

# Provisional Implants for Anchoring Removable Interim Protheses in Edentulous Jaws: A Clinical Study

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**Purpose:** The behavior of provisional implants in edentulous maxillae/mandibles used for anchoring removable interim overdentures was followed for the time of the intended healing of the definitive implants. **Materials and Methods:** Twenty-eight edentulous arches (19 maxillae, 9 mandibles) were provided with 77 provisional implants (2 to 4 in maxillae; 2 or 3 in mandibles) for anchoring removable interim protheses (overdentures). The provisional implants were to be maintained until final restoration (6 to 9 months in the maxilla and 3 months in the mandible). The loss rate of provisional implants and handling and behavior of the anchored overdenture were monitored until the definitive prosthetic restoration was placed. **Results:** Twenty-three (29.8%) of the 77 provisional implants were lost prematurely. The loss rate of maxillary provisional implants (21/58; 36.2%) was significantly higher than that of mandibular implants (2/19; 10.5%) ( $P < .01$ ). Determination of terminal stability (by means of the Periotest) of the provisional implants showed higher stability in the mandible ( $+3.8 \pm 2.3$ ) than in the maxilla ( $+8.6 \pm 3.9$ ) ( $P < .05$ ). In obvious contrast to mandibular interim overdentures, handling of maxillary interim overdentures was found to improve significantly during the follow-up period ( $P < .01$ ). **Discussion and Conclusion:** With both the low loss rate in the mandible and the higher loss rate seen in the maxilla, placement of provisional implants fulfills the requirements for initiating immediate prosthetic rehabilitation. The removable interim overdenture can be adequately stabilized and provides for added patient comfort and satisfaction as compared to a conventional complete denture. An important aspect of the continued use of provisional implants concerns the expectations placed in these implants by both clinician and patient, which are quite different than those for definitive implants. (INT J ORAL MAXILLOFAC IMPLANTS 2003;18:582–588)

**Key words:** dental implants, dental prosthesis, immediate loading, temporary denture

Prosthetic restoration using endosseous implants is considered a safe and clinically tested treatment method and has become an established dental procedure.<sup>1–3</sup> Implant dentistry still generally accepts the concept (ad modum Brånemark) that the submerged placement of an implant should be followed by a healing phase of 3 to 6 months (depending on the respective jaw) prior to loading.<sup>1,2</sup>

Immediate or early loading of implants has been attempted to reduce healing time.<sup>4,5</sup> In the edentulous mandible, immediate loading of interforaminal implants in the course of prosthetic anchorage has been used successfully for many years.<sup>4–8</sup> However, as a known limitation, this approach appears to require a minimum of 4 interforaminal implants.<sup>6,9,10</sup> On account of the varying quality and quantity of maxillary bone, no uniform opinion has yet been established as to how many implants are needed in the edentulous maxilla and when early or immediate loading may be initiated.<sup>10–12</sup> Though modifications of implant shape and implant surfaces have brought about changes in maxillary healing phase strategies, direct occlusal forces acting on newly placed implants should be pursued with caution on account of maxillary bone quality.<sup>10–12</sup>

In edentulous arches, removable overdentures may be used as interim protheses for bridging the time until final restoration. Using a complete denture

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**Table 1 Clinical Course of Provisional Implants (PI) in the Maxilla**

Pt.	No. of implants placed		Intended time (mo)	No. of PI surviving	PI losses		
	Provisional	Definitive			< 1/2t (n)	1/2t to 1/1t (n)	Total (n and %)
VG	4	6	9	2	2	0	2 (50)
MM	4	6	9	4	0	0	0 (0)
RM	4	6	9	1	1	2	3 (75)
DH	2	4	6	2	0	0	0 (0)
AG	2	4	6	2	0	0	0 (0)
AP	2	4	6	1	1	0	1 (50)
TR	2	4	6	0	1	1	2 (100)
LH	2	4	6	1	1	0	1 (50)
NH	2	8	6	0	2	0	2 (100)
ZF	4	6	9	3	1	0	1 (25)
TF	4	6	6	3	0	1	1 (25)
EA	2	8	6	2	0	0	0 (0)
WG	4	8	6	2	0	2	2 (50)
KF	4	6	6	1	2	1	3 (75)
FM	4	6	9	3	1	0	1 (25)
WO	4	8	9	3	0	1	1 (25)
LM	2	4	6	2	0	0	0 (0)
GW	4	6	6	3	1	0	1 (25)
KL	2	4	6	2	0	0	0 (0)
Totals	58	108		37	13/21	8/21	21

