Immediate Versus Delayed Loading of Dental Implants in Edentulous Maxillae: A 36-Month Prospective Study

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Purpose: The aim of this study was to compare survival rates and radiographic outcomes of immediate and delayed implant loading in edentulous maxillae.
Materials and Methods: Forty-nine patients in need of maxillary full-arch treatment were randomized into two groups: test group (n = 34) treated following the Columbus Bridge Protocol with 4 to 6 implants loaded within 24 hours and a control group (n = 15) treated following the ad modum Brånemark protocol with 6 to 9 implants loaded a mean 8.75 months after surgery. Two hundred sixty implants (test: n = 163, control: n = 97) were placed, and subjects were treated with screw-retained full-arch prostheses. Bone levels were measured at baseline and at 1, 2, and 3 years and analyzed using repeated-measures analysis of variance. ***Results:*** All patients appeared at all scheduled recall visits. No differences in cumulative survival rates were found between groups at 36 months. Ten implants (6.1%) failed in the test group; four (4.1%) failed in the control group. At 36 months, no prosthetic failures were detected. Significantly less bone loss was found in the test group at all time intervals ($P < .001$). The average bone level from the implant-abutment connection was 1.3 mm in the test group and 1.9 mm in the control group at 12 months, 1.5 mm and 2.2 mm at 24 months, and 1.6 mm and 2.3 mm at 36 months, respectively.
Conclusion: In the edentulous maxilla, the Columbus Bridge Protocol involving immediate loading of implants placed in both healed and fresh extraction sites exhibited equivalent implant survival and less marginal bone loss at 3 years compared to the conventional two-stage delayed loading protocol. *Int J Prosthodont 2011;24:294–302.*

The introduction of the two-stage surgical procedure for osseointegration with delayed occlusal loading has been challenged rapidly by proposals for different clinical protocols.[1–8] The objective was a decrease in overall treatment time via single-stage surgery and immediate prosthesis function. The anterior zone of edentulous mandibles provided the most predictable results with both fixed[1] and overdenture[2,3] prostheses; however, reports[4–8] on immediate loading protocols in edentulous maxillae were not supported by comparable long-term follow-up periods, as demonstrated in early research reports on osseointegration.[9–11] Table 1 summarizes the outcomes of clinical studies on immediate loading protocols of the maxilla.

The papers listed in Table 1 reported a mean number of implants per patient equal to 7.44, while Del Fabbro et al[12] reported that the mean number of implants placed for maxillary immediate occlusal loading was greater than 8.18. There are also numerous papers describing reduced implant numbers supporting full-arch prostheses, especially in edentulous mandibles.

In 2004, the Department of Implant and Prosthetic Dentistry, University of Genoa, Genoa, Italy, proposed a specific clinical protocol called the Columbus Bridge Protocol (CBP) for fixed implant-supported prostheses

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Table 1 Outcomes of Clinical Studies on Immediate Loading Protocols in the Maxilla

	Year of publication	No. of patients included	Mean no. of implants per patient	Follow-up (mo)	Implant CSR (%)	Bone reabsorption (mm)
Ibañez et al[4]	2005	26	8.3	6 to 74	99.42	at 1 year: 0.56 at 3 years: 0.84 at 6 years: 0.94
Degidi et al[8]	2005	43	9	60	99.29 for ≤ 10 implants per patient 96.30 for > 10 implants per patient	Not reported
Fischer et al[5]	2008	24	5.9	60	94.7	2.90
Collaert and De Bruyn[6]	2008	25	7.8	36	100.0	0.72
Bergkvist et al[7]	2009	28	6	32	98.2	2.09

CSR = cumulative survival rate.

in edentulous maxillae using a reduced number of implants compared to the reports in Table 1. The surgical protocol was developed to include multiple extractions prior to immediate loading of dental implants, as well as to obtain primary implant stability and avoid bone grafting procedures in the maxillary sinuses, while the prosthodontic portion of the protocol sought to optimize adverse occlusal loading. The CBP[13] requires the presence of sufficient bone volume to accommodate placement of 4-mm-diameter and, at least, 10-mm-long implants. The use of longer implants in residual bone can also be facilitated by angled distal implant placement, which places implants parallel to the anterior walls of the maxillary sinus. Patients are treated with fixed prostheses supported by at least four implants (maximum of six implants). Provisional screw-retained prostheses fabricated according to a specific prosthodontic protocol—no distal cantilevers, acrylic resin occlusal surfaces, cast passively fitting metal framework for optimal rigidity—are placed within 24 hours postsurgery. A 1-year report on the protocol's early use was published in 2008 with favorable preliminary results.[14] Prosthetic treatment planning and treatment using a reduced number of implants was based on a combination of theoretic,[15,16] clinical,[11] and encouraging biologic evidence.[17]

