

Straight Versus Angulated Abutments on Tilted Implants in Immediate Fixed Rehabilitation of the Edentulous Mandible: A 3-Year Retrospective Comparative Study

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Purpose: The aim of this study was to evaluate and compare the use of straight versus angulated abutments on tilted implants in the All-on-Four immediate function protocol. **Materials and Methods:** A total of 85 patients (36 men and 49 women; mean age 56.5 years) with edentulous mandibles were treated according to the All-on-Four concept using computer-guided implant placement. All patients received immediate interim prostheses screwed onto distal tilted implants by means of angulated (control group, $n = 42$) or straight abutments (test group, $n = 43$) and were followed for at least 3 years. Outcome considerations comprised implant and prosthetic survival and success rates, marginal bone level changes, patient satisfaction, and required clinical time. Student t test at a significance level of $P < .05$ was used to correlate the influence of the prosthetic protocol on marginal bone levels around the implants. **Results:** Overall implant survival rate was 98.21% for the control group and 98.83% for the test group. None of the 85 fixed prostheses were lost during the observation period (prosthetic survival rate of 100%). Statistically significant differences ($P = .0068$) in marginal bone loss were found between control and test groups. All patients were functionally and esthetically satisfied with their restorations. Required clinical time averaged 50 minutes for the control group and 30 minutes for the test group. **Conclusion:** The described simplified and shortened surgical-prosthetic protocol that avoids use of angulated abutments may be considered a reliable alternative to the traditional All-on-Four protocol. *Int J Prosthodont* 2016;29:219–226. doi: 10.11607/ijp.4448

Excellent and predictable results have been reported for immediate implant therapy outcomes in edentulous patients, including a reduction in clinical treatment time and functional and esthetic improvement.¹ However, residual ridge reduction in posterior mandibular regions may preclude or interfere with this treatment option and may necessitate complex bone augmentation procedures. An alternative and far less invasive protocol of four strategically placed implants, two axial and two distally tilted, has been proposed to reduce treatment time, avoid complications, and reduce overall cost.² It is argued that tilted implants may improve bone anchorage because longer implants are used. Moreover, prosthesis support is optimized as a result of shorter cantilevers and a divergence between the implants' host bone locations. The current ease of employing guided surgery for a minimally

invasive approach can optimize implant placement as well as measure divergence between implants and can simulate a prosthodontic strategy via virtual abutments. Angulated abutments can also help reduce this divergence to facilitate prosthodontic procedures. Depending on the implant-abutment connection system (eg, trilobe triangle, hexagon, octagon) different positions can be chosen for the angulated abutments. Finding the most suitable position may become laborious and time consuming, especially with tilted implants, when a flapless guided surgery is performed, due to soft tissue covering the implant site. In such situations, the use of straight nonengaging (NE) abutments is faster. In fact, this connection system with rotational features permits immediate placement of the abutment. Furthermore, the prosthetic components required for the screw-retained prosthesis fabrication are reduced as the use of temporary coping for angulated abutment may be avoided.

To the present authors' knowledge, there are no data to evaluate the use of straight NE abutments instead of angulated abutments in the All-on-Four treatment protocol for edentulous mandibles. The aim of this short-term report was to retrospectively evaluate the performance of two immediately loaded implant therapy prosthodontic protocols for edentulous mandibles using two axial and two tilted implants

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Table 1 Distribution of Implants According to Type, Diameter, Length, and Angulation

Implant type/ angulation	Implant diameter (mm)	Implant length (mm)				Total
		10	11.5	13	15	
Nobel Speedy Replace (n = 208)						
Axial (n = 104)	3.5	4	24	30	0	58
	4	2	18	26	0	46
Tilted (n= 104)	3.5	2	4	22	28	56
	4	0	10	23	15	48
Nobel Active (n = 132)						
Axial (n = 66)	3.5	2	17	19	0	38
	4.3	0	12	16	0	28
Tilted (n = 66)	3.5	0	0	18	22	40
	4.3	0	0	6	20	26
Total		10	85	160	85	340

placed with guided surgery. The null hypothesis was that clinical and radiologic outcomes after 3 years of function with the definitive prostheses would be the same, regardless of whether straight or angulated abutments were screwed into distally tilted implants.

Materials and Methods

This retrospective report on a treatment sample of 85 patients (36 men and 49 women) with a mean age of 56.5 years (range: 43 to 78 years) was carried out in the Department of Clinical Sciences and Translational Medicine, Section of Dentistry, University of Rome Tor Vergata, Italy between January 2008 and February 2011. Each patient was treated with an immediately loaded mandibular prosthesis.

