully support fixed implant screw-retained prostheses in the edentulous maxillae of 21 patients. (J Prosthet Dent 2008;99:351-360)

Clinical Implications

The treatment protocol described in this study may permit implant placement and immediate occlusal loading of 4 to 6 maxillary implants with survival rates similar to conventional protocols.

Schnitman et al[1] reported on the cumulative survival rates (CSR) of machined implants placed into mandibles of 10 edentulous patients. Some of the implants were immediately restored to full occlusal function; some were allowed to heal without occlusal function. The investigators reported a CSR of 85% for the machined implants that were immediately restored to full occlusal function. Tarnow et al[2] reported on immediate occlusal

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loading in 4 patients with edentulous maxillae and 6 patients with edentulous mandibles using implants with either machined or rough surfaces. Their study included implants from 4 different implant manufacturers, and found a CSR of 98% for implants placed into immediate occlusal function with 1-6 years of follow-up. Testori et al[3] reported on the results of a study of immediate occlusal loading in 15 patients with edentulous mandibles, and found a CSR of 98.9% with up to 48 months of follow-up. The previous studies, in general, reported on the success of splinted mandibular implants that were placed into immediate occlusal function. The bone in anterior, edentulous mandibles has been noted to be dense and favorable for long-term success.[4] However, edentulous maxillae are, in general, different from edentulous mandibles at both the macroscopic and microscopic levels. Especially when compared to the interforaminal portion of the mandible, maxillary bone is much more trabecular and, therefore, less dense.[5,6] Thus, it is more difficult to achieve high levels of implant stability at implant placement (primary stability). Primary implant stability is considered to be one of the most important factors for successful osseointegration.[4,6] In less dense bone, undersizing osteotomies and selecting implants with differing shapes, lengths, and diameters may help to overcome such anatomical limitations and permit the attainment of high primary stability.[7,8] An insertion torque of at least 40 Ncm has been suggested as the minimum value acceptable for immediate implant loading,[8] although controversy exists on this subject relative to multiple, splinted implants versus single, unsplinted implants.[9,10] Brunski[11] suggested that micromovement of implants within osteotomy sites may have a negative impact on osseointegration. Consequently, carefully controlled surgical and prosthetic protocols must be followed to achieve osseointegration predictably.[12]

In the past several years, a number of reports have addressed the treatment of edentulous maxillae with implant-supported prostheses.[4,13-28] In a review of the literature on immediate loading, Del Fabbro et al[10] encountered a wide variety of approaches in terms of numbers of implants as well as surgical and prosthetic protocols. The authors found, for instance, that the mean number of implants placed for immediate loading was 8.18. In another review of the peer-reviewed English literature relating to the outcomes of clinical studies on immediate and early loading, Attard and Zarb[29] identified shortcomings and found a number of questions that required exploration. Within the limitations of their review, Attard and Zarb concluded that treatment protocols involving immediate functional loading were predictable in the anterior mandible, irrespective of implant type, surface topography, and prosthesis design (survival rates 90%-100%). However, there was limited information on outcomes with immediate loading for edentulous maxillae. The authors suggested that the impact of these new treatment protocols should be evaluated relative to a patient's quality of life.

The aims of the present study were to describe a surgical-prosthetic protocol for treatment of edentulous maxillae with 4 to 6 immediately loaded implants and to report follow-up data, including cumulative survival rates, after at least 12 months of occlusal loading. The null hypothesis for this study was that there would be no significant difference between the survival of tapered or cylindrical screw-type implants placed in postextraction sockets versus those in healed edentulous sites, or between vertical and off-angle placed implants.