The purpose of this prospective clinical study was to evaluate the clinical and radiographic outcomes of immediate versus delayed loading in a convenience sample of patients with edentulous maxillae. The null hypothesis was that there would be no significant differences in cumulative survival rates and bone resorption of implants undergoing immediate postextraction loading versus those placed according to a standard protocol in healed edentulous sites.

Materials and Methods

Between September 2005 and January 2006, a convenience sample of 49 patients (25 women, 24 men) with edentulous maxillae or seriously unfavorable prognoses for their maxillary dentitions was identified for this study. Patients presented with a mean age of 58.2 years (women: 54.8 years, men: 61.5 years) and were treated with fixed screw-retained prostheses supported by implants (n = 260) in the Department of Implant and Prosthetic Dentistry of the University of Genoa.

All patients met the following criteria: desire to be treated with fixed prostheses supported by dental implants, possessing good general health, and no contraindications for undergoing oral surgery. A history of smoking or parafunctional habits did not disqualify any patients, although smokers were advised to give up smoking. All patients also agreed to return for the required recall appointments.

The surgical and prosthetic protocols required sufficient bone volume to accommodate a minimum of four implants (4 × 10 mm). Patients who required bone grafting prior to implant placement were excluded. Opposing dentitions consisted of natural teeth or were restored with fixed/removable prostheses. Subjects with opposing mandibular complete dentures were excluded since they were not able to load the study prostheses with forces comparable to the other patients (Table 2). The unfavorable prognoses for the maxillary dentitions for patients in this study were attributed to periodontal disease (n = 28), endodontic failures (n = 10), and dental caries (n = 11). All patients received detailed initial physical and radiographic examinations. For dentate patients, special emphasis was placed on periodontal charting and attendant treatment requirements. Additionally, baseline radiographs consisting of intraoral periapical films were obtained with the parallel long-cone technique. Volumetric computed

Table 2 Opposing Mandibular Dentitions for Patients in this Study

	Natural dentitions	Natural dentition with fixed implant restorations	Full-arch fixed implant prostheses	Natural dentition with RPDs	Mandibular implant-supported overdenture supported by 2 implants	Total patients
Test	14	5	8	5	2	34
Control	1	4	3	3	4	15

RPDs = removable partial dentures.

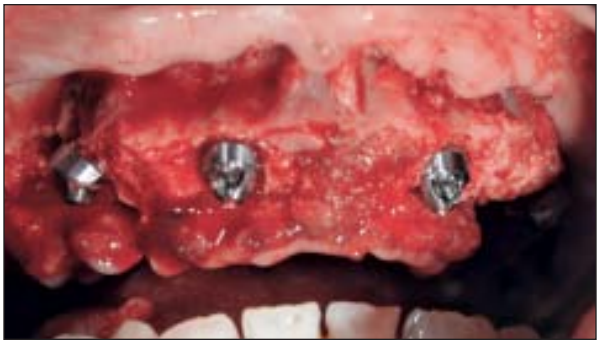

Fig 1 Intraoral photograph showing preangled conical abutments to correct implant inclination.

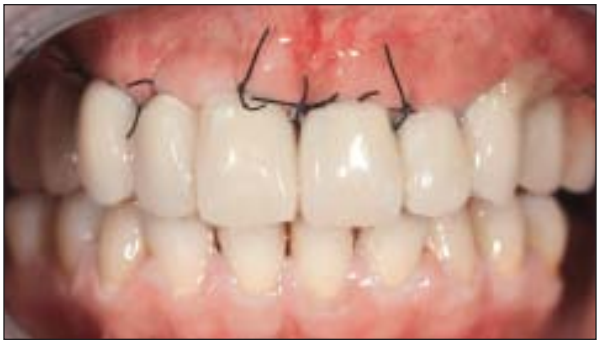

Fig 2 Clinical photograph of a patient in the test group immediately after the provisional prosthesis was delivered.

