Maxillary Interim Overdentures Retained by Splinted or Unsplinted Provisional Implants

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Purpose: The survival rate of splinted and unsplinted provisional implants for anchoring removable interim overdentures, as well as handling and maintenance of the interim dentures, was evaluated. ***Materials and Methods:*** Eighteen edentulous maxillae were provided with 72 provisional implants for anchoring interim overdentures. For 10 patients, 40 unsplinted implants were used with conical copings to retain the provisional prostheses, while for 8 patients 32 implants had a splinted bar architecture for supporting the interim prostheses. Failure rate of provisional implants, as well as handling and behavior of the anchored interim overdentures, was followed until definitive prosthetic restoration and compared between groups. ***Results:*** Eighteen (25.0%) of the 72 provisional implants were prematurely lost. The loss rate of unsplinted implants (37.5%) was significantly higher than that of splinted implants (9.3%). Patient handling and maintenance of maxillary interim overdentures during the follow-up period was found to be easier with the splinted bar-retained method than with the unsplinted prosthodontic method. ***Conclusion:*** Placement of provisional implants fulfilled the requirements for initiating immediate prosthetic rehabilitation and showed that removable interim overdentures can be adequately stabilized and provide added patient comfort and satisfaction. The results suggest benefits of the splinted retention modality over the unsplinted method because of advantages regarding failure rate, patient handling, and interim denture maintenance. *Int J Prosthodont 2005;18:195–200.*

Prosthodontic rehabilitation using endosseous implants is regarded as a safe and clinically well-tried therapeutic approach and has become an established dental procedure.[1–4] In general, dental implantology still follows the concept (Brånemark) that placement of an implant should be followed by a healing phase of 3 to 6 months, depending on the jaw and bone morphology, prior to loading.[1–3] However, attempts to reduce healing time and enhance patient comfort have involved immediate or early loading of implants.[5–7] Immediate loading of interforaminal implants in the edentulous mandible for anchoring overdentures has been successfully used for many years.[7,8] This approach apparently requires a minimum of four interforaminal implants, thus limiting its application.[7,8] Successful results for immediate loading with two implants for overdentures[9] and three implants for a fixed prosthodontic rehabilitation using the Brånemark Novum system (Nobel Biocare) have been reported and have changed the number of implants needed for immediate loading of edentulous mandibles.[10]

In obvious contrast to the mandible and on account of the varying quality and quantity of maxillary bone, no uniform opinion has yet been established as to how many implants are required in the edentulous maxilla and when to start early or immediate loading.[5,11–13] Bone quality/quantity, as well as intraoperative stability of the implants, will determine whether early or im-

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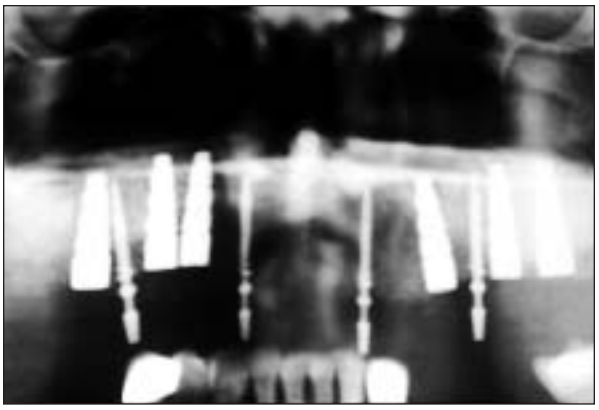
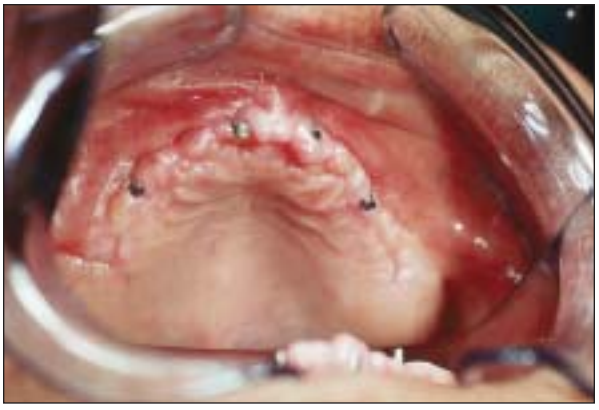


Fig 1a *(left)* Orthopantomogram shows unsplinted maxillary provisional implants.

Fig1b *(below left)* Intraoral view of unsplinted provisional implants.

