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Case report

Treatment planning in a case of restoration of the maxilla and mandible using osseointegrated implants with four types of bone graft

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Abstract: A case is reported of a 66-year-old woman who could not use a conventional, full upper denture because of a gag reflex. In the maxillary alveolar ridge, restoration was performed on a moderately atrophied, edentulous anterior area and a small defect in the right-side posterior area. In the mandibular alveolar ridge, restoration was performed on a moderate osseous defect in each molar area resulting from tooth extraction due to severe periodontal disease. Based on careful treatment planning, four types of bone graft were used with previously designed osseointegrated implants. The atrophied maxillary alveolar ridge was restored with veneer iliac bone grafts to avoid fenestration during implant placement, while alveolar process deficiency was restored using inlay and sinus bone grafts as placements for long implant fixtures. The defects in the mandibular alveolar bone were filled with corticocancellous bone chips at the implant placement sites. A combination of immediate and secondary placement of Brånemark fixtures was used. Bone-anchored bridge-type implant prostheses were fitted approximately twelve months after surgery. Three years later, there had been no failure of implant fixtures and satisfactory functional and cosmetic restoration had been maintained. (J. Oral Sci. 45, 227-232, 2003)

Key words: gag reflex; osseointegrated implant; treatment planning; four types of bone graft.

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Introduction

This paper reports a case in which careful treatment planning was used in providing implants for a patient with poor bone volume and quality at the desired implant sites. Based on presurgical examination and diagnosis, several types of bone graft were planned to overcome these bone deficiencies. In the edentulous maxilla, an inlay graft, a sinus graft and three veneer grafts were used. In the alveolar ridge at the molar area on both sides of the mandible, moderate osseous defects were filled with corticocancellous bone chips. Some implant fixtures were installed simultaneously with these bone grafts. Other fixtures were installed in a secondary procedure, limited to the anterior region of the maxilla where the veneer grafts had been placed. Bone-anchored bridges were put in place, which three years after surgery were still functional and providing a satisfactory cosmetic result.

Case Report

The patient was a 66-year old Japanese woman in good general health and a non-smoker, who for fifteen years

before her referral to the Nihon University Dental Hospital had used a partial denture in the maxilla. However, two weeks prior to her visit, the first and second molars on both sides of the mandible, as well as the remaining three teeth in her maxilla, had been extracted because of severe periodontal disease, and she had been given a full upper denture controlled by a soft resin temporary treatment liner. As well as the gag reflex with this new denture, she reported that it was not effective for mastication and she found it uncomfortable to wear for extended periods. She had therefore been referred to the hospital for implant treatment to the maxilla as an alternative to the denture.

As well as an edentulous maxilla, intraoral examination revealed missing teeth 2-3 and 14-15 in the mandible. The patient wore partial dentures in those areas, but reported no problems in using them. The alveolar ridge in the maxilla showed moderate horizontal and vertical atrophy in the anterior area. The second molar area of the ridge in the mandible was moderately concave on the right side, while the left side was moderately concave at the first molar area of the ridge.

A panoramic X-ray examination (Fig. 1) showed that, on the right side of the maxilla, there was a moderate concavity in the area of the first and second molars and that the distance from the ridge to the floor of the sinus on the left side had been reduced to approximately 7 mm at the thinnest point. It also revealed clearly defined radiolucent areas in the second molar area on the right side and in the first molar area on the left side of the mandible. These radiolucent areas corresponded to part of the area from which three molar teeth (15, 18 and 30) had been extracted due to severe periodontal disease, which was also the probable cause of osseous deficiencies revealed by the panoramic X-ray examination.

Computerized tomography (CT) producing transaxial images of the maxilla at 2-mm intervals revealed an osseous defect in the right-side first and second molar area, but no significant findings on the left side. It also showed that in the maxilla from the right molar to the left molar region, the width of the alveolar ridge had been reduced to the level of the root apices, and there was inadequate bone of implantable quality. The CT sinus view did not reveal any problems in the right or left maxillary sinus membrane.