Mean intended survival time of PIs:  $6.9 \pm 1.4$  mo.

following implant placement may necessitate a certain time without dentures. The prosthesis must be adjusted at the implant locations and requires regular relinings. Transmucosal loading of the implants may occur during healing in spite of adjustments.<sup>2,5,13-15</sup>

Provisional implants (PI) have been developed for interim restoration and immediate prosthetic rehabilitation.<sup>16,17</sup> These transitional/provisional implants prevent loading of the definitive implants and may allow immediate rehabilitation by ensuring adequate overdenture stabilization.<sup>16-19</sup>

The literature on transitional/provisional implants is limited to individual case reports and has been concentrated predominantly on fixed provisional prostheses.<sup>16-20</sup> The present study was intended to evaluate PI used specifically for the anchorage of a removable overdenture. For this purpose, behavior of the PI in the edentulous mandible/maxilla was followed for the time of the intended healing phase of the definitive implants, and subjective patient handling of the implant-retained overdentures was assessed.

## MATERIALS AND METHODS

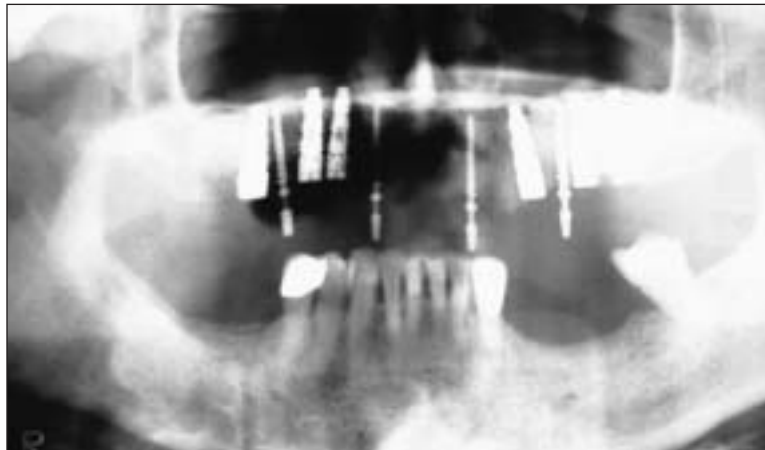
The study enrolled 28 patients with an edentulous maxilla ( $n = 19$ ) or mandible ( $n = 9$ ) undergoing the

placement of permanent implants (Brånemark System, Nobel Biocare, Göteborg, Sweden; Frialit-2, Friatec, Mannheim, Germany; or Camlog, Altatec, Wurmberg, Germany) for anchoring an implant-supported removable overdenture. Provisional implants (IPI; Nobel Biocare) were placed for the temporary anchorage of an interim overdenture. Skeletal morphology influenced the choice for removable solutions for both interim overdentures and definitive prostheses. As a limiting aspect of this study, it should be mentioned that the PI used (IPI) have actually been designed for the support of fixed transitional dentures, but were used for removable fixation in the present study.

Nineteen patients (13 female, 6 male; mean  $62.2 \pm 6.3$  years of age) with edentulous maxillae received 108 definitive implants and 58 PI (Table 1). Depending on the prosthetic concept chosen, either 4 definitive implants were placed in the interantral maxillary region (anterior maxilla;  $n = 7$ ; Fig 1) or 6 to 8 implants were placed in the posterior region following sinus augmentation ( $n = 12$ ; Fig 2). In addition, 2 or 4 PI were added to the definitive maxillary implants for temporary stabilization of a provisional overdenture. Usually, 2 PI ( $n = 9$ ) were used in patients with interantral location of the definitive implants (Fig 1), and 4 PI ( $n = 10$ ) were used in patients with implants in the posterior region (Fig 2).



**Fig 1** Orthopantomogram showing definitive and provisional implants placed in the maxillary anterior region (the left first molar was extracted).



**Fig 2** Orthopantomogram showing definitive and provisional implants placed in the maxillary posterior region.

Nine patients with edentulous mandibles (5 male, 4 female; mean age  $64.1 \pm 8.2$  years) received 24 definitive and 19 PI (Table 2). In these patients, the mandible was treated with 2 ( $n = 6$ ) or 4 ( $n = 3$ ) definitive interforaminal implants and 2 PI (3 in one patient) (Fig 3).