Fig 1c *(below)* Maxillary interim prosthesis with copings for retention on unsplinted provisional implants.



mediate loading is feasible.[14] Modifications of implant shape and surface have brought about changes in maxillary healing phase strategies, but direct occlusal forces acting on newly placed implants should be avoided because of maxillary bone quality.[11–14]

When using removable interim overdentures in edentulous arches for bridging the time until final restoration, the prosthesis frequently must be reground and shaped at the implant locations and requires regular relining.[11,15] In spite of these intricate and elaborate adjustments, transmucosal loading with resultant remodeling below the prosthesis may occur during healing.

Immediate prosthetic rehabilitation after implant placement, enhancing patient comfort, can also be done by using provisional implants (PI).[16–19] Initial PIs have been developed for interim restorations of fixed or removable implant-supported restorations to prevent loading of the definitive implants. This approach offers an immediate rehabilitation by ensuring adequate denture stabilization, but PIs are also useful for avoiding damage to healing grafts, membranes, or implants in poor bone quality/quantity.[19,20] Literature on PIs is limited to individual case reports predominantly focused on fixed provisional prostheses,[16–18] but there is a lack of information about PIs supporting removable interim prostheses.[20,21]

The present study was intended to evaluate PIs specifically used for the anchorage of a removable maxillary interim overdenture supported by splinted or unsplinted PIs. The aim of the study was to evaluate the survival of the PIs, as well as the subjective patient handling and maintenance of the implant-retained interim overdentures for both prosthetic modalities.

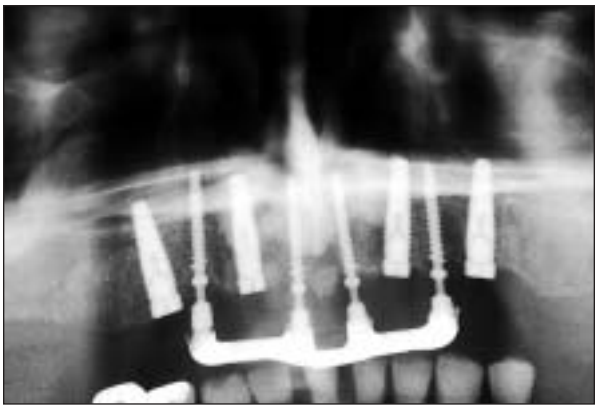
Materials and Methods

Eighteen patients (mean age 62.2 years, range 54 to 76 years; 12 women, 6 men) with edentulous maxillae received 92 definitive implants for anchoring an implant-supported removable maxillary overdenture (28 Brånemark, Nobel Biocare; 24 Frialit-2, Friatec; 40 Camlog, Altatec). Depending on the prosthetic concept selected, either four permanent implants were placed in the interantral maxillary region (anterior maxilla), or six to eight implants were placed in the posterior region (premolar/molar region) following internal sinus lift. Sinus lift procedures were done in 8 patients (54 implants) and varied in relation to the residual bone height between one stage (4 patients, 30 implants) and two stages (4 patients, 24 implants).

Fig 2a *(right)* Orthopantomogram shows bar splinting provisional implants.

Fig 2b *(below)* Intraoral view of bar connecting provisional implants.

Fig 2c *(below right)* Maxillary interim prosthesis with provisional bar retention modality.



In the opposite jaw (mandible), 12 patients were partially dentate, and 6 were edentulous with implant restorations.

Because of augmentation procedures and/or reduced bone quality, but specifically for enhancing patient convenience and comfort, for each patient four PIs (n = 72) were added to the definitive maxillary implants for provisional stabilization of an interim overdenture (Figs 1 and 2). As a limitation of this study, it must be pointed out that the PIs used (IPI, Nobel Biocare) had actually been designed for the support of fixed provisional dentures but were here used for removable fixation.

For all patients, the original complete denture was appropriately modified and reused as a removable overdenture. For the immediate prosthetic interim rehabilitation, patients were randomly grouped into a splinted and unsplinted group of PIs. (It was intended to include 10 patients in each group, but for one patient the costs of the splinted interim suprastructure caused a shift to the unsplinted group, resulting in a lack of two splinted patients.) For 10 patients (unsplinted group), confectioned conical superstructures (Coping, Nobel Biocare) were used for a removable anchorage on the PIs (n = 40; Fig 1). For 8 patients (splinted group), PIs and copings were connected with a cast-bar construction and luted on the PIs (n = 32; Figs 2a and 2b). On the cast-bar constructions, retention was accomplished with customized bar clips (Preci, Preci-line, Alphadent) fixed in the original complete prosthesis (Fig 2c).