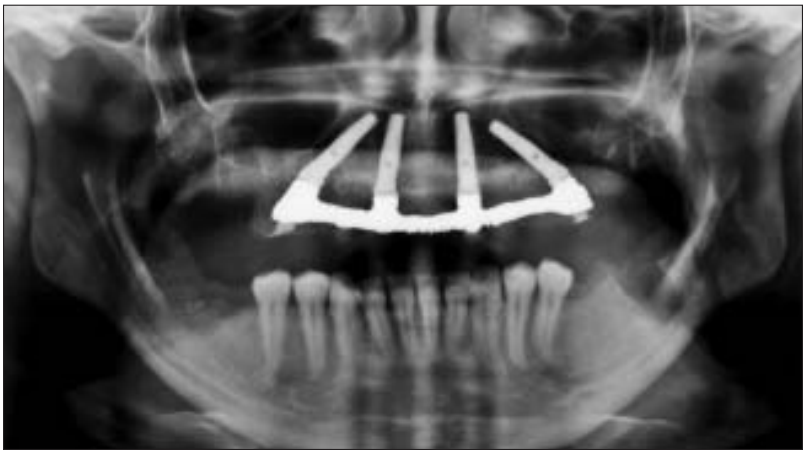

Fig 3 Panoramic radiograph of a fixed, screw-retained provisional prosthesis in place per the CBP 24 hours after the surgical procedure was accomplished. The mandibular removable partial denture is not in place.

tomograms (CT scans) were used to select and plan implant placement sites. The study was approved by the Scientific Ethical Committee of the University of Genoa, and all subjects provided informed consent prior to the start of the study.

Patients were divided into two unmatched groups on the basis of their existing maxillary condition (preexisting maxillary edentulism or candidates for a similar predicament). The test group comprised 34 patients (19 women, 15 men; mean age: women = 53.7 years, men = 60.5 years) with bad prognoses for their maxillary teeth. These subjects underwent postextraction implant placement with immediate loading according to the CBP (Figs 1 to 3). Provisional fixed screw-retained prostheses were placed within 24 hours of implant placement. The definitive prostheses were placed after a mean healing period of 4.5 months. The control group comprised 15 patients (6 women, 9 men; mean age: women = 56.0 years, men = 62.6 years) with hopeless maxillary teeth who were made edentulous 3 months prior to implant surgery and treated with transitional complete dentures. These subjects underwent the standard two-stage ad modum Brånemark implant protocol with delayed loading.[11] Definitive fixed screw-retained prostheses were placed after a mean healing period of 8.75 months.

Except for the time sequence for implant loading and for the number of implants, the control and test group did not differ in surgical/prosthetic protocols or maintenance programs.

Surgical Protocols

The surgical protocol applied was described in the 1-year preliminary report.[14] A customized surgical template was created to guide implant insertion and angled abutment connection according to the future prosthesis design, which was planned on the basis of diagnostic data. Remaining teeth were extracted, and alveolar sockets were carefully and thoroughly debrided. Full-thickness, mucoperiosteal flaps at or slightly palatal to the ridge crest were realized. Osseous crests were flattened as needed prior to osteotomy preparation. Bone quality was categorized as type I to IV, according to the classification of Albrektsson et al.[18] A total of 163 4-mm-diameter implants (Osseotite and Osseotite NT, Biomet 3i) were placed in the test group; implant numbers ranged from 4 to 6 per subject (mean: 4.8 implants per patient). Implants with natural taper (Osseotite NT) were primarily used in the fresh extraction sites, while cylindric, straight-wall implants (Osseotite) were placed in healed edentulous sites.

Ninety-seven implants (Osseotite) were placed in the control group. These patients received 6 to 9 implants each (mean: 6.5 implants per patient).