The provisional/transitional implants in the maxilla were to be maintained until definitive restoration after 6 or 9 months (for single-stage and 2-stage sinus augmentation procedures, respectively); those in the mandible were to be maintained for 3 months. In the maxilla, the period of intended stability of the IPI implants was additionally subdivided as follows: (1) loss within  $< 1/2$  of the intended time period ( $< 4$  months), (2) loss within  $1/2$  to  $1/1$  of the intended time period ( $> 4$  months), and (3) maximum intended time period achieved. Overall, the persistence/failure rate of the PI and the behavior of the PI-retained prostheses were followed until the time

of definitive prosthetic restoration. The stability of the PI was assessed at the end of the intended time of use (ie, prior to their removal) using the Periotest (Siemens, Erlangen, Germany).<sup>21</sup> The results of these assessments were compared for maxilla versus mandible and for provisional/transitional versus definitive implants.

For all patients, the original complete denture prosthesis was appropriately modified and reused as the interim removable overdenture. A removable anchorage was fabricated on the transitional implants by means of conical superstructures (coping; Nobel Biocare) (Fig 4). During the time of temporary treatment, the incidence of modifications (relining, fracture repair, renewal of retention) required on the temporary dentures was evaluated. Handling (insertion/removal) of the provisional maxillary and mandibular prostheses was evaluated by subjective questioning of the patients using a scoring system of

**Table 2 Clinical Course of Provisional Implants (PI) in the Mandible**

Pt.	No. of implants placed		Intended PI time (mo)	No. of PI surviving (t max)	Total PI losses
	Provisional	Definitive			
SH	2	4	3	2	0
SH	2	2	3	2	0
BJ	2	2	3	2	0
PA	2	2	3	1	1
SJ	2	4	3	2	0
AP	2	2	3	1	1
AS	3	4	3	3	0
SH	2	2	3	2	0
HM	2	2	3	2	0
Totals	19	24		17/19	2/19

**Fig 3** Orthopantomogram showing provisional and definitive implants placed in the mandible.

1 to 5 (1 = very easy, 2 = easy, 3 = normal, 4 = difficult, 5 = very difficult). Subjective scoring was done after the first prosthesis placement, at the follow-ups, and at the end of the required time period.

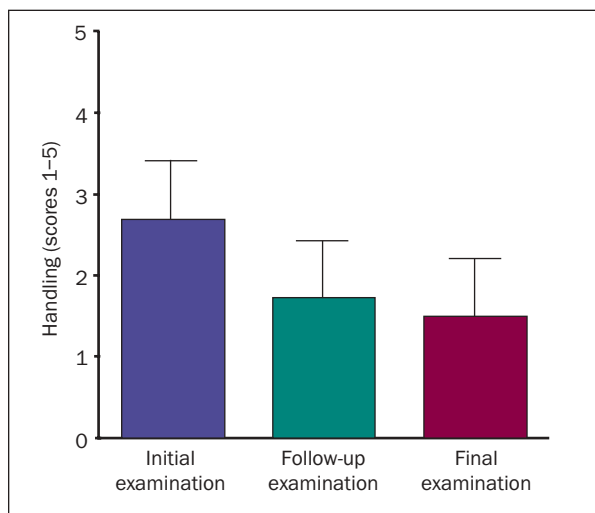
The data were tabulated and described. Mean values were compared using the Student *t* test; non-parametric data used the chi-square test.  $P < .05$  was taken as the statistical significance level.

## RESULTS

In the maxilla, the PI were to be maintained for a mean of  $6.9 \pm 1.4$  months (6 to 9 months). At the time of exposure, 106 of 108 definitive implants showed osseointegration (mean Periotest score,  $-3.4 \pm 2.7$ ) and could be used for prosthetic rehabilitation. In the maxilla, 21 (36.2%) of the 58 PI were lost. Significantly more PI were lost during the initial phase ( $< 4$  months) than during the late phase ( $> 4$  months) (13/21 [61.9%] versus 8/21 [38.1%];  $P < .01$ ; Table 1).