The PIs were followed clinically and radiologically at intervals of 6 to 8 weeks and were to be maintained until final restoration after 6 to 9 months. Clinical instability and/or radiographically discernible instability determined the loss of PIs. The stability of the PIs was assessed at the end of the intended time of use (ie, prior to their removal) using the Periotest (Siemens).[22] Overall, failure rate of the PIs was followed until the time of definitive prosthetic restoration. The incidence of failure rate and the stability (Periotest value) of remaining PIs were compared between the groups. During the intended time of provisional treatment, the incidence of interim denture modifications (relining, teeth fracture, denture repair, renewal of retention) was evaluated. Handling (insertion/removal) of the maxillary interim prostheses was evaluated by subjective questioning of the patients using a scoring system of 1 to 5 (1 = very easy; 2 = easy; 3 = normal; 4 = difficult; 5 = very difficult). Subjective scoring was done after the first insertion, at the follow-up evaluations, and at the end of the

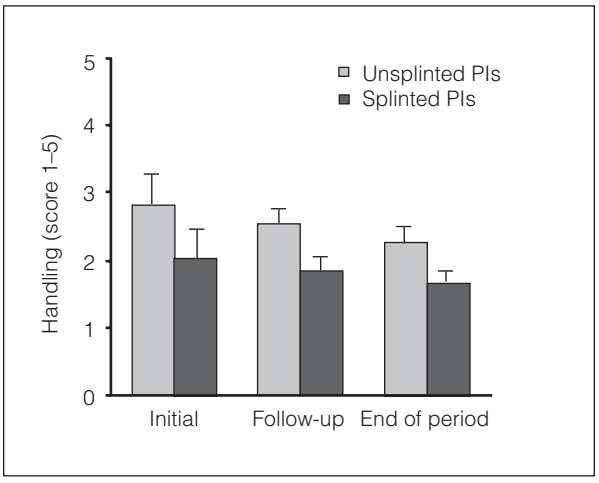


Fig 3 Handling of maxillary interim dentures retained by splinted and unsplinted provisional implants (PI).

required time period. Interim denture maintenance and handling were compared between the two retention modality groups.

The data were tabulated and described. Categoric variables for nonparametric data were compared using the chi-square test; continuous variables were tested with the Wilcoxon rank test. $P < .05$ was taken as the statistical significance level.

Results

Overall, 18 (25%) of the 72 PIs that were to be maintained for a period of 6.8 ± 1.6 months (range 6 to 9 months) were prematurely lost. Significantly, more PIs were lost in the unsplinted group (15/40, 37.5%) than in the bar-splinted group (3/32, 9.3%; $P < .01$). In the unsplinted group, 10 PIs failed within the first 6 weeks following placement and 5 PIs failed after a longer period of continued loading. In the splinted group, all 3 PIs that failed did so after a loading period of more than 3 months. In the unsplinted group (10 patients, 40 PIs), 2 patients lost 100%, 1 lost 75%, 1 lost 50%, 2 lost 25%, and 4 lost 0% of their PIs. In the splinted group (8 patients, 32 PIs), 3 patients lost 25% and 5 lost 0% of their PIs. In the splinted group, PIs showing instability were separated from the bar construction.

Overall patient handling of prostheses was easier with splinted (Fig 2) than with unsplinted (Fig 1) elements (mean score 1.8, standard deviation [SD] 0.3 vs mean 2.6, SD 0.5; $P < .05$). Figure 3 shows the results for the subjective evaluation of general handling (insertion/removal) of the provisional maxillary dentures for splinted and unsplinted retention modalities at the first insertion, at the follow-up, and at the end of the required time period. In the unsplinted group, the initial problems encountered improved with prolonged use ($P < .01$; Fig 3). In contrast, the splinted group showed no differences during the observation period and already described easy handling at the beginning of treatment.

The Periotest values for the maxillary PIs (n = 54) in situ at the last assessment before their removal was +8.1 (SD +4.2). Periotest values of PIs did not differ significantly between the splinted (mean +7.3, SD +3.6) and unsplinted groups (mean +8.9, SD +5.1) but showed weaker values for the unsplinted group.