Inclusion criteria included edentulous mandibles, mandibles with hopeless teeth, the presence of sufficient residual bone volume to receive four implants measuring at least 3.5 mm in diameter and 10 mm in length, and absence of any oral lesions.

Exclusion criteria were health conditions that did not permit surgical treatment, disorders in the planned implant area such as previous tumors, chronic bone diseases, any interfering medication such as steroid therapy or bisphosphonate therapy, alcohol or drug abuse, heavy smoking (> 20 cigarettes/day), poorly controlled systemic diseases, radiation therapy to head or neck region within the past 5 years, and high parafunctional activity (based on history and clinical examination).³

Panoramic radiographs were used to visualize an overview of the mandibular arch and the general status of remaining teeth.

Study casts with all anatomical landmarks were obtained from well-extended impressions of the arches of the patients and mounted on the articulator. Occlusal vertical dimension, mandibular position, and

occlusal plane were determined. A radiographic acrylic resin template was fabricated. In totally edentulous patients, when possible, the existing acrylic removable complete denture was modified and used as a radiographic template. In partially edentulous patients who wished to keep teeth slated for extraction until the day of the implant surgery and avoid wearing a removable complete denture, a two-piece radiographic template was fabricated.⁴

Patients underwent a CT scan (LightSpeed VCT, GE Healthcare) with a double-scan protocol (ie, a scan of the patient wearing the radiographic template and a second scan of the template alone).⁴ When a two-piece radiographic template was used, the patients underwent CT scan before the extraction of hopeless teeth wearing only the base portion of the template. This part of the template had an open window that went around the hopeless teeth, seated directly in contact with the mucosa without touching teeth and being influenced by them. The base portion and the teeth set-up portion was then assembled together and scanned in a second CT scan.

The planning data were then sent to a manufacturing plant (Nobel Biocare), and a stereolithographic surgical template (NobelClinician, Nobel Biocare) was fabricated. A working cast derived from the surgical template was made and mounted in an articulator to create an interim metal-reinforced acrylic resin complete restoration.

The All-on-Four technique was used, with two dentists (G.S. and A.B.) performing all the surgical and prosthodontic procedures and one dental laboratory preparing all the prostheses. The study was conducted according to the tenets of the Helsinki Declaration and followed STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines (<http://www.strobe-statement.org>).⁵ Written informed consent was obtained from each patient.

Surgical Procedure

A single 2 g dose of prophylactic antibiotic (amoxicillin/clavulanate potassium; Augmentin, GlaxoSmithKline) was administered 1 hour prior to surgery. Local anesthesia was induced by 4% articaine solution with epinephrine 1:100,000 (Ubistein; 3M Italy). For each treatment, four implants (Speedy Replace and NobelActive, Nobel Biocare) were placed using guided flapless surgery (Table 1).

According to the All-on-Four concept, the anterior implants were placed in the canine or lateral incisor area. The posterior implants were placed close to the anterior wall of the mental loop and tilted distally at about 30 to 40 degrees (Fig 1). The posterior implants typically emerged at the second premolar position.



Fig 1 (left) Mandibular edentulous ridge. (right) Computer-guided template-assisted implant placement.



Fig 2 The interim metal-reinforced prostheses fabricated on the basis of the diagnostic wax-up. Four openings, according to the abutment emergence, were created for the prosthetic screw access.



Fig 3 After surgery, four straight nonengaging abutments were screwed to the implants without any modification of the implant axis.

In 42 patients (control group), straight and angulated (17 and 30 degrees, respectively) multiunit abutments (Nobel Biocare) were used to achieve a relative parallelism between implants. In 43 patients (test group), only straight abutments (Temporary Abutment Non-Engaging, Nobel Biocare) were used without modification of implant axes (Table 2).

