Several treatment options with implants have been described for maxillary edentulous patients. Maxillary implant–supported overdentures have been shown to be a predictable, accepted treatment option for the edentulous maxilla. Patients with severe bone resorption present additional difficulties, and implant treatment in the atrophic maxilla represents a challenge. Anatomical limitations and patient desires in this case have forced the treatment to be 4 angulated implants supporting an upper overdenture. Since conventional single-retention mechanisms such as ball (O-ring), locator, or telescopes would transfer too much force to the implants, especially because of their angulation, an individual bar was fabricated. One-year follow-up of the case showed a stable peri-implant condition on bone as well as soft tissue level. Although further follow-up and higher case numbers will give more information about this treatment modality, the actual result is encouraging and can be recommended for similar cases.

**Key Words:** angulated implants, severely atrophied maxilla, individual bar, implant overdenture, Marius bridge

**INTRODUCTION**

Several treatment options with implants have been described for maxillary edentulous patients. Maxillary implant–supported overdentures have been shown to be a predictable, accepted treatment option for the edentulous maxilla. Patients with moderate to severe bone resorption and thin ridges present additional difficulties because of inadequate bone volume and missing soft tissue support; thus, because of mechanical and anatomic drawbacks, implant treatment in the atrophic maxilla represents a challenge. The maxillary sinus floor augmentation or the zygomatic implant placement, which are procedures mainly accomplished by maxillofacial surgeons, are invasive surgical interventions, and patients showing that kind of maxillary resorption are generally very old and have poor health status. Serious and complex surgical procedures could be contraindicated in these patients.

Results of investigative studies indicate that the use of angled implants is an effective and safe alternative to maxillary sinus floor augmentation procedures because longer implants can be inserted in this way. The use of reduced-diameter implants as an alternative to bone grafting for treatment of patients with severely resorbed maxillae was evaluated. As a conclusion, implant anchorage without bone grafting was shown to work well, although it is expected that patients with...
severely resorbed maxillae have an increased risk of implant failure in comparison to patients with good bone quantity and quality. In another study, severely resorbed maxillae bone grafting and implant placement was compared with modified implant placement but no bone grafting. The cumulative success rates were 83% in the graft group and 96% in the trial group, and a substantial reduction of the grafted bone, especially of the onlay grafts, occurred in many patients.12 According to these results, modified implant placement—in this case, angulated implant positioning to be able to use longer implants—seems to be a predictable therapy alternative.

**Case Description and Results**

A 63-year-old female edentulous patient presented to the Department of Removable Dentures in the Dental School of Istanbul University with the complaint of not being able to use any dentures because of strong choke reflex. The only choice of treatment seemed to be a denture without palatal coverage. Clinical and radiological assessment showed a severely atrophied maxilla, with bilateral large sinuses and very little amount of bone, making conventional implant placement impossible. After information and discussion about treatment alternatives, the patient rejected the sinus floor or any other augmentation procedures. The only bone available for implantation was in the region of the premaxilla and tuber maxilla, which were, even there, limited in height.

An overdenture attached to 4 implants and open palatal surface was planned. Because of lacking bone height, all 4 Astratech implants with a TiO-blast surface were inserted in an angulated manner. Two implants were inserted in the premaxillary region and 1 each in the tuber maxillae region bilaterally (Figure 1). Implant 22 was lost after 2 months and was substituted with a new implant following a 6-week healing time (Figure 2). The most probable reason for the loss of implant 22 was the nonsubmerged approach in the class 4 bone with a reasonable primary stability of the implant. This loss caused a delay of the prosthetic treatment. Eight months after the first implant insertion, the first impressions were taken. Because of the various implant angulations, an open individualized tray was used for the impression of the upper jaw. The impression tray borders were molded with functional silicone (Bisico Function, Bisico Deutsche Dental GmbH, Germany), and the final impression was taken with a high-viscosity polyether impression material (Impregum soft, 3M ESPE, St Paul, Minn). Before removing the impression from the mouth by opening the screws of the transfer posts, the open parts of the tray were strengthened by the use of a pattern resin (GC Pattern Resin, GC Dental Products Corp, Tokyo, Japan) to avoid even a slight movement of the posts, which would make the model useless. Parallelly, the impression of the lower jaw was taken for fabrication of a conventional complete denture. After wax rim try-in and determination of vertical dimension and centric relation, a facebow recording was done. The tooth setup was done on the articulator and then controlled in the patient. After correction of esthetic and functional determinants, the planning of the attachment system could be done. Since conventional single-retention mechanisms such as ball (O-ring), locator, or telescopes would transfer
too much force to the implants,\textsuperscript{13,14} an individual bar was fabricated. In this manner, the force applied for removal of the denture was shared by the implants (Figure 3).