MATERIAL AND METHODS

From March 2004 to January 2007, 21 subjects with edentulous maxillae (10 women, 11 men), with a mean age of 58 years (women, 58.6; men, 57.4 years) were treated with fixed screw-retained prostheses supported by 4 to 6 implants. All subjects treated in this study, which was approved by the Scientific Ethical Committee of the University of Genoa, provided informed consent prior to the start of the study. Subjects included in this study met the following criteria: desire to be treated with fixed complete dentures supported by dental implants and good general health without any contraindications for undergoing oral surgery. Subjects also agreed to return for the required recall appointments. The surgical and prosthetic protocols required sufficient bone volume to accommodate 4 to 6 implants with a minimal implant length of 10 mm. The minimum insertion torque value for each implant was 40 Ncm, measured on the drill units. Patients who required bone grafting prior to implant placement were excluded. Opposing dentitions were natural teeth or fixed or removable prostheses. Subjects with opposing mandibular complete dentures were excluded. Nine patients had mandibular natural dentitions; 3 patients had mandibular dentitions that contained natural teeth and fixed implant-supported prostheses; 6 had complete-arch fixed implant-supported prostheses; 3 dentitions consisted of natural teeth and removable partial dentures (RPDs). Maxillary tooth loss for the patients in this study was attributed to periodontal disease for 11 patients, endodontic failures for 5 patients, and dental caries for 5 patients.

All patients received detailed initial physical and radiographic examinations. Special emphasis was placed on smile line analysis (high, medium, low) and, in dentate patients, on periodontal probing depth measurements. Additionally, baseline radiographs consisting of intraoral periapical films were obtained with the parallel long-cone technique. In situations in which treatment plans initially required the extraction of the remaining maxillary teeth, volumetric computerized tomograms (CT scans) were made for

planning implant placement.

The evaluation of the preextraction data determined the design of the immediate provisional prostheses. Horizontal bone loss greater than or equal to 5 mm, measured from the cemento-enamel junctions of the natural teeth, dictated that the provisional prosthesis would also need to replace missing soft tissues. However, if bone loss was less than 5 mm and the need for extraction of residual teeth was not caused by periodontal disease, patients were treated with fixed provisional prostheses without soft tissue replacement in the prostheses. These teeth were extracted at the surgical appointment during which the implants were placed. Diagnostic tooth arrangements, on casts mounted in semiadjustable articulators, were made for each patient. Surgical guides were made using autopolymerizing acrylic resin (ProBase; Ivoclar Vivadent, Schaan, Liechtenstein).

Implant placement was performed under local anesthesia (4% articaine with 1:100,000 adrenaline; Alfacaina SP; Dentsply Italy Srl, Rome, Italy). Patients were sedated 1 half hour preoperatively with 20 mg of oral diazepam (Valium; Roche SpA, Milan, Italy). Preoperative antibiotic prophylaxis was administered with 2 g of amoxicillin (Zimox; Pfizer Italia Srl, Rome, Italy) 1 hour before and 1 g following surgery and every 12 hours for 6 days thereafter. In 8 patients, an antacid, omeprazole 20 mg (Mepral 20; Bracco SpA, Milan, Italy), was prescribed additionally for gastric protection.[30]

The surgical protocol required mucoperiosteal flaps at or slightly palatal to the ridge crest, with buccal relieving incisions in the first molar areas. Remaining teeth were extracted and the alveolar sockets were carefully and thoroughly debrided. The osseous crests were flattened as needed prior to implant site preparation. Bone quality was categorized as type I to IV, according to the Lekholm and Zarb classification.[4] A total of 111 implants, 4 mm in diameter, were placed (Osseotite and Osseotite NT; Biomet 3i, Palm Beach Gardens, Fla).

Implants with natural taper (Osseotite NT) were primarily used in extraction sockets, whereas cylindrical, straight wall implants (Osseotite) were placed into healed edentulous sites. All implants achieved insertion torque values of at least 40 Ncm (Table I).[31] To increase the potential for sufficient primary stability, implant sites were "underprepared." In sites with type III or IV bone, the final drill size was 2 mm in diameter in the apical area, whereas the coronal portions of the osteotomies were prepared with 3.25-mm-diameter drills. A manual wrench (Biomet 3i) was used in the last phase of implant placement. Implant restorative platforms were positioned at the level of the osseous crest, and bicortical stabilization was established whenever possible. Angulated implants were used in the distal areas where the caudal extensions of the maxillary sinus precluded placement of implants with a length of 10 mm or greater.[15-17] Absorbable monofilament sutures (Monocryl 3-0; Ethicon, Inc, Somerville, NJ) were placed.