Immediate Prosthodontic Protocol

Prefabricated metal-reinforced, screw-retained, acrylic resin interim restorations were delivered immediately in all patients. The interim prostheses were fabricated by a technician on the basis of the diagnostic wax-up and presented four large openings according to planned abutment emergence (Fig 2). Multiunit abutments and temporary copings were used for the control group. Four straight temporary nonengaging (NE) abutments were used instead for the test group (Fig 3). The experimental protocol was adopted for those patients whose crown height space (CHS) did not exceed 15 mm. The passive seating and the occlusal relationship of the interim prostheses were checked. The prostheses were then intraorally relined with autopolymerizing polyurethane resin (Voco) (Fig 4a). After polymerization the prostheses were

Table 2 Distribution of Implants According to Prosthetic Solution

Prosthetic solution	Implant insertion		Total
	Axial	Tilted	
Multiunit abutment	84	84	168
Temporary abutment	86	86	172
Total	170	170	340

removed from the implants and retention, marginal precision, and stability were improved by resin addition around the collar of the abutment (Fig 4b).

All centric and eccentric contacts were assessed using 40- μ m articulating paper (Bausch) until light occlusal contacts, uniformly distributed on the entire prosthetic arch, were obtained. Patients were advised to adhere to a soft diet for the first 2 months post-surgery and then to return to a regular diet but avoid harder food items for another 2 months.

Definitive Prosthodontic Protocol

After 4 months in function with the provisional, definitive restorative procedures were started. The surgical template was used as a custom open tray (Fig 5) and a pickup implant level impression (Impression



Fig 4 (a) The interim prostheses was placed and relined with autopolymerizing polyurethane resin. (b) The provisionals were removed from the implants and retention, marginal precision, stability, and esthetics were improved by resin addition.



Fig 5 The surgical template was used as a custom open tray by removing the metallic sleeve, and the definitive implant impression was taken using an impression plaster to avoid any displacement of the transfers during the snap of the impression.



Fig 6 The framework was customized without using angulated abutments according to definitive prosthetic design.

Coping Bridge Open Tray, Nobel Biocare) was taken (SnowWhite Plaster no. 2, Kerr). Interim restorations were screwed onto the master cast to transfer into a fully adjustable articulator the vertical dimension and the occlusal relationship of each patient.

Definitive milled high-precision titanium ($n = 45$) and zirconia ($n = 40$) prosthodontic frameworks (Procera Implant Bridge, Nobel Biocare) were fabricated and screwed into the implants (Fig 6). Zirconia was used as framework material to satisfy the high esthetic demands of the patients. The fit of each cross-arch framework was assessed intraorally according to established criteria, such as strain-free screwing and no open margins at the clinical and radiographic examinations during the Sheffield one-screw test performed chairside.⁶

Acrylic resin (Sinfony Resin, 3M ESPE) or ceramic (Cerabien Zirconia, Kuraray Noritake Dental) were used as veneering materials. Ceramic was used when the opposite arch presented natural dentition. Most final prosthesis frameworks included 12 teeth, with a maximum of a one-unit cantilever (≤ 10 mm) (Fig 7). Centric occlusion was used, with group function for laterotrusive and protrusive excursions.

Follow-up visits were scheduled each week for the first month after surgery, once a month up to the sixth

month, and annually up to 3 years after implant insertion. The mean follow-up period was 42.7 months (range: 36 to 58 months). The primary outcome measures were implant and prosthetic survival and success rates. Implants considered as surviving were those that remained in the jaw and functionally loaded, even if all the individual success criteria were not fulfilled; while a failed implant was one that had been removed. Restoration success was defined as the absence of fractures of the framework or the veneering superstructure, even if one or more implants supporting the restoration had been removed. (Prosthesis success was evaluated using modified evaluation criteria suggested by the California Dental Association).⁷ A surviving prosthesis was defined as a prosthetic reconstruction that was stable and in good function. The secondary outcome with respect to efficacy was the marginal bone level changes. Radiographic evaluations of marginal bone level were made using intraoral radiographs at 1, 2, and 3 years (Fig 8). All radiographs were displayed in an image analysis program (Scion Image v4.0.2; NIH Scion) and evaluated under standardized conditions.

The software was calibrated for every image by considering the length of the implant. Bone levels were recorded mesially and distally in each implant



Fig 7 Definitive cross-arch zirconia framework with veneering ceramic at 3-year follow-up. **(a)** Occlusal view. **(b)** Frontal view.

using the implant-abutment junction as a reference point. The first bone-to-implant contact at surgery was defined as the baseline. The marginal bone loss was calculated as the difference between the reading at the examination and the baseline value. The third outcome, assessed at the 3-year follow-up examination, was patient satisfaction. Patients gave overall satisfaction scores regarding masticatory and phonetic function and esthetics of their definitive implant-supported restorations on a 100-mm visual analog scale (VAS; 0 = maximal disagreement or minimum experienced and 100 = maximal agreement or maximum experienced). Clinical time to place implants and provisional prostheses were assessed.