All implants achieved insertion torque values of at least 40 Ncm. To increase primary stability, implant sites were "underprepared" relative to the implant diameter. Implant restorative platforms were positioned at the level of the osseous crest without using countersink drills. Angled implants were used in the distal areas where the floor extensions of the maxillary sinus precluded placement of straight implants at least 10 mm in length. In the control group, cover screws were placed onto the implants before the surgical sites were closed. Mean healing time in the control group was 8.75 months. During this period, patients wore complete dentures relined with a soft material (Viscogel, Dentsply) at 14 days and every month thereafter. During the first 2 weeks, patients were asked not to wear their dentures to allow the peri-implant soft tissues to heal without pressure from the dentures. Later, implants were exposed during a second surgical procedure; prosthetic abutments were then placed onto the implants prior to fabrication of the definitive prostheses.

Prosthetic Protocols

In the test group, conical abutments (0, 17, 25, and 45 degrees; Biomet 3i) were placed onto the implants immediately after implant placement. Abutments were placed onto the implants prior to suturing the mucoperiosteal flaps. This enabled the clinicians to completely visualize the abutment-implant interface and ensured accurate abutment placement onto the implant restorative platforms. Bone profiling was accomplished as needed to ensure complete abutment seating onto the implant restorative platforms. Abutment screws were torqued to 20 Ncm with a torque instrument (Contra Angle Torque Driver, Biomet 3i). Pickup abutment impression copings were placed onto the conical abutments. Holes were prepared into plastic impression trays corresponding to the impression copings, and impressions were made using a pickup impression technique with impression plaster (BF-plaster, Dentaltorino) per the manufacturer's instructions. Impression coping screws were uncovered prior to setting of the impression plaster. After the impression plaster was completely set, the impression coping screws were unscrewed so that they were completely free of the abutments, and the impressions were removed. Conical abutment analogs (Biomet 3i) were placed into the impression copings; master casts were poured with type IV die stone (GC Fujirock EP, GC) and mixed according to the manufacturer's instructions. Conical abutment healing caps (Biomet 3i) were placed onto the abutments; preliminary wax jaw relation records (Beauty Pink Wax Extra Hard, Miltex) were made at the preselected optimal occlusal vertical dimension. Patients were discharged and asked to return the following day for placement of the provisional prostheses.

Provisional screw-retained fixed prostheses were made in the laboratory with the following design characteristics: no distal cantilevers, acrylic resin occlusal surfaces, and cast metal framework (NewStart, Cendres + Metaux). Metal frameworks provided increased strength and rigidity to the provisional prostheses. Nonhexed conical cylinders (SintTech Technology) were placed onto the conical abutment analogs prior to developing acrylic resin patterns. Resin patterns were developed for the maxillary frameworks (Pattern Resin, GC Corp) and then cast in palladium alloy (NewStart). All provisional prostheses were screw-retained and inserted within 24 hours of the surgical procedures. Retaining screws were torqued to 10 Ncm with a torque instrument (Contra Angle Torque Driver). A small amount of polyvinyl siloxane impression material was placed into the screw access openings to block out the screw hexes; for optimal esthetics and hygiene, light-polymerized composite resin restorative material (SR Adoro, Ivoclar Vivadent) was used to restore the screw access openings. An occlusal scheme was designed that minimized nonworking side interferences and provided group function on the working sides. All prostheses were fabricated to allow for oral hygiene procedures, including flossing around the conical abutments and the intaglio surfaces of the

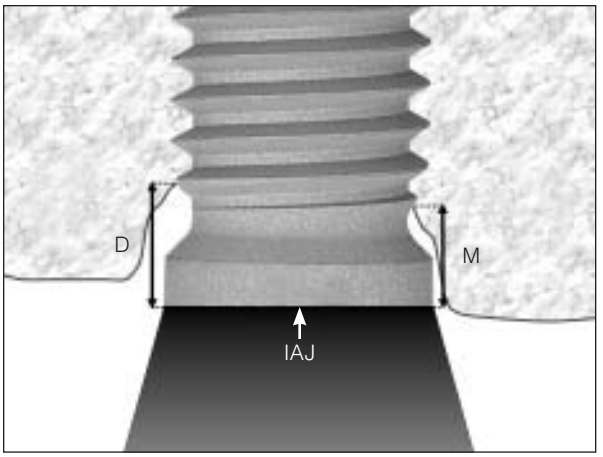

Fig 4 Illustration of how measurements were made in this study. Interproximal crestal bone levels were measured from the implant-abutment junction *(IAJ)* to the most coronal bone-implant levels on mesial *(M)* and distal *(D)* implant surfaces.

provisional prostheses. Hygienic instructions, including the use of periodontal gel (0.5% chlorhexidine), soft bristle toothbrushes (from the day sutures were removed), and flossing techniques with spongy dental floss (after soft tissue healing, around the third week post–implant placement), were given. Patients were also provided with detailed dietary instructions describing which foods they could and could not eat in relation to the time of healing to avoid excessive loads on the implants. Starting from a liquid diet in the first days after implant insertion, patients were gradually instructed to increase their chewing activity until they could resume a normal solid diet once osseointegration was reached (around the eighth week post–implant placement).