Immediately after surgery, 30 mg intramuscular ketorolac (Tora-Dol, 30 mg/ml; Recordati SpA, Milan, Italy) was administered. Oral naproxen (Naprosyn 500 mg; Recordati SpA), 550 mg twice each day for 5 days, was also prescribed for pain relief. All patients were instructed to rinse twice daily for 10 days with chlorhexidine 0.2% solution (Curasept 0.2; Curaden Healthcare Srl, Milan, Italy). Recall appointments for reevaluation and removal of any remaining sutures were scheduled 7 to 10 days after surgery.

Conical abutments (0, 17, 25, and 45 degrees) (Biomet 3i) were placed onto the implants. The selection of the appropriate angulated abutments was made consistent with the location of the teeth within the surgical guides. To ensure that the abutments were completely seated onto the implants, the abutments were placed prior to suturing the mucoperiosteal flaps. Bone profiling was accomplished as needed to ensure complete abutment seating onto the implant restorative platforms. The abutment screws were torqued to 20 Ncm with a torque instrument (Contra Angle Torque Driver; Biomet 3i). Conical abutment impression copings (Biomet 3i) were placed onto the conical abutments. Holes were placed into plastic impression trays corresponding to the impression copings, and definitive impressions were made using a pick-up impression technique with impression plaster (Bf-plaster; Dentaltorino, Turin, Italy),[32] mixed per the manufacturer's instructions. The impression trays were inserted and the impression coping screws were uncovered prior to setting of the impression plaster. After the impression plaster completely set, the impression coping screws were unscrewed so that they were completely free of the conical abutments, and the impressions were removed. Conical abutment analogs (Biomet 3i) were placed into the impression copings and the definitive casts were poured with type IV die stone (GC Fujirock EP; GC Europe, Leuven, Belgium), mixed according to the manufacturer's instructions. Protective caps (Biomet 3i) were placed

Table I. Type and number of implants placed

	10 mm	11.5 mm	13 mm	15 mm	18 mm	Total
Cylindrical implants 4-mm diameter	1	2	20	30	20	73
Tapered implants 4-mm diameter	1	1	8	28	-	38

onto the abutments and wax maxillomandibular jaw relation records (Beauty Pink Wax Extra Hard; Miltex, Inc, York, Pa) were made at the predetermined occlusal vertical dimension. The patients were discharged and asked to return the following day for insertion of the provisional prostheses. Provisional screw-retained fixed prostheses were made in the laboratory with the following design characteristics: no cantilevers distal to the distal implants, acrylic resin masticatory surfaces, and metal (NewStart; Cendres + Metaux SA, Biel/Bienne, Switzerland) frameworks for increased strength and rigidity (Fig. 1).

Nonhexed conical abutment cylinders (Sint Tech Technology, Canelli, Italy) were placed onto the conical abutment analogs prior to developing acrylic resin patterns. The metal frameworks were first modelled in resin (Pattern Resin; GC Corp, Tokyo, Japan) and then cast in palladium alloy (NewStart; Cendres + Metaux SA).[33,34] All provisional prostheses were screw retained and inserted within 24 hours after surgery. The retaining screws were torqued to 10 Ncm with a torque instrument (Contra Angle Torque Driver; Biomet 3i).

