Provisional Implants for Immediate Restoration of Partially Edentulous Jaws: A Clinical Study

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Purpose: *The aim of this study was to evaluate the use of provisional implants, which can provide patients with provisional fixed partial dentures during the healing time of augmentation procedures and/or during the osseointegration period of definitive implants until delivery of the definitive prosthesis.* ***Materials and Methods:*** *Thirty-one patients were consecutively included in the study. Eighteen patients (group A, primary simultaneous group) were initially treated simultaneously with provisional and definitive implants and provided with 18 interim fixed partial dentures. Thirteen patients (group B) received provisional implants in a staggered procedure. In the first stage of group B patients (augmentation phase), provisional implants were placed to bridge the augmentation phase and for anchoring 13 interim fixed partial dentures. In the second stage (secondary simultaneous group), patients of group B received provisional implants to bridge the osseointegration phase for simultaneously placed definitive implants by further use of 13 interim fixed partial dentures. All patients were followed from provisional implant and definitive implant placement to delivery of the definitive prosthesis. Loss of provisional implants and interim fixed partial dentures was noted, and stability of provisional implants was evaluated using the Periotest device. The procedures of immediate rehabilitation with fixed partial dentures using provisional implants were subjectively rated by patients with regard to satisfaction, treatment period, and acceptance.* ***Results:*** *In 31 patients, 44 provisional fixed partial dentures were supported by 98 provisional implants. No provisional implant loss in group A or group B-second stage was observed. Only 3 (3%) provisional implants were lost in group B-first stage during the augmentation phase. Incidence (90.8% versus 9.2%) and stability (Periotest values: 8.6 ± 3.9 versus 4.8 ± 2.7) of provisional implants differed significantly between maxilla and mandible (*$P < .01$*). All interim fixed partial dentures (*$n = 44$*) remained in place for the intended time period but in 3 cases with provisional implant loss they were shortened. No definitive implant loss (*$n = 94$*, survival: 100%) and especially no implant loss in cases of maxillary sinus augmentation was seen. The items rated showed high satisfaction and good acceptance of the intensive surgical and prosthodontic program.* ***Conclusion:*** *This clinical review showed that* (1) *provisional implants can successfully provide patients with a fixed partial denture for immediate rehabilitation to bridge the osseointegration or augmentation phase, even in cases with an initially compromised bone situation and* (2) *although treatment is elaborate, the selected patients decided on a fixed interim rehabilitation with provisional implants rather than on a removable solution.* Int J Oral Maxillofac Implants 2008;23:717–725

Key words: *immediate rehabilitation, partially edentulous jaw, provisional implants*

Immediate restoration by immediate loading of dental implants has been a topic in the discussion of modern treatment concepts in the rehabilitation of totally and partially edentulous patients.[1–3] Immediate loading of dental implants has been of interest for clinicians; it has been a means for decreasing treatment time and the extent of surgical procedures and also as a solution for temporization.[1–4]

In literature, the number of published reports on the immediate loading of dental implants is rapidly increasing, and the majority of such articles have been published in recent years.[1–6] In several meta-analyses, edentulous mandibular and maxillary anterior regions have been well documented and are considered to be potentially acceptable for immediate implant load-

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ing.[1,5,7–10] Preservation of soft and/or hard tissue in conjunction with the immediate prosthodontic rehabilitation are major advantages of immediate implant placement and loading.[1,5,11–13] However, reduced bone quality/ quantity, the need for hard and/or soft tissue augmentation procedures, and the necessary amount of implant insertion torque in posterior maxillary and mandibular regions often constitute limiting factors for immediate implant placement followed by immediate rehabilitation.[1,2,5,12,14–18]