**Fig 4** Mandibular complete interim denture with attachments (copings for IPI).

The distribution of loss rates of PI in the maxilla can be seen in Table 1. In 6 of 19 patients (31.6%), all PI were maintained for the complete intended time period. Complete preservation of the PI (100%) was significantly more frequent with the method involving 2 implants (5/6; 83.3%) than with the method



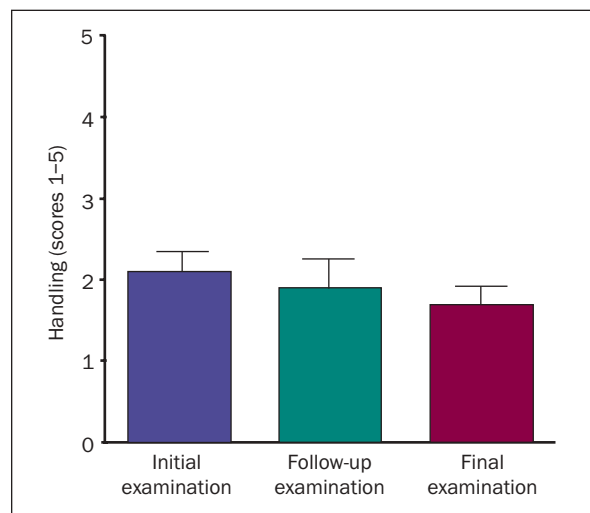
**Fig 5** Mean scores for denture handling (placement onto and removal of maxillary provisional overdentures retained by IPI). Scores ranged from 1 ("very easy to handle") to 5 ("very difficult to handle").

using 4 implants (1/6; 16.6%) (Table 1;  $P < .01$ ). In 68.4% of patients (13/19), the loss rate ranged between 25% and 100% (Table 1). Overall, significantly more implants were lost with the method that used 4 PI than with the method that used only 2 PI (15/21 [71.4%] versus 6/21 [28.6%];  $P < .01$ ). In 2/19 patients (10.5%), all PI (100%) were lost, necessitating conversion to a conventional complete denture.

Figure 5 shows the results obtained for general subjective handling (insertion/removal) of the provisional maxillary dentures. The initial problems encountered improved with increasing time of use ( $P < .01$ ). Initial handling was easier with 2 provisional implants than with 4 elements (scoring:  $2.27 \pm 0.49$  versus  $2.94 \pm 0.58$ ;  $P < .05$ ). The Periotest values obtained for the maxillary PI in situ at the last follow-up before their removal ( $n = 37$ ) were  $+8.6 \pm 3.9$  (range, +4 to +18) and were significantly higher than those for the definitive implants ( $-3.4 \pm 2.7$ ; range, -1 to -6;  $P < .01$ ).

In the mandible, 2 PI were lost during the intended time period. All definitive implants were osseointegrated and could be used for prosthetic rehabilitation. Handling in the edentulous mandible showed no significant improvement after initial difficulties ( $P > .05$ ; Fig 6). The Periotest values obtained for the provisional mandibular implants were  $+3.8 \pm 2.3$  (range, +1 to +12) and thus higher than those seen for the definitive mandibular implants ( $-4.2 \pm 2.6$ ; range, -1 to -6;  $P < .05$ ).

Overall, 77 PI were placed in 28 edentulous arches, and 23 of these (29.8%) were lost prematurely. Significantly more ( $P < .01$ ) PI were lost in the maxilla than in the mandible (21/58 [36.2%]



**Fig 6** Mean scores for denture handling (placement onto and removal of mandibular provisional overdentures retained by IPI). Scores ranged from 1 ("very easy to handle") to 5 ("very difficult to handle").

versus 2/19 [10.5%]). Results of terminal stability (Periotest) of the PI showed a higher stability in the mandible ( $+3.8 \pm 2.3$ ) than in the maxilla ( $+8.6 \pm 3.9$ ;  $P < .05$ ). In obvious contrast to the mandible, management of provisional maxillary prostheses improved significantly during the follow-up period.

The prosthetic modifications ( $n = 19$ ) required on the provisional prostheses ( $n = 28$ ) were subdivided as follows: relining 8 times, fracture repair 4 times, activation/renewal of retention 7 times. In the maxilla, loss of all PI in 2 patients necessitated conversion of an interim prosthesis to a conventional complete prosthesis. In all other patients, the interim prosthesis could be used for the intended time period.

## DISCUSSION

Immediate prosthetic treatment of the edentulous maxilla or mandible following endosseous implantation continues to be a major challenge for the clinician. The temporary denture should not adversely affect the definitive implants, and prosthetic rehabilitation should be initiated as early as possible and with maximum patient convenience and satisfaction.<sup>1,2,14,15,22-25</sup> Immediate loading of implants and immediate prosthetic rehabilitation has become an established procedure for mandibular fixed prostheses, though it is still dependent on the primary stability achieved and placement of the required minimum number of definitive implants.<sup>4-7</sup> In the maxilla, immediate loading is frequently limited by reduced bone quality/quantity, varying primary stability, and

inadequate definition of the number of implants required for immediate loading.<sup>9,13-15</sup>