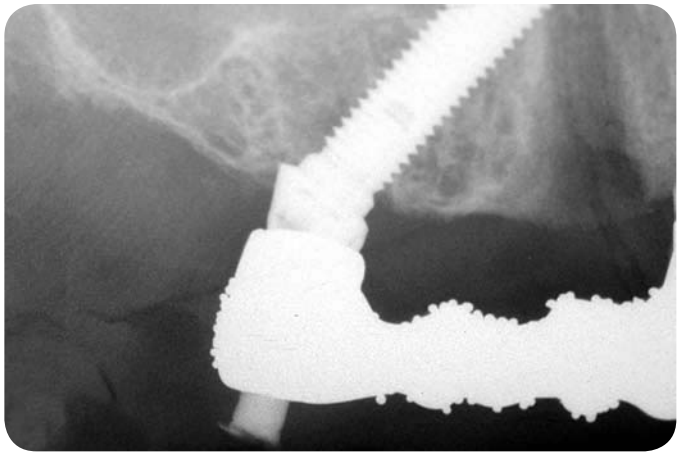
A small amount of vinyl polysiloxane impression material was placed into the screw access openings to block out the screw hexes from the light-polymerized composite resin restorative material (SR Adoro; Ivoclar Vivadent). An occlusal scheme was designed that minimized nonworking side interferences and provided group function on the working side. All of the prostheses were fabricated to allow for oral hygiene procedures, including flossing around the conical abutments and the intaglio surfaces of the provisional prostheses. Hygiene instructions, including the use of toothbrushes and flossing techniques, were given.

The definitive prostheses were placed after a mean healing time of 18 weeks. If indicated, definitive prostheses were designed with a maximum cantilever of 1 tooth distal to the distal implants (Fig. 2). All of the definitive prostheses consisted of cast metal frameworks with the same alloy used in the provisional prostheses; the occlusal surfaces were designed completely in porcelain (Ceramco 3; Dentsply Ceramco, Burlington, NJ) or acrylic resin artificial teeth (Executive; Dentsply Italia, Rome, Italy). All of the definitive prostheses were screw retained.

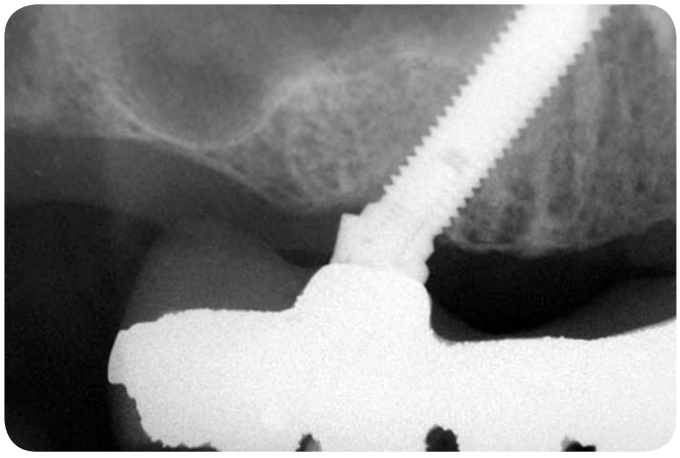
An implant was classified as surviving if it fulfilled its supporting function and was clinically stable when tested individually, and no pain or signs of infection were detected during clinical examinations. Bone-implant contact had to be present on the radiographs, without evidence of radiolucencies. An implant-supported prosthesis was classified as surviving if it was in function, had no fractures, and provided patients with adequate masticatory, esthetic, and phonetic function.

The subjects were seen by a dental hygienist every 4 months for the first year. At each follow-up visit, the prostheses were removed and the implants and abutments were evaluated individually for tenderness, swelling, and mobility. Additionally, the following clinical assessments were made: plaque scores,[35] bleeding index,[36] centric occlusion and lateral excursion contacts, pain, and prosthesis mobility.

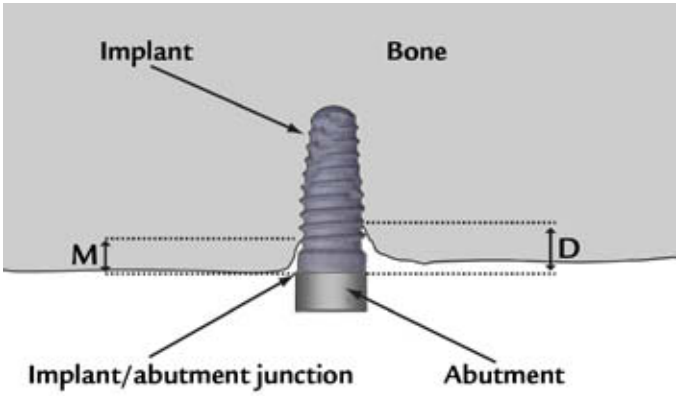
Radiographic examinations were accomplished to assess the interproximal bone levels at baseline (provisional prosthesis insertion) and at the 1-year follow-up appointments. The radiographs were made using a long-cone paralleling technique with an individualized film holder (Rinn