In general, fewer articles can be found reporting on immediate implant rehabilitation of the edentulous maxilla and, in particular, of partially edentulous arches in maxilla and mandible. However, with the use of immediate rehabilitation in partially edentulous regions, it can be particularly difficult to provide the comfort and fulfill the esthetic results the patients concerned are requesting. Patients deciding for dental implant treatment also request an adequate interim treatment program, even in cases with compromised bone situation.[19,20] For psychological and social reasons, removable partial dentures are not accepted by patients, and immediate restoration is strictly demanded.[19–21]

Therefore, the topic of immediate rehabilitation in partially edentulous regions is increasingly discussed and has led to a renewed interest in provisional implants and their use, especially for situations associated with particular risks.[19–23] Because the use of temporary implants is short-term, the techniques and their successful use have been predominately described in case series or case reports.[20,21] Although several clinical studies have described the successful use of provisional implants for stabilization of removable interim prostheses and for fixation of complete interim dentures in edentulous jaws,[19–23] there is a lack of detailed information on immediate rehabilitation with the use of temporary implants with fixed restorations with particular focus on partially edentulous patients. Provisional implants supporting a fixed partial denture for immediate rehabilitation may either be used to bridge the healing phase after augmentation procedures or to bridge the ossointegration phase of the definitive implants.[19,20] This technique can even be used in compromised maxillary and mandibular regions; the clinical use of provisional implants offers a wide spectrum of immediate rehabilitation possibilities.

The purpose of the present clinical study was to evaluate the use of provisional implants for providing patients with provisional fixed partial dentures during the healing phase of augmentation procedures as well as during the healing phase of permanent implants in both jaws.

MATERIALS AND METHODS

The present study enrolled 31 patients (18 female/13 male, mean age: 47.3 years; SD 8.2 years) with partially edentulous maxillae (n = 27) or mandibles (n = 4) undergoing insertion of permanent implants (Camlog; Alltec, Wurmberg, Germany) for anchoring an implant-supported fixed partial denture (FPD). The need for augmentation procedures (maxillary sinus lift/alveolar ridge augmentation) as well as reduced insertion torque were exclusion criteria for immediate rehabilitation by definitive implants.

To enhance temporary comfort for the patient with partially edentulous jaws, provisional implants (provisional implants; IPI; Nobel Biocare, Göteborg, Sweden) were placed for the temporary anchorage of an immediate interim FPD. The preoperative radiographic diagnosis (orthopantomography, periapical radiography, computerized tomography) and the prosthodontic records as well as the characteristics of the definitive implants planned (length, diameter) influenced the approaches for definitive and provisional implant placement. According to these criteria, the population included (n = 31) was subdivided into 2 groups: the initial simultaneous group (group A) or in a staggered (group B) treatment program of PIs and definitive implant placement.

Group A (initial simultaneous group) consisted of 18 patients for whom definitive implants and provisional implants could be placed simultaneously. The prerequisite for simultaneous implant placement was the presence of adequate anchoring possibilities for the definitive implants (ie, residual ridge height > 5 mm). Placed provisional implants were used to provide interim FPDs for immediate rehabilitation of the partially edentulous space during the consolidation of augmentation procedures and/or osseointegration of the definitive implants.

Group B (staggered procedure) consisted of 13 patients for whom provisional and definitive implants were placed and used in a staggered approach. In stage 1, the augmentation phase, provisional implants were placed in situations in which definitive implants and provisional implants could not be simultaneously inserted (ie, higher amount of maxillary sinus augmentation procedures with residual ridge height < 5 mm or postextraction sites). The initially inserted provisional implants were used for immediate rehabilitation with provisional FPDs, allowing for an undisturbed healing process of the augmentation procedures. In stage 2, (osseointegration phase, secondary simultaneous), provisional implants were newly inserted and simultaneously used with definitive implant placement. The secondary simultaneously inserted provisional implants were used for new

Table 1 Distribution of Provisional Implant Locations

	Group A		Group B		Total	
	n	%	n	%	n	%
Maxillary anterior	4	4.1	4	4.1	8	8.2
Maxillary posterior	32	32.6	49	50	81	82.6
Mandibular anterior	1	1	2	2	3	3
Mandibular posterior	1	1	5	5.1	6	6.1

immediate prosthodontic rehabilitation (with another new/modified provisional FPD) so that each patient of group B received interim FPDs twice.