Statistics

Descriptive analysis was performed using mean and standard deviation. The marginal bone levels and remodeling of the test group (without angulated abutments) were compared to those of the control group (with angulated abutments) with the Student *t* test at a significance level of $P < .05$ (one tailed). Statistical calculations were performed with the statistical software SPSS 14 for Windows (SPSS).

Results

On the day of surgery, 72 patients (84.7%) were edentulous and 13 (15.3%) were partially edentulous. Sixteen patients (19%) were smokers, and 3 patients (3%) exhibited signs of occasional parafunctional activity (based on history and clinical examination). The opposite arches presented implant-supported restorations ($n = 16$), fixed prostheses on teeth ($n = 21$), removable partial dentures ($n = 14$), maxillary full dentures ($n = 6$), or natural dentition ($n = 28$). A total of 340 implants (208 Speedy Replace and 132 NobelActive) were placed. Of these, 27 were placed in fresh extraction sockets and 313 were placed in healed sites. All implants achieved primary stability at placement with a minimum torque of 35 Ncm and were immediately



Fig 8 Panoramic radiograph at 3-year follow-up.

loaded, supporting 85 fixed provisional prostheses. The mean implant length was 12.2 ± 0.9 mm for axial and 13.8 ± 1.26 mm for tilted implants. In the control group, straight ($n = 66$) and 17-degree ($n = 18$) multiunit abutments were used for mesial implants, while 30-degree multiunit abutments ($n = 84$) were used for distal implants. During the first 4 months after implant placement, 5 implants failed (3 control group and 2 test group). One tilted implant each in two control group participants failed due to mobility. Two implants of the same length and larger diameter were then placed and left unloaded until the definitive prostheses were delivered. The final prosthesis was supported by three immediately loaded implants and one replaced implant. Another patient lost one axial implant after 2 months without compromising prosthetic function. The lost implants were replaced 4 months later and loaded at the placement of the final prosthesis. In the test group, two patients each lost one implant (one axial and one tilted) after 3 months, but the interim prosthesis survived on the remaining three implants. The lost implants were replaced with implants of the same length and larger diameter and left unloaded until the definitive prostheses were completed and inserted. No additional implant failures

Table 3 Lifetime Analysis of Survival of Implants Supporting Immediate Restorations with Multiunit Abutments (Control Group)

Time from loading	Functioning	Failed	Lost to follow-up	Survival rate (%)	CSR (%)
4 mo	168	3	0	98.21	98.21
4–12 mo	168	0	0	100	98.21
12–24 mo	168	0	0	100	98.21
24–36 mo	168	0	0	100	98.21

Table 5 Bone Marginal Loss Relative to Implant Platform for Axial and Tilted Implants According to Prosthetic Solution

	Time from loading		
	12 mo (mm)	24 mo (mm)	36 mo (mm)
Axial multiunit abutment (n = 84)	0.92 ± 0.37	0.95 ± 0.37	1.00 ± 0.37
Axial temporary abutment (n = 86)	0.96 ± 0.39	0.98 ± 0.39	1.02 ± 0.40
Tilted multiunit abutment (n = 84)	1.06 ± 0.34	1.13 ± 0.34	1.19 ± 0.33
Tilted temporary abutment (n = 86)	0.96 ± 0.39	1.03 ± 0.39	1.09 ± 0.39

were experienced during the study period, for a cumulative implant survival rate of 98.21% and 98.83% for the control and test groups, respectively, and a cumulative prosthesis survival rate of 100% at 3 years (Tables 3 and 4). No dropouts occurred.

Two patients in the test group (4.7%) experienced fractures in their acrylic resin interim prostheses during the healing period. No fractures of temporary abutments occurred. The prostheses were repaired and instructions were given to the patients to minimize the overloading of their prostheses. Four patients in the control group (9.5%) and three patients in the test group (7%) presented with fracture of a tooth of the provisional. The prosthesis was repaired without removing it from the oral cavity. No signs of excessive occlusal wear were noted at the 3-year evaluation in any of the patients. No other mechanical complications (eg, abutment screw loosening and/or fracture, titanium or zirconia framework fracture) occurred during the entire follow-up period. Chipping of the veneer material occurred in four definitive prostheses (control group n = 2, test group n = 2), but replacement of the prosthesis itself was not necessary. Thus, the cumulative prosthetic survival rate was 100% (control group success rate 95.23%, test group success rate 95.34%).