1 Radiograph of distal angulated implant in right posterior maxilla at time of immediate loading with provisional prosthesis. Implant axis was corrected with angled abutment.



2 Radiograph of same implant as in Figure 1, 12 months after implant placement and immediate loading. Definitive prosthesis was made with cast metal alloy framework. See Figure 3 for description of bone level measurements.



3 Interproximal crestal bone loss was measured from implant-abutment junction to most coronal bone-implant level on mesial (M) and distal (D) aspects of implants.

Table II. Cumulative survival rate (CSR), 12 months following implant placement

Follow-up (Months)	Number of Implants	Number of Failing Implants	CSR (%)
0	111	0	100
6	103	8	92.8
12	103	8	92.8

Table III. Type and number of implants lost

	10 mm	11.5 mm	13 mm	15 mm	18 mm	Total
Cylindrical implants 4-mm diameter	-	1	-	1	2	4
Tapered implants 4-mm diameter	1	-	2	1	-	4

film holder; Dentsply Rinn, Elgin, Ill) and fast-speed films (Kodak Ultra-speed; Carestream Health, Rochester, NY). Care was taken that the threads on both sides of the implants were clearly imaged in each radiograph. The implant-abutment interface was taken as the reference point for the bone level measurements[37] (Fig. 3). The interproximal bone levels were assessed from these reference points to the most coronal bone at the mesial and distal aspects of each implant. A radiologist otherwise not involved in the study performed the radiographic readings using a diaphanoscope (Tecno-Gaz SpA, Parma, Italy) and magnifying lens.[37]

Statistical analyses were performed using the statistical software (SPSS 15.0; SPSS Inc, Chicago, Ill). Bone levels (mesial and distal sites) between baseline and 1-year follow-up post loading were compared using a repeated measures 1-way analysis of variance (ANOVA). Between-group bone resorption changes were compared using 2-way ANOVA corrected for patient effect. The groups differed in implant shape (tapered versus cylindrical), implant inclination (upright versus angulated), and type of site (healed bone versus extraction sockets). All tests were 2-tailed and the alpha was set to .05.

RESULTS

All of the 21 patients returned for the 1-year follow-up visits. The mean follow-up time period for all of the patients in this study was 20 months. The cumulative survival rate (CSR) for implants was 92.8% (Table II). Eight implants failed during the first 3 months. Four of the failed implants were tapered and 4 were cylindrical. Two patients lost 2 implants each, and 4 patients lost 1 implant each. Of the 8 implants that failed, 5 new implants were placed after a period of 4 weeks and loaded with the definitive prosthesis. Five of the 8 implants lost were in distal areas (Table III). Two of

the failed implants were shorter than 13 mm. At the 12-month follow-up appointments, the CSR for the prostheses was 100%.

The mean interproximal bone level at baseline was 0.65 mm at the mesial sites and 0.41 mm at the distal sites. The mean interproximal bone levels at the 1-year follow-up appointments were 1.39 mm at the mesial sites and 1.35 mm at the distal sites (Tables IV, V). There were no significant differences noted between the mean bone loss reported between upright and angulated implants, between cylindrical and tapered implants, and between implants placed in healed bone versus extraction sockets (Tables VI, VII).