All provisional FPDs consisted of a metal-reinforced framework with resin veneering, and all were cemented (temporary cement; Temp Bond, Kerr, MI) on provisional implants (and on residual tooth abutments, if present). The provisional implants and provisional FPDs were followed clinically and radiographically at intervals of 8 to 10 weeks and were to be maintained until definitive restoration after 3 to 9 months. Clinical instability and/or radiographically discernible instability determined the failure of the provisional implants. The stability of all provisional implants was assessed at the end of the intended time of use, ie, prior to their removal using the Periotest (Medizintechnik Gulden, Bensheim, Germany).[24] Periotest values (PTVs) for provisional implants were obtained at the site closest to the bone implant border; PTVs definitive implants were assessed at the healing abutments closest to the implant edge. Failure rate and stability (PTV) of remaining provisional implants were compared between placement in maxilla and mandible and between groups A and B (and between subgroups of B: stage 1 versus stage 2 of group B).

The procedures of provisional implant placement as well as the prosthodontic use of provisional implants for immediate rehabilitation were assessed by a subjective rating by the patients using 3 questions.[25] *(1)* Satisfaction with the immediate rehabilitation was given a score of 1 (not satisfied), 2 (poor), 3 (acceptable), 4 (good), or 5 (very satisfied). *(2)* The duration of implant prosthodontic procedure was rated as 1 (too long), 3 (long), or 5 (acceptable). *(3)* In addition, patients were asked if they would undergo the same procedure once again or would prefer removable provisional dentures (answer: yes or no). Results for these items were compared for groups A and B.

Definitive implants in both groups were uncovered 3 to 6 months after their initial placement to allow proper abutment connection according to the original protocol and were examined for osseointegration after uncovering.

The data were tabulated and described. Categorical variables for nonparametric data were compared using the χ^2 test; continuous variables were tested with the Wilcoxon rank sum test. $P < .05$ was taken as the statistical significance level.

RESULTS

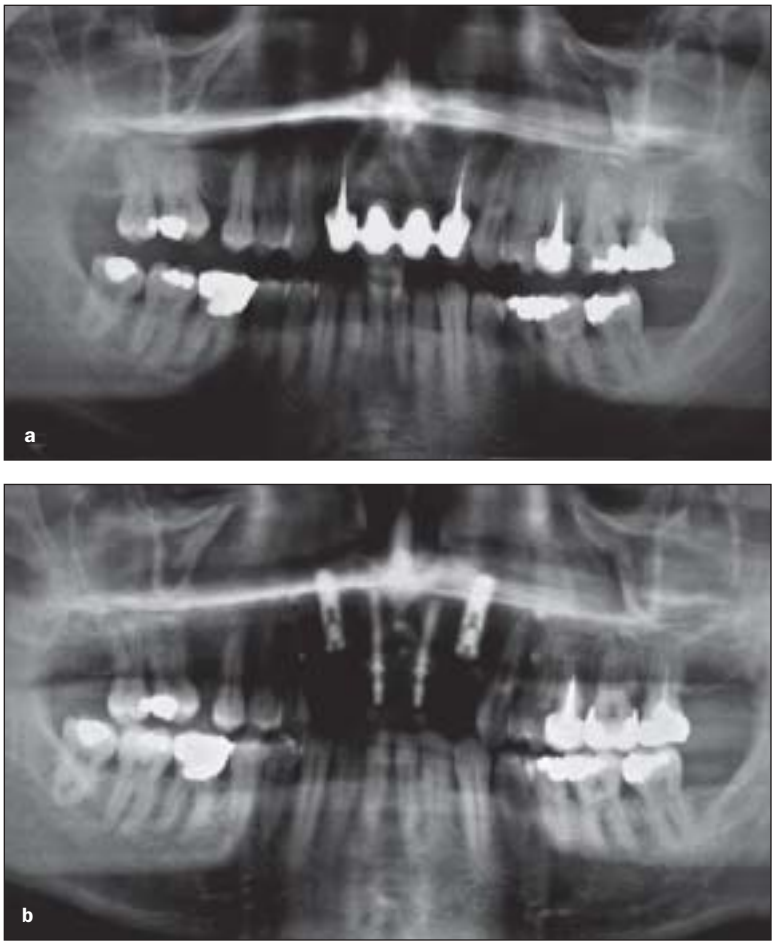
In total, 31 patients were given 44 provisional FPDs (18 in group A, 26 group B) as temporary solution for immediate rehabilitation until placement of the definitive prosthesis. The 44 provisional FPDs for immediate restorations were supported by 98 provisional implants and 17 natural abutment teeth (2.6 abutments/provisional FPD). Table 1 shows the distribution of provisional implant locations placed in groups A and B. The majority (82.6%) of the provisional implants (81/98) were placed in maxillary posterior regions in conjunction with maxillary sinus augmentation for 23 patients either in a simultaneous (32 provisional implants/13 patients) or staggered (49 provisional implants/10 patients) treatment procedure. Comparing the prevalence of provisional implants for the maxilla and mandible, significantly more ($P < .01$) provisional implants were placed in the maxilla than in the mandible—89/98 (90.8%) versus 9/98 (9.2%); Table 1). In the maxilla, the provisional implants were to be maintained for a period of 6.9 ± 1.4 months (6 to 9 months) and in the mandible for 3 months.