The prosthetic modifications (n = 15) required on the provisional prostheses were subdivided as follows: 5 relining, 2 teeth fracture, 2 denture fracture repair, and 6 activation/renewal of retention. There were significantly more interventions for maintenance of the interim overdenture in the unsplinted group (11/15, 73.3%) than in the splinted group (4/15, 26.6%; $P < .05$). Loss of all unsplinted PIs in two cases necessitated conversion of an interim prosthesis into a conventional complete prosthesis. In all other cases, the interim prostheses could be used for the intended time period At the time of exposure, 90 of 92 definitive implants (survival 98.3%) showed adequate osseointegration (Periotest mean –3.4, SD –2.7) and could be used for prosthetic rehabilitation. Two definitive implants were lost during osseointegration in two patients each with unsplinted PIs without any relation to adjacent PIs. Both patients had sinus lift procedures, one a one-stage and one a two-stage procedure.

Discussion

Immediate prosthetic treatment of the edentulous maxilla following endosseous implant placement continues to be a major challenge for the clinician.[5,11] It is well-known that the provisional denture should not adversely affect the period of osseointegration of definitive implants.[22] On the other hand, prosthetic rehabilitation should be started as early as possible, and patient convenience and satisfaction should be enhanced by providing a prosthesis as soon as possible following implant placement.[11–13,22–24] In the edentulous mandible, immediate loading of implants and immediate prosthetic rehabilitation has become an alternate procedure for fixed as well as removable dentures.[5–10] The different prosthodontic procedures are influenced by the required minimum number of definitive implants.[5,6,9,10]

Reports have demonstrated that two implants for removable dentures and three for a fixed prosthesis is the minimum number for immediate rehabilitation.[9,10] In the maxilla, immediate loading is frequently limited by the reduced maxillary bone quality/quantity, varying primary implant stability, and inadequate definition of the

number of implants required for immediate loading.[11,14] But cosmetic and psychosocial reasons mean that prolonged periods without a prosthesis will not be acceptable for many maxillary edentulous patients requesting an immediate rehabilitation.[24,25]

The use of PIs is an additional prosthodontic tool to enhance the desired comfort and security of immediate prosthodontic rehabilitation.[18–21,25] The use of PIs has been described in several case reports using fixed interim dentures to ensure adequate cosmetic and functional satisfaction of the patient during the healing phase of the definitive implants.[18,19] Because PIs are predominantly designed for fixed provisional dentures,[18,19] reports about their use for removable dentures are rare.[20,21]

However, the findings of the current study show that PIs may also be successfully used for an immediate prosthetic rehabilitation by anchoring removable overdentures. The main findings were that connected PIs provided advantages including a higher survival rate, easier handling, and reduced incidence of interim denture maintenance compared with unsplinted prosthodontic constructions. According to these findings, it was assumed that the kind of maxillary suprastructure may especially affect the loss rate of PIs. Unsplinted PIs show a certain degree of disparallelism; using the prefabricated conical superstructure, certain micromovements as a result of multiple removals and insertions of the anchored hybrid prosthesis may cause premature loss.[21,26,27] Bar-type stabilization of the PIs provides for a similar effect as a fixed prosthesis, reducing micromovements and having beneficial effects regarding loosening of individual PIs.[17,27–30] This effect was confirmed by Khoury and Happe,[17] who report a loss rate of 12% for interim implants in the maxilla when using a complete fixed interim denture. The results support the recommendation of splinting PIs in edentulous maxillae when removable interim dentures are placed. Disadvantages of unsplinted PIs have been seen in an earlier study, where a significantly higher loss rate of unsplinted PIs in the maxilla compared to the mandible was found.[25] This may be explained by the differing bone quality in the maxilla and specifically by the construction of the removable interim dentures used.[14,28–30]

According to the results obtained, the bar-connected suprastructure also showed advantages in handling, with an obvious benefit regarding insertion and removal at the beginning of treatment in comparison to unsplinted PIs. The disparallelism, but also the minute and delicate shape of the conical anchorage, may negatively influence handling in patients with unsplinted PIs.[25,29] However, the added amount of work and cost for PIs and the cast-bar constructions of a removable interim denture are often in obvious contradiction to the intended purpose and must be especially noted.[31,32] The variable changes of maxillary hard and soft tissue following implant placement often necessitate time-consuming modifications of the conventional complete interim dentures to obtain sufficient fit and stabilization.[33,34] In comparison to the higher costs for the initial production and prosthetic techniques for PIs as a retention modality of immediate interim rehabilitation, the repeated maintenance time for a conventional interim denture after soft/hard tissue changes following implant placement should be considered.[33–36] The use of PIs helps to achieve sufficient stabilization of interim complete dentures at the beginning of incorporation and even later, when maxillary soft tissues have changed.[19–21] Overall, only minor maintenance interventions of the interim dentures were necessary during the intended healing time, which may justify the use of PIs for immediate rehabilitation. Considering the added amount of work and costs, remarkable benefits concerning maintenance additionally speak for a bar-connected construction rather than the unsplinted method of PIs.[19,21,29,30]