In the test group, definitive prostheses were placed after a mean healing period of 4.5 months; definitive prostheses were delivered after 8.75 months in the control group.

In the test group, definitive prostheses were designed and fabricated in a similar fashion as the provisional prostheses, except that cantilever extensions were permitted one tooth distal to the distal implants. All definitive prostheses consisted of cast metal frameworks with the same alloy used in the provisional prostheses; occlusal surfaces were designed completely in composite resin (SR Adoro). All definitive prostheses were screw-retained.

Assessment

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 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. Subjects were seen by a dental hygienist every 4 months for the first year. At each follow-up visit, prostheses were removed and implants and abutments were evaluated individually for tenderness, swelling, and mobility.

Radiographic Examinations

Radiographic examinations were accomplished to assess interproximal bone levels at baseline (provisional prosthesis placement for the test group; implant placement for the control group) and at the 12-, 24-, and 36-month follow-up appointments. To guarantee reproducibility of the radiographs over time, they were made using a long-cone paralleling technique with an individualized film holder (Rinn bite film holder for periapical radiographs, Dentsply) and a customized centric occlusion registration with a polyvinyl siloxane impression material putty (Express STD, 3M ESPE). Fast-speed films (Kodak Ultraspeed, Carestream Health) were used. For reproducibility and accuracy, care was taken that the threads on both sides of the implants were clearly imaged in each radiograph.

The implant-abutment interface was used as the reference point for the bone level measurements (Fig 4). Interproximal bone levels were assessed from these reference points to the most coronal bone levels at the mesial and distal surfaces of each implant. A radiologist otherwise not involved in the study performed the radiographic readings using a diaphanoscope (Tecno-Gaz) and magnifying lens.

Statistical Analysis

The Shapiro-Wilk test was used to evaluate normality of the dependent variables used and the data rank-transformed if normality was rejected. Differences between test and control groups with respect to time-dependent bone loss (mesial and distal) were analyzed with repeated-measures analysis of variance, and contrasts among baseline and successive measures were assessed. Survival analysis was performed by means of a marginal Cox model to evaluate the effect of group on survival, and a survival curve for each group with its 95% confidence interval (CI) was realized. Statistical analysis was completed using SPSS 15.0 software (IBM) with alpha set to .05.

Results

Clinical Outcomes

No patients were lost to recall, and they were all followed for at least 36 months, with the average follow-up period being 40.5 months (range: 36 to 47 months). Ten implants (6.1%) failed in the test group and occurred during the first 3 months after implant placement and occlusal loading. Two patients lost 2 implants each, and 6 patients lost 1 implant each. Six of the 10 implants lost were distal implants. Of the 10 implants that failed in the test group, 6 new implants were placed into the distal areas to increase molar support in the prostheses and were immediately loaded. A new impression at the abutment level was taken. The framework of the prosthesis was cut and welded with a new fused portion made on the abutment corresponding to the replaced implant. The acrylic esthetic material was finally replaced, and placement of the definitive prostheses was delayed.These implants were not considered in the survival calculations or for peri-implant bone level evaluations. The cumulative implant survival rate at the 36-month follow-up visit (after implant placement) was 93.9% (95% CI: 90% to 97.8%) for the test group (Fig 5).

In the control group (n = 97), 4 implants (4.1%) failed during the first 12 months after implant placement. One implant failed before it was uncovered, and 3 implants were lost 2 months postloading, approximately 8 months after implant placement. No patient had more than 1 implant failure, and no additional implants were placed after implant failure. The cumulative survival rate (CSR) at the 36-month follow-up visit (after implant placement) was 95.9% (95% CI: 92% to 99.8%) for the control group (Fig 5).