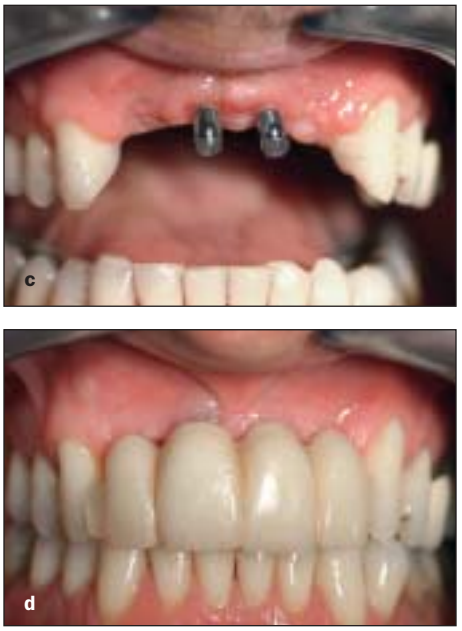
Table 2 shows the detailed data for the patients of group A, which comprised 18 patients (10 female/8 male; mean age: 47.1 ± 10.2 years). In group A, 38 provisional implants were simultaneously placed with 54 definitive implants for anchorage of 18 provisional FPDs (16 maxillary, 2 mandibular). Seven of the 18 provisional FPDs were additionally connected to residual natural teeth (Table 2). Thirteen of 18 patients (72%) underwent 1-stage maxillary sinus augmentation for insertion of 44 definitive implants. Figs 1a to 1d show immediate rehabilitation in the anterior maxilla by interim FPD on 2 provisional implants.

Table 2 Group A: Initially Simultaneous Placement of PIs, DIs, and Interim FPD

Patient	Provisional implant	Total abutments	Definitive implants
Anterior mandible			
GH	1	2	2
Posterior mandible			
SH	1	2	2
Anterior maxilla			
SM	1	2	2
MW	1	2	2
WD	2	2	2
Posterior maxilla			
SA	3	3	4
SA	3	3	4
WG	2	2	4
WG	2	2	4
WN	3	3	4
WN	3	3	4
SF	2	3	3
MH	2	2	4
KR	3	3	3
KG	3	3	3
BG	2	2	2
DM	2	3	2
DM	2	3	3
Mean ± SD	2.1 ± 0.8	2.5 ± 0.5	3.0 ± 0.9