Conclusions

The present study demonstrated that removable overdentures can be adequately stabilized using PIs for immediate rehabilitation and added comfort for functional and psychosocial reasons. Although the applications are limited in removable dentures, especially in cases where significant ridge augmentation procedures have been performed, this technique may be beneficial in reducing undesired problems.

Within the limitations of this study, the following conclusions can be drawn:

- Placement of PIs fulfills the requirements for initiating immediate prosthetic rehabilitation and provides added patient comfort and satisfaction through adequate stabilization of removable interim overdentures.
- It is recommended to splint PIs in use for immediate rehabilitation in removable dentures. Splinted PIs provided advantages including higher survival rate, easier handling, and reduced incidence of interim denture maintenance compared with unsplinted prosthodontic constructions.

References

1. Adell R, Lekholm U, Rockler B, Brånemark P-I. A 15-year study of osseointegrated implants in the treatment of the edentulous jaw. Int J Oral Surg 1981;10:387–416.
2. Adell R, Eriksson B , Lekholm U, Brånemark P-I, Jemt T. Long-term follow-up study of osseointegrated implants in the treatment of totally edentulous jaws. Int J Oral Maxillofac Implants 1990;5:347–359.
3. Albrektsson T, Zarb G, Worthington P, Eriksson AR. The long-term efficacy of currently used dental implants: A review and proposed criteria of success. Int J Oral Maxillofac Implants 1986;1:11–25.