TABLE IV. Bone levels comparison* between baseline and 1 year following loading

Source of Variation	*df*	Sum of Squares	Mean Squares	F	*P*
Mesial site					
Time (T0; T12)	1	28.41	28.40	41.714	<.001
Subject	102	99.78	0.978		
Time x subject	102	69.47	0.681		
Distal site					
Time (T0; T12)	1	44.74	44.738	76.039	<.001
Subject	102	83.22	0.816		
Time x subject	102	60.01	0.588		

* 1-way analysis of variance (ANOVA) for dependent observations

TABLE V. Paired means comparison (1-way repeated measures ANOVA) between baseline and 1-year post loading

	Number of Implants	Mean (mm)	95% Lower	95% Upper
Mesial site				
Baseline (T0)	103	0.65	0.50	0.80
1 year (T12)	103*	1.39	1.19	1.59
Distal site				
Baseline (T0)	103	0.41	0.29	0.54
1 year (T12)	103*	1.35	1.15	1.54

*Eight failed implants

Table VI. Bone levels comparison (2-way analysis of variance (ANOVA) for independent observations)

Source of Variation	*df*	Sum of Squares	Mean Squares	F	*P*
Mesial site (tapered; cylindrical)	1	0.672	0.672	0.709	.403
Patient	20	40.93	2.047	2.159	.009
Mesial site x patient	11	19.62	1.783	1.881	.057
Residual	70	66.38	0.948		
Distal site (tapered; cylindrical)	1	0.250	0.250	0.309	.580
Patient	20	30.13	1.507	1.868	.029
Distal site x patient	11	22.72	2.065	2.560	.009
Residual	70	56.463	0.807		
Mesial site (upright; tilted)	1	0.221	0.221	0.208	.650
Patient	20	48.52	2.426	2.276	.007
Mesial site x patient	17	18.65	1.097	1.029	.441
Residual	64	68.23	1.066		
Distal site (upright; tilted)	1	0.032	0.032	0.032	.858
Patient	20	41.04	2.052	2.038	.017
Distal site x patient	17	15.36	0.904	.898	.580
Residual	64	64.44	1.007		
Mesial site (healed bone; extraction sockets)	1	< 0.001	< 0.001	< 0.001	.986
Patient	20	40.77	2.039	1.809	.037
Mesial site x patient	14	11.72	0.837	0.743	.724
Residual	67	75.49	1.127		
Distal site (healed bone; extraction sockets)	1	0.918	0.918	0.902	.346
Patient	20	24.44	1.222	1.200	.282
Distal site x patient	14	11.44	0.817	0.802	.663
Residual	67	68.2	1.018		

TABLE VII. Mean difference in bone resorption (T12-T0) among sites, implant shapes, implant inclinations, and types of socket

	Number of Implants	Mean Difference (T12-T0) (mm)	95% Lower	95% Upper
Mesial site (tapered)	34	0.97	0.48	1.46
Mesial site (cylindrical)	69	0.63	0.38	0.88
Distal site (tapered)	34	1.03	0.53	1.53
Distal site (cylindrical)	69	0.88	0.68	1.09
Mesial site (upright)	61	0.62	0.32	0.93
Mesial site (tilted)	42	0.92	0.56	1.27
Distal site (upright)	61	0.86	0.60	1.12
Distal site (tilted)	42	1.04	0.67	1.41
Mesial site (healed bone)	56	0.98	0.64	1.33
Mesial site (extraction sockets)	47	0.46	0.18	0.73
Distal site (healed bone)	56	1.14	0.84	1.45
Distal site (extraction sockets)	47	0.68	0.40	0.96

DISCUSSION

The findings of this preliminary 12-month pilot study do not support rejection of the null hypothesis. The cumulative survival rate for the immediately loaded maxillary implants in this study (CSR 92.8%) was consistent with reports of survival rates of maxillary implants without immediate occlusal function.[19,23,26,27,38] These findings suggest that, in certain instances and with certain protocols, 4 to 6 implants may be sufficient to immediately support fixed implant-retained prostheses in edentulous maxillae. Successful outcomes with immediate occlusal loading in edentulous maxillae require careful treatment planning and must include primary implant stability as documented in the published scientific literature (insertion torque values greater than 40 Ncm were used in this study).[6,8,17,28,31] Patients also should be followed carefully on a long-term basis for optimal maintenance of the prostheses and occlusal schemes.[37]