The difference in CSRs between test and control groups was not statistically significant ($P = .42$). At the 36-month follow-up appointments, no prosthetic failures were found in either group.

Radiographic Outcomes

Normality of bone level at baseline and all other intervals was rejected ($P < .001$), and, thus, data were rank-transformed. Repeated-measures analysis of variance demonstrated statistically significant differences in bone loss between the two groups at the 12-month follow-up and at all other intervals, with greater bone reabsorption in the control group ($P < .001$ for all comparisons). No effect for implant side (mesial vs distal) was found overall ($P = .91$) or among groups ($P = .29$ for interaction).

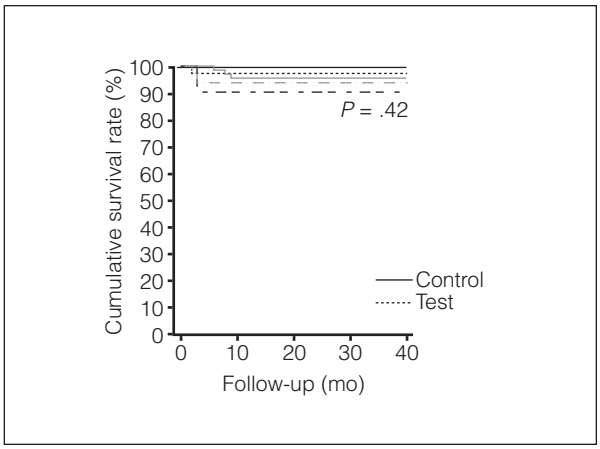

Fig 5 Life table analysis for implants in the test and control groups.

Average bone level at baseline was 0.5 mm from the implant-abutment connection both in the test and control groups. After 12 months, it was 1.3 ± 0.8 mm in the test group and 1.9 ± 0.8 mm in the control group. At the 24-month recall, it was at 1.5 ± 0.9 mm in the test group and 2.2 ± 0.9 mm in the control group. Finally, after 36 months, it was 1.6 ± 0.9 mm in the test group and 2.3 ± 1.1 mm in the control group. Bone loss revealed moderate peri-implant bone resorption during the first 12 months, and a steady-state condition during all other intervals. (Figs 6a and 6b).

Discussion

The observations reported do not support complete rejection of the null hypothesis, since no differences in CSRs were noted ($P = .42$), while the statistical analysis revealed significantly less marginal bone loss in the test group when compared to the control group ($P < .001$).

More implants failed in the test group (CSR: 93.9%) than in the control group (CSR: 95.9%), but this difference was not statistically significant ($P = .42$). These observations are comparable to reports on similar clinical treatments with maxillary implants placed into immediate occlusal function (see Table 1).

Moreover, the apparent context of the observed implant failures seemed to be different for the two groups. For the test group (immediate loading), osseointegration failed to occur earlier in the process, during the 3 first months post–immediate occlusal loading. No implants in the test group were lost after definitive prostheses were placed (18 weeks post–implant placement). In the control group, three patients had implants that failed after fixed prosthesis delivery, and they needed their definitive prostheses modified secondary to implant failures.