A lateral cephalometric X-ray examination, together with clinical assessment, allowed the resorbed area of the patient's maxilla to be classified as a "C" type morphology, according to the Lekholm-Zarb classification system (1).

Treatment Planning

Treatment planning for this patient required careful selection of the types of bone graft to be used, keeping in mind not only her current condition, but also the desired end result of a satisfactory relationship between the jaws and the shape of the dental arches. To select the types of bone graft, first, the relationship between the maxilla and mandible was determined using an articular diagnostic cast mounted on a semiadjustable articulator. The diagnostic cast also revealed in both jaws many areas with deficiencies in bone volume and/or height, as well as small osseous defects in the alveolar ridge. In addition, the cast showed that there was a poor horizontal relationship on both sides between the maxilla and mandible.

Based on the findings of the panoramic X-ray examination, the CT scan and the diagnostic cast, it was decided to use three buccal veneer bone grafts to augment the volume of the alveolar ridge in the edentulous maxilla, from the right premolar to the left premolar region. For the first and second molar area of the right side of the maxilla, it was considered that the softness of the maxillary bone made it unsuitable to use corticocancellous bone chips to fill the defect. Therefore, an inlay bone graft was chosen, which also achieved a cosmetically acceptable level base for a prosthesis that was also partly based on the veneer bone grafts. In addition, use of an inlay graft made it easier to simultaneously insert a 10 mm implant fixture that would be likely to retain stability.

On the left side of the maxilla from the premolar to the molar area, a sinus bone graft was selected to increase the alveolar height for the placement of longer implant fixtures. Corticocancellous bone chips were selected to fill the osseous bone defects in the mandible and increase alveolar height, as it was considered unnecessary to use the limited supply of iliac bone graft material to treat defects that were not severe.

Surgical Procedure

Bone was harvested from the right iliac crest using a 7 cm incision, starting 1 cm posterior to the anterior superior iliac spine (to avoid damaging the lateral superficial branch of the femoral nerve), and running parallel to the iliac crest. A 4 cm long bony lid, encompassing the iliac crest and attached only to the inner periosteum, was tilted medially. A full-thickness iliac block of approximately $4 \times 3 \times 1$ cm was harvested, including the iliac crest.

An intraoral approach to the maxilla was made using a horseshoe-shaped incision along the alveolar ridge from the region of the right second molar to the left second molar. The alveolar crest was revealed by raising a mucoperiosteal flap, and the nasal floor was identified. The entire bony palate and alveolar process were exposed, and the extent of the nasopalatine canal was explored.

The material for the inlay bone graft and the three veneer grafts was shaped and trimmed with a bur to create the largest possible contact surfaces with the underlying bone surface. The three contiguous veneer bone grafts were placed in alignment to cover the deficient labial area of the maxillary alveolar process, and holes were drilled with a guide bur from the lateral aspect of the bone grafts and into the alveolar process. These were used for a total of four titanium mini-screws to hold each graft in place. The screws were removed six months later, during the secondary implant procedure.

Next, the inlay bone graft was held firmly against the concavity on the right side of the maxillary alveolar ridge, and a hole was drilled with a guide bur through the graft and into the alveolar ridge. The hole was used to insert a titanium mini-screw to hold the graft in place. A self-tapping, 13 mm long implant fixture of 3.75 mm diameter was then installed in the bone graft, according to the Brånemark procedure. The temporary mini-screw was then removed. In addition, another self-tapping, 10 mm long implant fixture of 3.75 mm diameter was inserted at the first molar area of the maxilla, between the inlay graft and the first of the three contiguous veneer grafts (Fig. 2).

The residual iliac bone material that had been harvested for grafts was processed to provide cancellous bone chips for the sinus augmentation procedure at the left side of the maxilla. This was performed simultaneously with the placement of two standard Brånemark fixtures of 4 mm diameter and a length of 13 mm, as well as one self-tapping fixture 3.75 mm in diameter and 10 mm long (Fig. 3). Bone chips were used to densely fill the cavity in the maxillary sinus area around the exposed tips of the standard fixtures (Fig. 4).