Table 3 shows the individual patient characteristics of group B patients (staggered procedure), which comprised an overall 13 patients (8 female/5 male, mean age: 51.3 ± 7.8 years). The 60 provisional implants placed in a staggered approach could be subdivided as follows: *(1)* stage-1 (augmentation phase)—31 provisional implants were placed and initially used to support a provisional FPD (n = 13) and *(2)* stage-2 (osseointegration phase, secondary simultaneously)—29 PIs were newly inserted simultaneously with 40 definitive implants (32 in maxillary sinus augmentation). The secondary provisional implants (n = 29) inserted simultaneously were used for immediate prosthodontic rehabilitation again as well as for protecting the definitive implants during the osseointegration phase with another 13 new/modified provisional FPDs. Thus, 13 patients of group B received 26 provisional FPDs for immediate restoration of 60 provisional implants. For 5 patients (10 interim FPDs), natural tooth abutments were additionally included in the stabilization (Table 3). Figs 2a and 2b and 3a and 3b show radiographically the treatment procedure of the staggered approach





Figs 1a to 1d Simultaneously placed definitive and provisional implants in anterior maxilla for immediate temporary rehabilitation using provisional implants (group A).

in patients of group B in the maxillary (Figs 2a and 2b) and mandibular regions (Figs 3a and 3b).

The mean numbers of provisional implants and total abutments (provisional implants + natural teeth) for anchoring interim FPD did not differ between the groups using simultaneous groups A and B. Provisional implants placed in the maxilla differed in their stability according to the residual maxillary bone. Provisional implants placed in group B stage-1 (augmentation phase) had a significantly ($P < .05$) reduced stability (PTV mean: 8.9; SD: 2.1) than provisional implants placed in group A (PTV mean: 6.9; SD: 1.2) or in the postaugmentation group (stage-2) of group B (PTV mean: 7.5, SD: 0.8). Overall findings revealed that terminal stability (Periotest) of the provisional implants showed a higher stability in the mandible (4.8; SD: 2.7) than in the maxilla (8.6; SD: 3.9; $P < .01$).

Only 3 provisional implants (3%) failed during the observation period and had to be removed before the intended healing time. All provisional implants lost were located in posterior maxilla and had reduced initial bone quantity/quality in the maxillary

Table 3 Group B: Staged Procedures for Provisional Implants and Definitive Implants: Placement and Interim FPD Support

Patient	PI-1 stage	AB-1 stage	PI-2 stage	AB-2 stage	DI
Anterior mandible					
GS	1	2	1	2	2
Posterior mandible					
MJ	3	3	2	2	4
Anterior maxilla					
HK	2	3	2	3	2
Posterior maxilla					
ZF	1	2	1	2	3
SG	3	3	3	3	3
GH	3	3	3	3	4
HM	3	3	2	2	2
FJ	3	3	3	3	4
AR	2	2	2	2	2
JG	2	3	2	3	5
ZH	2	3	2	3	3
WO	3	3	3	3	3
CK	3	3	3	3	3
Mean ± SD	2.4 ± 0.8	2.8 ± 0.4	2.2 ± 0.7	2.6 ± 0.5	3.1 ± 0.9

PI = provisional implants; AB-1 (2) stage = abutments in the first (second) stage, DI = definitive implants.

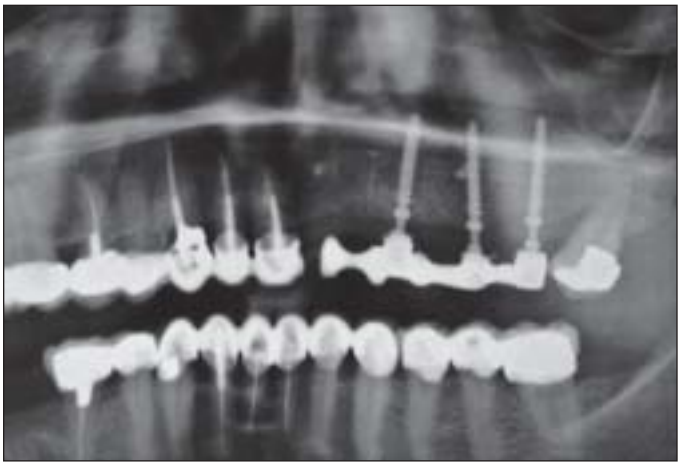


Fig 2a 1-stage procedure; provisional implants and interim FPD bridging the maxillary augmentation phase.