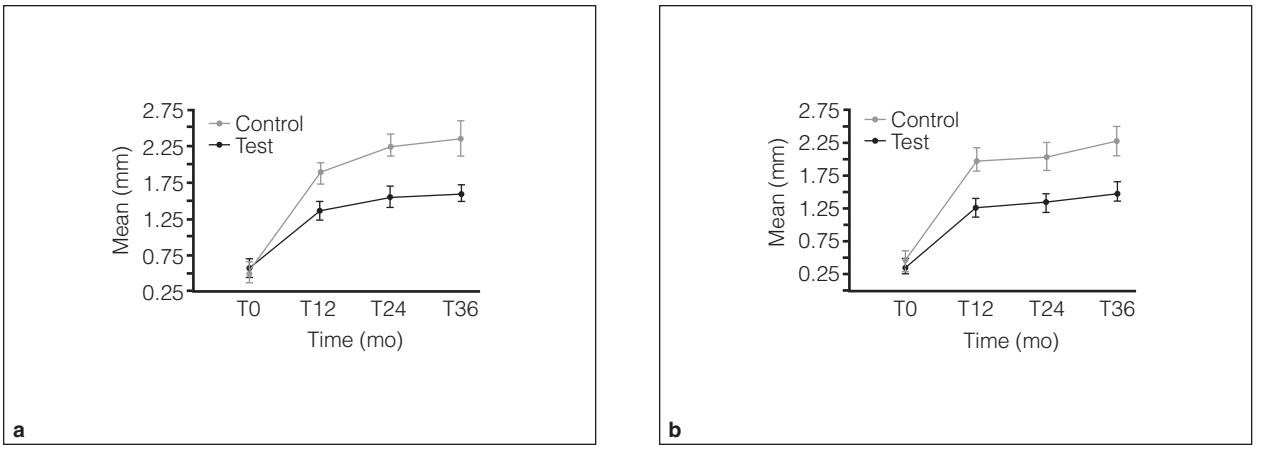

Fig 6 Bone level comparisons between baseline (T0) and 3-year follow-up appointments (T36) for **(a)** mesial and **(b)** distal implant surfaces.

A key component of the CBP is the reduction in the number of implants required to support full, fixed provisional and definitive prostheses relative to traditional loading protocols, and cost savings for patients was not an integral part of the employed protocol in reducing the number of implants. In this study, a mean of 4.8 implants per patient (range: 4 to 6) were placed in the test group, while a greater number of implants were placed in the control group (mean: 6.5, range: 6 to 9).

In the test group, the majority of implant failures were noted in the first few treated patients. Presumably, a learning curve was necessary to optimize the surgical-prosthetic application of CBP used in the test group. Therefore, it is important to acknowledge the absence of external validity for this particular protocol in spite of the fact that at the 36-month follow-up appointment, the CSR for fixed prostheses was 100% for both groups.

Other protocols that have been promoted that also involve immediate loading and a reduced number of implants do not integrate both surgical as well as prosthodontic methods. For example, the major difference between this and other protocols, such as the so-called "all-on-four" (mainly a surgical technique), is the presence of the metal framework in the provisional prosthesis. This may very well prove to be particularly important to improve the stiffness and rigidity of the structure splinting the implants, which may impact the favorable outcome of predictable osseointegration.[14,19]

Moreover, a different diagnostic approach is followed in the CBP, wherein the creation of a customized surgical prosthetic template for implant insertion and conical abutment connection is employed instead of a standard device. A possible additional contributor to the recorded favorable result may also be the impression technique, which requires the use of dental plaster instead of softer elastic materials. This could contribute to an improvement in splinting of impression copings and the precision of data transfer to the laboratory. Furthermore, a resin-luted passivation technique is also used for the metal-reinforced prostheses. The latter integral parts of the protocol deserve additional comprehensive research to validate their likely contribution to the protocol's overall efficacy

It should be noted that none of the patients in the control group presented relatively well-healed postextraction sites, while osteotomies performed in the healed sockets of the control group presented no intrabony defects. In the test group, healed bone was preferred whenever possible, and implant shoulders were always placed at the bone crest level in postextraction sites. Furthermore, a more palatal implant insertion was frequently followed. Whenever a small vestibular bony deficit was observed, it was filled with bone chips taken from the drills. The patients in the test group were selected for treatment with the immediate loading protocol on the basis of both their expectations and demand for immediate, fixed implant prostheses; they sought to avoid the use of a transitional complete denture. On the other hand, the patients in the control group were willing to accept wearing a complete denture for a short time interval, and this cohort was composed of older patients relative to the test group (median age: 59.3 vs 57.1 years). It has now been popularly noted, albeit anecdotally, that immediate full-arch treatment yields instant significant improvement in patient satisfaction and perceptions related to comfort and function. In contrast, patients in the control group did not initially

show particular interest in a management protocol that automatically included treatment time reduction. However, they were concerned when they were instructed to avoid wearing the complete dentures for the first 2 weeks post–implant placement and experienced increased intraoral discomfort during the first month of treatment. Discomfort associated with the second surgical procedure to uncover the implants was less, but some patients required additional analgesics to manage the discomfort. Increased chairtime was noted relative to the two-stage protocol and was regarded as an unfavorable occurrence by some patients.

