Implant Treatment after Sagittal Splitting Ramus Osteotomy and Alveolar Ridge Augmentation in Patient with Mandibular Prognathism and Multiple Missing Maxillary Teeth

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Abstract

An abnormal maxillomandibular ridge relationship frequently hinders oral implant treatment in patients with jaw deformities. Here, we describe a patient who was experiencing difficulty using dentures due to multiple maxillary tooth loss and mandibular prognathism. Treatment comprising sagittal splitting ramus osteotomy and alveolar ridge augmentation using bone grafts harvested from the mandibular ramus followed by implant treatment yielded good outcomes. The patient was a 47-year-old woman presenting with an unstable upper partial denture. Although prior prosthetic treatment for mandibular prognathism had resulted in normal overbite, she had since lost an increasing number of teeth due to advanced periodontal disease, impairing support for the denture. She was referred to the Department of Oral Implantology at the Tokyo Dental College Chiba Hospital in October 2008. Subsequent treatment comprised implant treatment following maxillary alveolar ridge augmentation and sagittal splitting ramus osteotomy to correct the maxillary-mandibular relationship. In January 2010, sagittal splitting ramus osteotomy and alveolar bone augmentation using a bone graft from the mandibular ramus were performed under general anesthesia. In July and August 2010, a total of 7 implants were placed in the maxilla and implant superstructure preparation started after 3 months. Taking both the patient's wishes and ease of maintenance into account, retrievable superstructures made of Auro Galvano Crown were fitted in April 2011. The jaw-to-jaw alveolar ridge relationship was improved by sagittal splitting ramus osteotomy, rendering subsequent treatment, from implant placement to superstructure preparation, feasible by conventional methods. The use of surplus bone generated during sagittal splitting ramus osteotomy for bone augmentation avoided the need to harvest bone from another area.
**Introduction**

Oral implant treatment in patients with jaw deformities is frequently hampered by an abnormal maxillomandibular ridge relationship. In some cases, implant treatment may be infeasible as it stands if this interarch relationship has been made worse by alveolar ridge atrophy associated with tooth loss and insufficient bone is present. Herein, we report a patient who presented with difficulty using a partial denture due to multiple maxillary tooth loss and mandibular prognathism. Treatment comprised sagittal splitting ramus osteotomy and alveolar ridge augmentation using bone grafts harvested from the mandibular ramus followed by implant treatment, with good results.

**Case Presentation**

A 47-year-old woman presented at our hospital (Department of Oral Implantology, Chiba Hospital, Tokyo Dental College) with instability of an upper denture. Her previous medical history included nothing of note. She had already undergone orthodontic and prosthetic treatment after noticing mandibular protrusion as a teenager, which had resulted in normal overbite. Since then, however, she had lost an increasing number of maxillary teeth due to advanced periodontal disease, and this, coupled with maxillary prognathism, had made her denture extremely unstable. She therefore requested implant treatment and was examined here in October 2008.

Oral findings on initial examination revealed maxillary alveolar ridge atrophy associated with tooth loss, and the ridge was well behind the mandibular dental arch. Although teeth #15, 17, and 26 were still present, all of these exhibited grade III mobility due to advanced periodontal disease. Her denture had been designed to generate a normal overbite, but it projected well in front of the alveolar ridge, and movement of the abutment tooth also contributed to its instability (Figs. 1, 2).

Given that bone resorption had progressed as far as the root apex, it was decided that the remaining maxillary teeth should be extracted and provisional dentures produced that would take into account the position of the alveolar ridge, occlusal plane, and lip support. Cephalometric radiograms, computed tomography scans, and facial photographs were taken, and the positioning of maxillary implants, amount of bone augmentation required, and maxillomandibular ridge relationship considered (Fig. 3). After fitting the provisional dentures, there remained a bilateral angle class III bite, with a 3-mm overjet and 1.5-mm overbite. Cephalometry also revealed skeletal class III morphology, with setback of the maxilla and mandibular prognathism. The Simplant® OMS (Materialise Japan, Yokohama, Japan) was used to model and simulate various procedures, with the aim of confirming the interarch alveolar ridge relationship, projecting the implant insertion positions, and determining the optimal method of bone augmentation. The maxillary setback and atrophy of the maxillary alveolar ridge were both severe, indicating that it would be difficult to improve the interarch alveolar ridge relationship by bone augmentation using grafting alone.