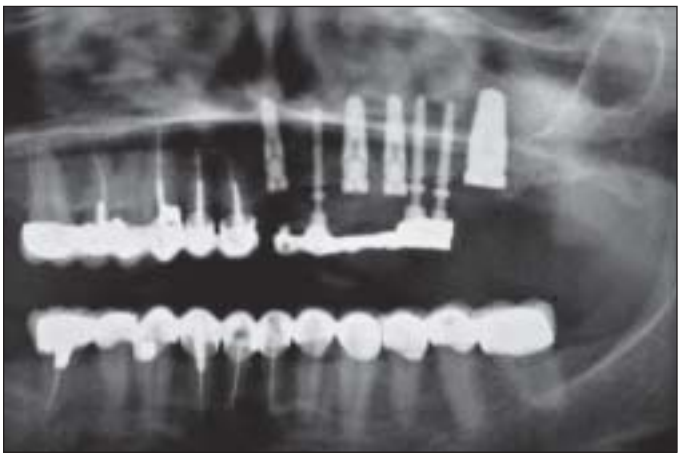
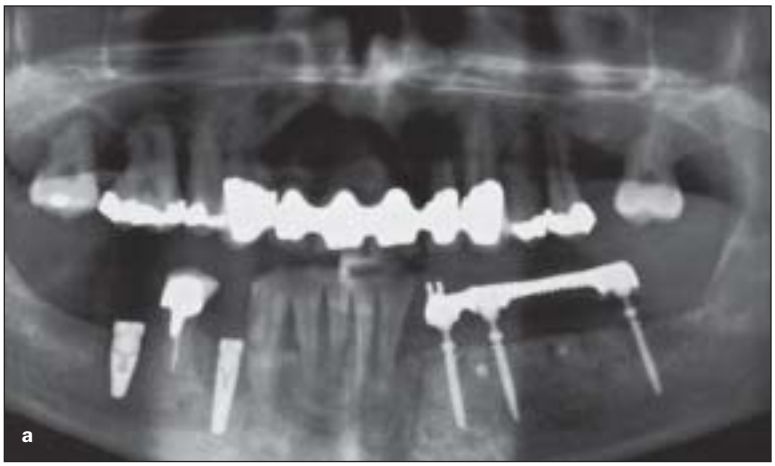
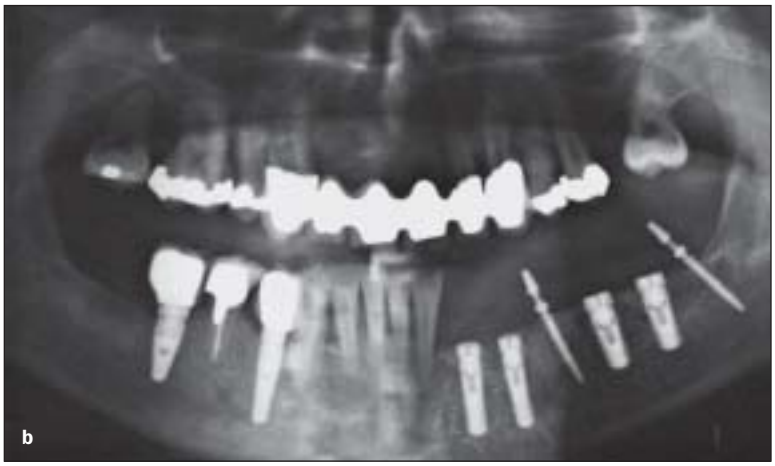


Fig 2b 2-stage procedure; secondary simultaneously placed provisional implants and definitive implants bridging the osseointergation phase.