4. Lill W, Thornton B, Reichsthaler J, Schneider B. Statistical analyses on the successs potential of osseointegrated implants: A retrospective single-dimension statistical analysis. J Prosthet Dent 1993;69:176–185.
5. Aparicio C, Rangert B, Sennerby L. Immediate/early loading of dental implants: A report from the Sociedad Espanola de Implantes World Congress Consensus Meeting in Barcelona, Spain, 2002. Clin Implant Dent Relat Res 2003;5:57–60.
6. Ganeles J, Rosenberg MM, Holt RL, Reichman LH. Immediate loading of implants with fixed restorations in the completely edentulous mandible: Report of 27 patients from a private practice. Int J Oral Maxillofac Implants 2001;16:418–426.
7. Gatti C, Haefliger W, Chiapasco M. Implant-retained mandibular overdentures with immediate loading: A prospective study of ITI implants. Int J Oral Maxillofac Implants 2000;15:383–388.
8. Ledermann PD, Schenk RK, Buser D. Long-lasting osseointegration of immediately loaded, bar-connected TPS screws after 12 years of function: A histologic case report of a 95-year old patient. Int J Periodontics Restorative Dent 1998;18:552–563.
9. Payne AG, Tawse-Smith A, Thompson WM, Kumara R. Early functional loading of unsplinted roughened surface implants with mandibular overdentures 2 weeks after surgery. Clin Implant Dent Relat Res 2003;5:143–153.
10. Brånemark P-I, Engstrand P, Ohrnell LO, et al. Brånemark Novum: A new treatment concept for rehabilitation of the edentulous mandible. Preliminary results from a prospective clinical follow-up study. Clin Implant Dent Relat Res 1999;1:2–16.
11. Zitzmann NU, Marinello CP. Treatment plan for restoring the edentulous maxilla with implant-supported restorations: Removable overdentures versus fixed partial denture design. J Prosthet Dent 1999;82:188–196.
12. Jemt T, Lekholm U. Implant treatment in edentulous maxillae: A 5-year follow-up report on patients with different degrees of jaw resorption. Int J Oral Maxillofac Implants 1995;10:303–311.
13. Palmqvist S, Sondell K, Swartz B. Implant-supported maxillary overdentures: Outcome in planned and emergency cases. Int J Oral Maxillofac Implants 1994;9:184–190.
14. Ulm CW, Solar P, Gsellmann B, Matejka M, Watzek G. The edentulous maxillary alveolar process in the region of the maxillary sinus—A study of physical dimension. Int J Oral Maxillofac Surg 1995;24: 279–282.
15. Tarnow DP, Emtiaz S, Classi A. Immediate loading of threaded implants at stage 1 surgery in edentulous arches: Ten consecutive case reports with 1 to 5 year data. Int J Oral Maxillofac Implants 1997;12:319–324.
16. Froum S, Emtiaz S, Bloom MJ, Scolnick J, Tarnow DP. The use of transitional implants for immediate fixed temporary prostheses in cases of implant restorations. Pract Periodontics Aesthet Dent 1998;10:737–746.
17. Khoury F, Happe A. Interim implants in extensive bone transplantation procedure: Results of a clinical study. Implantologie 2000;9:375–387.
18. Nagata M, Nagaoka S, Mukunoki O. The efficacy of modular transitional implants placed simultaneously with implant fixtures. Compend Contin Educ Dent 1999;20:39–42.
19. Petrungaro PS. Fixed temporization and bone-augmented ridge stabilization with transitional implants. Pract Periodontics Aesthet Dent 1997;9:1071–1078.
20. Bohsali K, Simon H, Kan JY, Redd M. Modular transitional implants to support the interim maxillary overdenture. Compend Contin Educ Dent 1999;20:975–978.
21. Krennmair G, Weinlander M, Schmidinger S. Provisional implants for anchoring removable interim prostheses in edentulous jaws: A clinical study. Int J Oral Maxillofac Implants 2003;18:582–588.
22. Emmer TJ Jr, Emmer TJ Sr, Vaidyanathan J, Vaidyanathan TK. Measurement of submucosal forces transmitted to dental implants. J Oral Implantol 1999;25:155–160.
23. Carlsson GE. Clinical morbidity and sequelae of treatment with complete dentures. J Prosthet Dent 1998;79:17–23.
24. Humphris GM, Healey T, Howell RA, Cawood J. The psychological impact of implant-retained mandibular prostheses: A cross-sectional study. Int J Oral Maxillofac Implants 1995;10:437–444.
25. Aparicio C. The use of the Periotest value as the initial sucess criteria of an implant: 8-year report. Int J Periodontics Restorative Dent 1997;17:150–161.
26. el Attar MS, el Shazly D, Osman S, el Domiati S, Salloum MG. Study of the effect of using mini-transitional implants as temporary abutments in implant overdenture cases. Implant Dent 1999;8:152–158.
27. Schneider AL, Kurzman GM. Restoration of diveregent free-standing implants in the maxilla. J Oral Implantol 2002;28:113–116.
28. Khadivi V. Correcting a nonparallel implant abutment for a mandibular overdenture retained by two implants: A clinical report. J Prosthet Dent 2004;92:216–219.
29. Naert I, Gizani S, van Steenberghe D. Rigidly splinted implants in the resorbed maxilla to retain a hinging overdenture: A series of clinical reports for up to 4 years. J Prosthet Dent 1998;79:156–164.
30. Narhi TO, Hevinga M, Voorsmit RA, Kalk W. Maxillary overdentures retained by splinted and unsplinted implants: A retrospective study. Int J Oral Maxillofac Implants 2001;16:259–266.
31. Takanashi Y, Penrod JR, Lund JP, Feine JS. A cost comparison of mandibular two-implant overdenture and conventional denture treatment. Int J Prosthodont 2004;17:181–186.
32. van der Wijk P, Bouma J, van Waas MA, van Oort RP, Rutten FF. The cost of dental implants as compared to that of conventional strategies. Int J Oral Maxillofac Implants 1998;13:546–553.
33. Jackson RA, Ralph WJ. Continuing changes in the contour of the maxillary residual alveolar ridge. J Oral Rehabil 1980;7:245–248.
34. Chan MF, Howell RA, Cawood JI. Prosthetic rehabilitation of the atrophic maxilla using pre-implant surgery and endosseous implants. Br Dent J 1996;181:51–58.
35. Johansson B, Grepe A, Wannfors K, Hirsch JM. A clinical study of changes in the volume of bone grafts in the atrophic maxilla. Dentomaxillofac Radiol 2001;30:157–161.
36. Schulze-Mosgau S, Schliephake H, Schulze-Mosgau S, Neukam FW. Soft tissue profile changes after autogenous iliac crest onlay grafting for the extremely atrophic maxilla. J Oral Maxillofac Surg 2000;58:971–975.