The findings in this clinical pilot study did not appear to be influenced by the nature of the implant sites, that is, healed edentulous sites versus fresh extraction sockets,[20] although this premise was not included in the experimental variables of this study. It appears that there was no contraindication for using tapered implants in extraction sockets. This variable was not specifically tested for by comparing the primary stability of cylindrical (straight) implants versus tapered implants in extraction sockets. Other factors such as bone density at implant sites, including extraction sockets, implant length and diameter, as well as the use of threaded implants, may be as important in obtaining adequate primary stability as the taper of dental implants.[29]

In the current study, radiographs demonstrated that the bone resorption patterns for posterior, angulated implants were similar on the mesial and distal surfaces and were in agreement with the findings of others.[13,15-17,21,22,28] The mean change in interproximal bone levels at the 1-year follow-up visits, obtained with serial, reproducible radiographs, was 0.84 mm (CI 95%; 0.68-0.99 mm), and is also consistent with other data found in the literature.[15,17]

In the absence of significant differences between bone levels of angulated versus vertical implants, the surgical protocol in the current study appears to validate the use of longer implants in healed edentulous sites even though shorter implants were

not used for comparison. However, the authors are aware that the follow-up term for this study was relatively short, and further long-term clinical and radiographic follow-up is needed to better validate the results of this study. This surgical-prosthetic protocol also seems to validate the reduced length of the prostheses' cantilevered segments. Implant placement and orientation provided effective cross-arch stabilization without the need for bone grafting procedures. Eliminating maxillary sinus bone grafts resulted in significantly less morbidity and dramatically decreased the financial costs associated with those procedures. This protocol also decreased the number of implants required for fixed, implant-retained prostheses in the edentulous maxillary jaws of the patients treated in this study.

The provisional and definitive prostheses in this study were made with cast metal frameworks. Metal frameworks are significantly stronger than all-acrylic resin frameworks,[34] and this design feature may have provided increased rigidity to the immediate provisional prostheses as compared to all-acrylic resin prostheses. Loose abutment screws of angulated and nonangulated abutments were not reported by patients, nor observed by the clinicians in this study. During the course of this study, there were no reported fractures of prosthesis frameworks. The authors believe that the increased rigidity associated with the metal frameworks in both the provisional and definitive prostheses had an important role in the CSRs seen with this protocol, although the literature is not conclusive in this matter. Grunder, [27] in a small pilot study, reported on the results of treating 5 patients with edentulous maxillae and found that 5 of the 7 implant failures were found in patients with nonmetal-reinforced provisional restorations. Other authors[17,28] who have used all-acrylic resin prostheses without metal frameworks have also reported high survival rates.

Even though the international literature is conflicting on this point,[39-41] several authors maintain that the use of a shock-absorbing occlusal surface (such as acrylic resin) results in reduced stresses transmitted to the bone-implant interface,[12,42,43] thus reducing the risk of overload. This is particularly important in an immediate loading protocol.

The majority of implant failures reported in the present study were in the first few patients treated. However, this study does not have power enough to account for such a source of variability. Presumably a learning curve was necessary to optimize the surgical-prosthetic protocol used in this pilot study. The authors expect that this accumulated experience will result in better outcomes in the future when this treatment modality is applied. More long-term prospective clinical trials are needed to affirm the effectiveness of the surgical-prosthetic protocols used in this study.

CONCLUSIONS

Within the limitations of this pilot study, patients with edentulous maxillae can be effectively treated with fixed implant restorations supported by 4 to 6 implants placed within 24 hours after implant surgery. Sinus grafting to provide adequate bone in posterior maxillary segments may not be a prerequisite for fixed maxillary implant prostheses as long as distal implants can be placed parallel to the anterior walls of maxillary sinuses. Primary implant stability is important and may be quantified with sufficiently high insertion torques (at least 40 Ncm in this study). Metal frameworks may also play a role in satisfactory CSRs of immediately loaded implants due to increased strength and rigidity when compared to all-acrylic resin prostheses.

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