Figs 3a and 3b Radiographic presentation of staged treatment procedure in posterior mandibular region for immediate temporary rehabilitation using provisional implants (group B). The first-stage procedure *(a)* and the second-stage procedure *(b)* are shown.

Table 4 Implant Characteristics of the Definitive Implants Placed

	Diameter									
	3.3 mm		3.8 mm		4.3 mm		5.0 mm		6.0 mm	
Length	n	%	n	%	n	%	n	%	n	%
13 mm	0	0	0	0	0		3	3.2	0	0
16 mm	2	2.1	42	44.6	27	28.7	17	18.1	3	3.2
Total	2	2.1	42	44.6	27	28.7	30	21.3	3	3.3

augmentation phase (group B stage-1). There were no lost provisional implants in the mandible or in the initial simultaneous (group A) or secondary simultaneous group (second stage of group B; osseointegration phase). In cases where provisional implants were lost and removed, the FPD was modified (shortened) for further support by the remaining provisional implants.

Distribution and position of the definitive implants (n = 94) used for definitive implant–supported FPDs (n = 31) are presented in Table 4. All definitive implants placed (n = 94; 84 maxillary, 10 mandibular) showed successful osseointegration with uneventful healing process and without any disturbance by the adjacent provisional implants. Implants placed with maxillary sinus augmentation (n = 76) showed successful osseointegration for both groups (group A: n = 44, group B: n = 32), The mean PTVs obtained for the definitive implants (maxilla: –3.1; SD: –2.7; mandible: –4.5; SD: –2.3) were lower than those seen for the provisional implants in either the mandible or maxilla.

All patients were highly satisfied (score: 4.7; SD: 0.4) and expressed preference for having the same

procedure once again (31 yes answers). The mean score for overall duration of the prosthodontic procedures was 4.0 (SD: 1.3). Considering both groups (A versus B), 3 of 13 patients in the staggered group (23%) complained about the long time period (score of 1) until placement of the definitive prosthesis.

DISCUSSION

Immediate loading and prosthodontic rehabilitation of single-tooth implants placed in the maxillary anterior region and of interforaminal implants for edentulous mandibles have been associated with high implant and prosthesis survival and success rates.[1–5] In the clinical setting, however, immediate rehabilitation as requested by patients is more frequently required for partially edentulous regions than for mandibular edentulism and even for single-tooth gaps.[1–5,11–13,25] When implant prosthodontic rehabilitation is to be performed in partially edentulous regions, patient requests for an optimal interim rehabilitation must be taken into account.[10–13,25,26]

To fulfill patients' wishes for immediate rehabilitation even in compromised regions, clinicians have turned to the use of provisional implants for anchorage of the interim FPD.[19–23] The renewed interest in provisional implants for immediate restoration/rehabilitation offers clinicians and patients an implant prosthodontic tool for immediate rehabilitation and provides several benefits for the patients.[19,20] The present study demonstrated that provisional implants can be successfully used to provide for appropriate patient comfort with a provisional FPD during the healing time of augmentation procedures or during the osseointegration phase of definitive implants. In contrast to previous reports, which predominately described full-arch rehabilitations supported with provisional implants, the current findings concur with previous findings of a highly successful use of provisional implants in conjunction with a high satisfaction rate expressed by the patients, especially for partial denture rehabilitation.[20,21]