In consideration of the invasive nature of the surgery and postoperative positional stability of the jawbones, it was decided to prioritize implant placement within the scope envisaged with the provisional dentures. The
decision was made to place a veneer bone graft on the lingual side of the alveolar ridge to move the relative position of the maxilla further forward, and to perform sagittal splitting ramus osteotomy to set the mandible further back. The amount of bone required for augmentation was determined to be around 10 cm in height, 20 mm in length, and 3 mm in width between the right and left maxillary premolar regions. The use of an iliac bone graft for bone augmentation was considered, but the patient preferred that bone not be harvested from this area. Additionally, imaging simulation indicated that surplus bone generated during sagittal splitting ramus osteotomy would be sufficient for the procedure. Therefore, it was decided to harvest bone solely from the mouth.

Clinical Procedures and Outcomes

In January 2010, sagittal splitting ramus osteotomy and maxillary alveolar arch augmentation using bone harvested from the posterior margin of the mandibular ramus were performed under general anesthesia. During the procedure, the provisional dentures were secured to the maxilla with screws while sagittal splitting ramus osteotomy was performed. The mandible was moved to align it with the dentures, and bone was harvested from the posterior margin of the surplus piece of the medial mandibular ramus. The harvested bone was grafted onto the maxilla and intermaxillary fixation carried out after the provisional dentures had been fixed with screws and suspended from the zygomatic arch with a wire (Fig. 4).

Implant insertion was scheduled for 6 months after sagittal splitting ramus osteotomy and bone grafting. Although some bone graft resorption had occurred, the bone was of sufficient width and height to permit implant insertion. The implants closest to the back of the mouth on both sides were inserted by using the osteotome technique.

In July and August 2010, implants were inserted under intravenous sedation. Implants were inserted at the positions of teeth #15, 13, 11, 22, 23, 25, and 26, with the insertion pro-
procedure divided into two sessions due to an intraoperative rise in blood pressure. Straumann implants (Straumann Holding AG, Basel, Switzerland) were used as the implants closest to the back of the mouth on both sides, and Ankylos implants (Dentsply-Sirona, Pennsylvania, USA) were used in the other locations. Adequate initial fixation was achieved in all implants (Fig. 5).

Implant superstructure preparation was started 5 months after implant insertion, and the superstructures were attached in April 2011. Retrievable superstructures made of hybrid resin veneered Auro Galvano Crown were used for ease of cleaning.

Although the implants had moved slightly lingually due to some bone resorption occurring at the insertion sites, their locations remained within the scope envisaged with the provisional dentures. The superstructures were prepared by the usual method.

To date, 6.5 years after the completion of implant treatment, no obvious peri-implant bone resorption or superstructure issues have been observed, and oral function has been maintained. The right side mandibular first molar was re-treated at a local dental clinic during the follow-up observation period (Figs. 6, 7). The patient is attending follow-up appointments at approximately 6-month intervals, and we will continue to monitor her carefully.
Discussion

1. Mechanical risks associated with jaw deformity

Superstructure-related mechanical risk factors include lateral force, cantilevers force, and offset load. All of these may generate excessive load on implants, and the further the point of application is from the implant axis, the greater is their effect. In many cases, implant treatment in patients with jaw deformity necessarily entails the point of action being located at a point distant from the implant axis. This is due to problems with the interarch relationship between the maxillary and mandibular alveolar ridges at the implant insertion points in the alveolar bone, and this risk must therefore be taken into account. The effects of excess load are not limited to a greater risk of peri-implant bone resorption, but may also include prosthetic issues, such as superstructure fracture and loosening of screws. In the present case, the relative positional relationship of the maxillary and man-
dibular alveolar ridges was improved by inserting a veneer graft in the area of the maxillary front teeth and carrying out sagittal splitting ramus osteotomy. The fact that no obvious peri-implant bone resorption or superstructure loss or fracture was observed at 6.5 years after fitting the superstructures suggests that mechanical risk factors associated with jaw deformity were successfully negated.

2. Bone harvesting from the posterior margin of the mandibular ramus

Autologous bone is the only graft material used for bone augmentation in implant treatment that combines osteogenic potential, osteoinductive capacity, and osteoconductivity, and is therefore regarded as the gold standard\(^6\). Locations in the mouth from which bone can be harvested include the anterior margin of the mandibular ramus, chin, and maxillary tuberosity; and restricting surgery to the mouth reduces the level of invasiveness to the patient compared with harvesting bone from elsewhere in the body. It has the disadvantage, however, that the amount of bone that can be taken is limited, making bone augmentation of large defects difficult. In the present case, preoperative simulation indicated that sufficient bone could be harvested from the posterior border of the mandibular ramus by using the surplus medial piece of the mandibular ramus generated during sagittal splitting ramus osteotomy, and this was borne out during the actual procedure. Although this method makes the procedure more complex, the fact that bone can be collected in the same operating field as that of the sagittal splitting ramus osteotomy suggests that it offers a valuable technique for bone augmentation in patients with jaw deformity.

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