The VAS results revealed that all participants were functionally and esthetically satisfied with their prostheses. The average VAS score was 99.5 ± 2.2 (range: 95 to 100) for masticatory function, 99.3 ± 2.5 (range: 95 to 100) for phonetic function, and 98.8 ± 2.7 (range:

Table 4 Lifetime Analysis of Survival of Implants Supporting Immediate Restorations with Temporary Abutments (Test Group)

Time from loading	Functioning	Failed	Lost to follow-up	Survival rate (%)	CSR (%)
4 mo	172	2	0	98.83	98.83
4–12 mo	172	0	0	100	98.83
12–24 mo	172	0	0	100	98.83
24–36 mo	172	0	0	100	98.83

90 to 100) for esthetics. No difference in VAS score was recorded between the test and the control group.

The average surgical time ranged from 15 to 25 minutes. Adjustment time to seat the acrylic resin interim restoration averaged 50 and 30 minutes for control and test group, respectively.

Radiographic results

In the control group (n = 168) at the 36-month evaluation, marginal bone loss averaged 1.00 ± 0.37 mm for axial (n = 84) and 1.19 ± 0.33 mm for tilted implants (n = 84). In the experimental group (n = 172) a mean marginal bone loss of 1.02 ± 0.40 mm for axial implants (n = 86) and 1.09 ± 0.39 mm for tilted implants (n = 86) was found (Table 5).

Statistically significant differences ($P = .0068$) in crestal bone loss were found between control and experimental groups, and in both groups between tilted and axial implants ($P = .0000$) at 12, 24, and 36 months.

Discussion

The 3-year clinical and radiologic results of this investigation have shown that both the traditional and tested protocols have favorable prognoses. However, in addition to abutment type, several variables present in this study (ie, edentulous vs dentate patients, type of implant, framework material, veneering material, type of antagonist) might have affected the results.

Five patients lost one implant each, and all prostheses survived on the remaining three implants until the replacement implants were loaded. The cumulative implant survival rates for the control (98.21%) and the test group (98.83%) were comparable to results obtained with other reported immediate/early loading protocols for the same indication.^{8–11}

Other studies found similar bone resorption patterns on the mesial and distal surfaces for tilted implants in both groups.^{8,9}

Chipping of the veneering material occurred in four definitive prostheses but did not require replacement of the prosthesis itself, for a prosthetic survival rate of

100%. A possible explanation for such fractures could be occasional parafunctional habits or poor occlusal equilibration.

The advantages of a full-arch fixed prosthesis supported by two anterior axial and two distal tilted implants are well known: longer implants may be placed, bone grafting may be avoided, implant-to-bone contact area and primary implant stability may be increased, tilting the implant relative to the foramina reduces or eliminates the need for a prosthetic cantilever, resulting in better load distribution.¹² However, the prosthesis chairside adaptation may be difficult due to different fixture orientation. The traditional protocol introduced by Malo et al² provides the use of angulated abutments, which correct the divergence of the tilted implants. Nevertheless, a perfect parallelism between axial and tilted implant platforms is never achieved. The angulated abutment placement is very easy when an open flap surgery is performed according to the original technique. When a flapless guided surgery is performed, soft tissue covering implant sites may not allow for a fast engagement in the correct position of the angulated abutments, due to lack of visibility. The prosthodontist is compelled to make several attempts to find the most suitable position, causing repeated trauma to the soft tissues and stress for the patient and extending operating times.

In the tested protocol, the multiunit abutments are replaced by straight abutments featuring a NE platform (ie, without prosthodontic axis correction of the tilted implants). The use of four straight NE abutments in this protocol has several advantages. The connection system with rotational features permits an immediate insertion of the abutment, since every abutment position does not affect the prosthodontic requirements. The shallow NE internal connection allows a maximum draw angle of 40 degrees between splinted implants. This means that anterior axial and posterior tilted implants with up to 40 degrees of divergence can be splinted to each other with no implant-abutment angle modification while ensuring a passive fit of the restoration. No frictional stress between implant platforms and abutments was generated during seating and screwing.