Apart from the beneficial effects of subjective comfort of rehabilitation with interim FPDs, provisional implants offer additional advantages for the osseointegration period of definitive implants.[19–21] The use of provisional implants avoids the undesirable effects of removable partial dentures in disturbing the healing process of bone augmentation or the healing phase of definitive implants by remodeling soft and/or hard tissue.[27–29] The bridging effect of the fixed interim dentures stabilized by provisional implants prevents alterations of the underlying mucosa and protects the definitive implants and thus appears to be beneficial for an optimal outcome.[28–31] For the present study, no loss of definitive implants was noted, and it may thus be assumed that avoidance of loading of the mucosa by fixed dentures may be beneficial for the outcome of definitive implants, which is in contrast to removable dentures with their obvious disturbance potential.[27]

The stability of provisional implants as measured with the Periotest device showed acceptable stability levels, though these were lower than those found for the definitive implants.[24,32] The differences of the PTVs for the maxilla and mandible obtained for provisional implants and among provisional implants placed in different amounts of residual bone ridges may be predominantly influenced by the implant and bone stiffness. Because the provisional implants are only intended for temporary use, the reduced stability of provisional implants is beneficial for their later removal when the definitive prosthesis is delivered.[19–23,33] However, for reducing the premature loss rate of provisional implants, their placement should preferably be done in dense bone, such as the buccal/lingual cortical bone or interdental septa, as described in previous studies.[19–23,33] This is also confirmed by the present findings, which demonstrated that provisional implants placed in maxillary bone with reduced bone quality/quantity showed the lowest stability and involved loosening of PIs. When provisional implants are placed in soft bone, they may be prematurely lost and thus may affect the healing process of adjacent permanent implants.

However, when provsional implants are placed in dense bone, they will stay in place for the intended healing period, which has been demonstrated for PIs placed in the mandible or in postaugmentation areas of the maxilla.[19,20] Overall, the low provisional implant loss rate (3%) of the present study was consistent with previous results and was mostly due to the reduced bone situation before augmentation procedures in posterior maxillary posterior areas. However, no provisional implant losses were seen in bone with initially adequate bone quantity/quality, and no additional provisional implants were lost after successful bone augmentation. In cases with premature removal of provisional implants, shortening of the provisional fixed partial dentures provided for a longer fixation of the interim prostheses until the definitive prosthesis was available.

Nevertheless, it is important to follow the provisional implants in a strict recall program and to determine bone loss or suspected implant loss. In the presence of radiographic evidence of instability, the provisional implants should be removed early to ensure that no inflammation of the PIs will damage the definitive implants.[22,34]

Another aspect that needs to be discussed is the additional prosthetic work, the added financial expense, and the increased treatment time associated with such temporary treatment solutions. It is beyond doubt that treatment with provisional implants involves added financial costs and requires more time expense than the placement of a removable denture.[19–23,35–37] However, considering that the patient population concerned is requesting definitive implants, acceptance of the added financial costs and the additional time required for more intense treatment can be anticipated in most of the cases. With the placement of a fixed provisional restoration as a temporary solution, the prolonged treatment time required for augmentation will be accepted by most patients for psychologic reasons. This has also been confirmed with the results of subjective patient responses; 100% of patients confirmed that they would undergo the same prosthetic temporary solution again.

Certainly, the use of provisional implants does not represent the usual treatment in regions otherwise provided with removable solutions. However, the use of PIs for immediate rehabilitation provides the clinician with a wide range of solutions for immediate rehabilitation.[19–21] When such treatment is requested by the patient, his/her wishes can be fulfilled with the use of provisional implants and immediate rehabilitation with optimal quality can be performed. However, the surgical/prosthetic requirements are quite demanding, and close and intense cooperation between the surgeon, dental technician, and prosthodontist is required, while the treatment results are characterized by nearly perfect satisfaction on the part of the patients and the treating physicians.

CONCLUSION

On the basis of this clinical review the following was observed:

- Provisional implants successfully provide patients with a fixed partial denture for immediate rehabilitation to bridge the osseointegration or augmentation phase.
- Using provisional implants allows for immediate rehabilitation even in cases with an initially compromised bone situation.
- Although treatment is more complex and extensive, selected patients would still prefer fixed interim rehabilitation with provisional implants to a removable solution.

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