The bar try-in was passive and well fitting (Figure 4), so the denture was finished and delivered to the patient (Figures 5 and 6). The patient was very satisfied with the result.

The follow-up controls in the 6th (Figure 7) and 12th months (Figure 8) after denture insertion showed clinically and radiologically in comparison to the beginning situation a stable situation around the implants. Clinical measurements at control sessions included plaque score, gingival index, sulcus bleeding, and pocket probing depth. In addition, the occlusion, retention, and stability of the dentures were examined. The implants were evaluated following the success criteria of Albrektsson.\textsuperscript{15} Mesial and distal marginal bone levels were measured on panoramic radiographies.

\textbf{DISCUSSION}

Severely resorbed jaws provided with overdentures were reported as the most demanding cases.\textsuperscript{16} The reduction or elimination of palatal coverage with maxillary implant–supported overdentures may be perceived as advantageous to patients by providing greater comfort through reduction of tissue coverage.\textsuperscript{17} The Marius bridge is a complete-arch, double-structure prosthesis for maxillae that is removable by the patient for oral hygiene. Satisfactory medium-term results of survival and patient satisfaction show that the Marius bridge can be recommended for implant dentistry. The technique may reduce the need for grafting because it allows for longer implants to be placed with improved bone anchorage and prostheses support.\textsuperscript{18} Overdentures supported and retained by endosteal implants depend on mechanical components to provide retention. In general, an implant is loaded via axial and horizontal forces, but sometimes moment loading can also occur.\textsuperscript{19} The clinician may be able to make empirical decisions on attachment selection, depending on the amount of retention desired and the specific clinical situation,\textsuperscript{20} but the force transfer to the implants should always be respected.

Different overdenture attachments are found to affect the stress distribution in the maxillary bone surrounding the overdenture implants,\textsuperscript{21} and for different loading locations, significant differences were found among the different overdenture attachment systems\textsuperscript{22} since every attachment type has different retention characteristics.\textsuperscript{23} Ball attachments are frequently described because of simplicity and low cost, but the retentive capacity of these components may be altered by a lack of implant parallelism.\textsuperscript{24} Divergent
implants in the maxilla can make restoration with removable prosthetics difficult when the implants will not be splinted with a superstructure. Attachments to be used with individual implants require that the implants be within $10^\circ$ of divergence. In addition, primary splinting of fixtures with bar attachments has proved to be clinically effective for overdentures on osseointegrated implants because there is a tendency for better axial load sharing with bars.\textsuperscript{13,14}

Studies of maxillary overdentures supported by endosseous implants often show a high implant failure rate.\textsuperscript{26} One study showed that patients with implant losses were characterized by severely resorbed maxillary ridges and inferior bone quality, together with unfavorable loading circumstances such as short implants combined with long leverages.\textsuperscript{27} For these reasons, in this case, the use of longer implants was chosen despite the lack of available bone, with the implants inserted in an angulated position.

Meanwhile, it is a well-known fact that the first year is the most critical one for implant failure and also for crestal bone resorption.\textsuperscript{28–33} The results of an investigation showed that practically all implant losses occurred during the first 2 years, whereupon a steady state seemed to follow for up to 5 years after loading.\textsuperscript{34}

Despite disadvantageous loading conditions and poor bone quality and quantity, this case showed a stable situation around the implants after 12 months of loading time. Although further follow up and larger case numbers will give more information about this treatment modality, the actual result is encouraging and can be recommended for similar cases.

\begin{figure}
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\includegraphics[width=\textwidth]{figures.png}
\caption{Figure 6. The denture in place. Figure 7. Radiographic view after 6 months. Figure 8. Radiographic view after 12 months.}
\end{figure}

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