Several investigations have evaluated the effect of implant angulation, connection type, impression technique, and impression material on the dimensional accuracy of implant impressions.^{13,14} Sorrentino and colleagues reported that addition silicones produced accurate casts in the presence of angulated implants with internal connection because the lower modulus of elasticity reduces strains in impressions during removal and thus reduces potential distortion.¹⁴ The present investigation also differs from previous studies in that it used implants with internal connection,

whereas the original All-on-Four protocol used implants featuring external antirotational connection. The shallow connection of the NE impression copings enabled use of a rigid and precise impression material (impression plaster) which led to accurate casts and passive fit between implants and frameworks, although in the presence of physical undercuts.

Another important observation is that angulated and straight NE abutments are tightened to the implant by the same connection screws. Temporary copings are screwed onto the angulated abutment by means of a screw with a reduced dimension. Since these different screws are made of the same material (titanium), the difference in size affects the mechanical properties (strength). The smaller screw can therefore withstand a lower tightening torque value (15 Ncm) than the bigger one (35 Ncm). This means that the whole connection torque value of the prosthesis on the implants is different in the two protocols. The lower the tightening torque, the greater the risk of screw loosening and potential fracture. The difference in size also affects handling and ease of engagement. As reported by Khraisat in a finite element study, stress on the implant collar and thus on the marginal bone is always generated by the abutment screw preload, even without the application of external load.¹⁵ It might be speculated that the stress state in the traditional protocol is higher than in the experimental one, since each implant is subjected to two screw preloads (angulated abutment + temporary coping). Further studies are needed to validate this hypothesis since no data are available in the current literature.

Special attention should be given to another important difference between the protocols evaluated. Multiunit abutments are also used to elevate the restoration platform when the restoration-to-implant level is neither practical nor indicated due to implant depth. In this study using the traditional protocol, multiunit abutments with minimum heights of 2 and 3.5 mm (17 and 30 degrees, respectively) were used and supragingival abutment exposure occurred due to temporary coping collar height. In the experimental protocol, the prosthetic platforms were deeper and allowed for better management of the available gingiva. A straight emergence from soft tissue was planned when the CHS was ≤ 15 mm, thanks to the esthetically favorable positioning of the transmucosal abutment. This solution allowed achievement of a natural appearance by avoiding empty spaces between the soft tissue and the prosthesis. A drawback of this protocol could be the increase in radiation for the patient, as all try-ins need radiographic verification as opposed to the visual verification that can be used once multiunit abutments are in place.

In the tested protocol, the chair time has been reduced by 20 minutes on average. According to previous studies, guided surgery and prosthetic placement were both performed in approximately 60 minutes. In other studies, the average time to complete the procedure (including guided surgery and placement of the provisional prosthesis) was between 75 and 195 min.^{16,17} In this study, the fast insertion of the NE abutments and the intraoral relining of the provisional restoration derived from a diagnostic wax-up could have led to shorter times.

The alternative protocol as evaluated in the study may combine, in a repeatable manner, the benefits of guided surgery and immediate loading for both the patient and the surgical-prosthetic team. The much more invasive nature of the traditional protocol is avoided while implant placement is optimized according to anatomical and prosthetic needs. A working cast derived from the surgical template allows the technician to create a prefabricated prosthesis according to the diagnostic wax-up before the day of surgery. The final implant planned position does not affect the abutment choice. Indeed, the NE abutment platform is not affected by implant inclination or the rotation degree of the implant internal connection, allowing for simpler and faster placement compared with multiunit abutments. Screwing an additional prosthodontic part (ie, temporary coping) onto the multiunit abutment is no longer required. Moreover, the total number of connection screws, the weakest points of the restoration, is reduced by half. Unlike the traditional protocol, no postoperative pick-up impression taking is required. This procedure allowed the clinician to avoid intermediate laboratory steps that may introduce errors and increase chair time for the adaptation of the prosthesis. The adjustment of the prefabricated prosthesis may be performed in a few minutes, and the resulting occlusal relationship will keep the prosthesis in the right position during the intraoral relining. All these variations result in a less invasive and less time-consuming treatment for the immediate rehabilitation of edentulous mandibles with two axial and two tilted implants.

Conclusions

The proposed prosthetic protocol should be considered a reliable alternative to the traditional All-on-Four protocol when a divergence between axial and tilted implants is as great as 40 degrees. The implant and prosthetic rehabilitation can be simplified and shortened for the patient and the clinical team by avoiding the use of the angulated abutments. More long-term prospective clinical trials are needed to confirm the effectiveness of the prosthodontic protocol used in this study.

Acknowledgments

The authors reported no conflicts of interest related to this study.

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