For cosmetic and psychosocial reasons, prolonged periods without a prosthesis will not be acceptable for many edentulous patients.<sup>24,25</sup> Therefore, immediate loading by the use of temporary transitional/provisional implants may provide these patients with the desired comfort and security.<sup>16,17,26,27</sup> However, literature on the use of PI is scarce and limited to case reports describing temporary treatment with a fixed interim denture.<sup>16-20</sup>

While the PI used in the present study are principally designed for fixed interim dentures, the results show that with adequate consideration of this requirement, PI may also be used for immediate prosthetic rehabilitation by the anchorage of removable overdentures. Using PI, immediate prosthetic rehabilitation may even be undertaken in mandibles with a limited number of definitive implants.<sup>22,26,27</sup> Similar to the results of El Attar and coworkers,<sup>26</sup> a low loss rate of transitional mandibular implants was seen, which may be the result of the predominantly cortical bone quality in the mandible.

Though the present authors attempted to anchor the PI in cortical bone, a significantly higher loss rate was seen in the maxilla versus the mandible.<sup>14,16-18,26</sup> This higher loss rate of provisional maxillary implants may be explained by the varying maxillary bone quality, but specifically by fabrication of the removable interim dentures used.<sup>28</sup> Though the PI were made parallel manually, they still showed a certain lack of parallelism with the prefabricated conical superstructure. Micromovements as a result of the frequent removal and insertion of the anchored hybrid prosthesis may cause premature loss of the transitional implants.<sup>28-30</sup> Manual handling, ie, removal and insertion of the prosthesis, may initially prove very difficult in the maxilla, presumably because of the lack of parallelism but also because of the minute and delicate shape of the conical anchorage. During follow-up, handling was shown to improve considerably with practice (learning curve) but also because of the numeric reduction (loss rate) of the maxillary PI. Since the initial number of maxillary PI decreased in nearly 70% of cases, this may explain the improved handling. By contrast, handling in the mandible was easy and without complications for the patients from the very beginning, as a result of the reduced number of initial transitional implants.

It may be assumed that the kind of maxillary suprastructure used affects the loss rate of PI. Thus, Khoury and Happe<sup>17</sup> reported a loss rate of 12% for maxillary interim implants when using a fixed interim denture. This is in obvious contrast to the present results and may be the result of the different type of

prosthetic treatment utilized with the PI. As a result of implant splinting, fixed interim prostheses can reduce micromovement of the individual implants and thus may reduce loss of the PI.<sup>13-15,27,31-34</sup> However, if skeletal disharmony requires a definitive removable solution, the same kind of prosthesis should also be preferred as a provisional solution.<sup>13</sup> To reduce the loss rate of maxillary PI, even when using a removable overdenture, splinting of transitional implants as described for other systems<sup>18,19</sup> will provide for beneficial effects as regards the loosening of individual implants.<sup>26,27</sup> Bar-type stabilization of PI may reduce micromovements and thus provide for the same effect as a fixed structure.<sup>32,33</sup> However, the added amount of work and expense for such a temporary removable denture is in obvious contradiction to the primary indication and the patient's expectations in temporary rehabilitation.

With a certain degree of PI loosening, the surrounding bone will show loss of bone substance that cannot be fully predicted. In the frequent cases requiring placement of definitive and transitional implants in close proximity, this could affect osseointegration of the definitive implants. Therefore, either a minimum distance between any implants should be observed or patients should be recalled frequently during the time of provisional use to ensure early detection and early removal of any mobilized transitional implants.<sup>14-19</sup> Overall, the placement of provisional/transitional implants adequately stabilized removable overdentures in the present population and may provide added patient comfort versus conventional complete prostheses. Certainly, an important aspect of the continued and promising use of PI concerns the expectations placed in these implants by both clinician and patient, which should be quite different from those for definitive implants.

## CONCLUSION

Within the limitations of this study, the following conclusions can be drawn. The placement of PI fulfills the requirements for initiating immediate prosthetic rehabilitation, even when removable dentures are used. The removable interim overdentures can be adequately stabilized and provide for added patient comfort and satisfaction as compared to a conventional complete denture. A comparison of the results for maxilla and mandible showed significantly more premature loss of PI in the edentulous maxilla than in the edentulous mandible. Results of terminal stability measurements of the PI showed a higher stability in the mandible than in the maxilla. In obvious contrast to the mandible, handling of

provisional maxillary prostheses improved significantly during the follow-up period.

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