While recognizing the inherent limits of the radiographic monitoring technique used, a statistically significant difference was nonetheless observed in peri-implant bone resorption at 12 months as well as at all following intervals (higher values in the control group). Mean bone loss around implants at the 12-month follow-up visit (T12–T0) was 0.85 mm in the test group and 1.45 mm in the control group. At the 24-month follow-up visit, the mean bone loss (T24–T12) was 0.10 mm in the test group and 0.25 mm in the control group. Finally, mean bone loss at the 36-month follow-up visit (T36–T24) was 0.10 mm in both the test and control groups. The 36-month bone loss was also comparable with values published by other authors for fixed implant treatment with maxillary full-arch immediate occlusal loading.[6,7] While the proximity of adjacent implants in the control group could have had a bearing on marginal bone loss,[17] a minimum interimplant distance of 3 mm was always maintained, as suggested in the literature.[20]

Bone loss differences between groups were noted in the first 12 months after implant placement. Extraneous lateral loads and stresses on the nonloaded, covered implants could be responsible for increased bone loss in the control group. In the test group, provisional prostheses were fabricated with metal substructures and inserted within 24 hours of implant placement. Metal substructures increase prosthesis rigidity in splinting implants and seem to provide better stress distribution in supporting tissues.[14,19]

All provisional prostheses in this study were fabricated with acrylic resin occlusal surfaces. The authors note that there are conflicting opinions on this topic. Many authors assert that occlusal surfaces of implant prostheses should be fabricated from materials that have a shock absorption capacity, similar to acrylic resin, to reduce the stresses transmitted to the bone-implant interface,[21,22] thereby reducing overload risks to recently placed implants.

It must be emphasized that patients selected for this study were part of a convenience sample and not the result of a power analysis to determine an optimal sample size. Moreover, the test and control groups were unmatched, treated differently, and seen by the same team of experts. All of these concerns recognize the study's absence of external validity and demand that the reported results should be interpreted with caution. The test group patients received four to six implants in fresh extraction or healed edentulous sites, while in the control group, patients received six to nine implants in recently healed edentulous sites. Tapered implants were placed in extraction sites while cylindric implants were placed in healed sites. Other differences between the groups related to the prosthodontic treatment phase. The test group was treated according to the CBP for immediate rehabilitation of edentulous maxillae, while the control group was treated according to the two-stage protocol as proposed by Branemark et al.[9–11] Therefore, it must be conceded that overall differences between the two groups could affect the interpretation and relevance of the results.

Conclusion

A 36-month follow-up of the application of the CBP for immediate rehabilitation of edentulous maxillae led to similar results with the traditional two-stage protocol. Moreover, greater peri-implant bone loss at the 1-, 2-, and 3-year follow-up visits was actually noted in patients treated with the latter delayed loading protocol. The significance of a learning curve to better manage surgical and prosthodontic application and possible complications of this novel approach demands consideration.

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Disclosure

Dr Carl Drago was the director of dental research for Biomet 3i, who produced several implant components used in this study, until 2010.

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Literature Abstract

Allogeneic bone onlay grafts for alveolar ridge augmentation: A systematic review

This systematic review examined the published literature to determine the clinical effectiveness and predictability of allogeneic bone blocks for the correction of alveolar ridge deformities to support dental implant placement in humans. MEDLINE and EMBASE databases were searched from 1950 to September 2008. Data extraction included the following outcomes: *(1)* vertical and/or horizontal bone gain/loss, *(2)* graft complication and failure rates, and *(3)* implant survival rates. Nine publications were identified to have met the inclusion criteria: two case reports, six case series, and one prospective multicenter consecutive case series. High rates of graft incorporation were reported, and overall, the implant survival rate was 99.9% after a minimum of 1 year. However, no randomized controlled trials were available in the literature, and the high success rates seen were based on case reports and case series. Allogeneic bone onlay grafts have the potential to support alveolar ridge augmentation and implant placement but clinical evidence remains limited and its long-term efficacy has yet to be determined.

Waasdorp J, Reynolds MA. *Int J Oral Maxillofac Implants* 2010;25:525–531. **References:** 45. **Reprints:** Dr Mark Reynolds, Department of Periodontics, University of Maryland, Dental School, 650 West Baltimore Street, Baltimore, MD 21201. Email: mreynolds@umaryland.edu—*Clarisse Ng, Singapore*