In the mandible, two standard Brånemark fixtures each 3.75 mm × 13 mm were placed at the right-side second molar area, and two fixtures 3.75 mm × 10 mm and 3.75 mm × 15 mm were placed at the left-side first molar area (Fig. 5). Bone chips were then used to firmly fill the cavities around the exposed upper half of the fixture threads (Fig. 6). Finally, the initial incision in the alveolar ridge was closed using 4-0 sutures, together with horizontal mattress sutures to provide a watertight closure.

After approximately five months, a series of dental X-ray films and a panoramic X-ray film were obtained to check the condition of the bone grafts. The volume of bone had slightly decreased in each graft and the density had increased, indicating that bone remodelling was almost complete and the secondary placement of implants could be performed. All the four mini-screws in the veneer graft in the maxilla were removed under local anesthesia, and three additional implant fixtures were placed in the maxilla, two in the right-side premolar area (one standard type 10 mm long × 4 mm diameter, and one Mark II, self-tapping type 13 mm long × 3.75 mm diameter) and one in the left-side canine area (Mark II, self-tapping type 13 mm long × 3.75 mm diameter) (Fig. 7).

Six months later, second-stage abutment connection surgery was performed. Eight implant fixtures were placed to support a full-arch fixed prosthesis in the maxilla. In the mandible, four fixtures were placed (two on the right and two on the left side) to support a bridge-type prosthesis. Clinical postoperative examinations were undertaken regularly in the interval prior to the abutment operation, as well as at 2, 4, 6, and 12 months after completed prosthodontic treatment; thereafter, the patient was examined annually. Radiographic examination was performed immediately after the abutment connection, and after a further 6 months, 1 year, 2 years, and 3 years (Fig. 8). These final-stage X-rays revealed slight resorption of approximately 1 mm around two fixtures in the maxilla, but otherwise the results were successful. There were no clinical problems, and the patient reported that she could use the prostheses without difficulty.

Discussion

The restoration of totally or partially edentulous jaws with endosseous implants is usually successful, but it is often difficult to treat a severely or moderately resorbed maxilla. To overcome this, various types of bone graft are needed to augment the alveolar ridge (2). However, treatment planning in these cases is not easy, due to the influence of various factors on the final outcome (3). The success rate of bone grafts is variable, and the implant survival rate is unpredictable (4,5). In addition, designing the implant prosthesis to give the patient the expected result is complex, because the design must take into consideration the position, direction and number of implant fixtures, as well as such factors as the likely level of dental hygiene.

In the mandible, similar success rates have been reported for all types of bone graft, placed simultaneously or secondarily (5,6). In the maxilla, most authors agree that inlay bone grafts, veneer bone grafts and the use of cancellous bone chips are usually successful, and they recommend similar surgical procedures (7). However, although a consistent success rate of 85% to 98% has been reported for sinus bone grafts (8), opinions vary about the appropriate time to perform them and whether block or chip type grafts should be used (9). The biggest variation in authors' results occurs in relation to implant survival rates when combined with any type of bone graft in the maxilla: a range of 25% to 85% has been reported

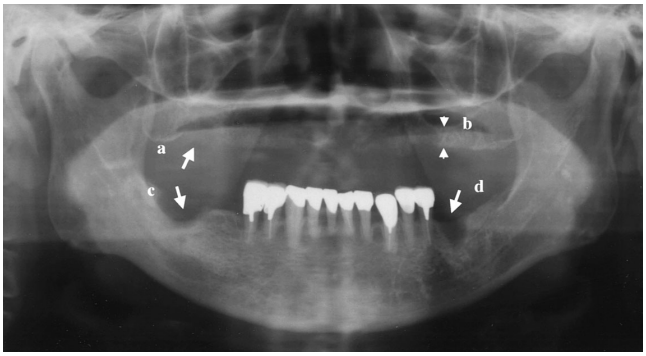

Fig. 1 Initial panoramic X-ray examination:(a) Moderate concavity in 1st and 2nd molar area, (b) Sinus height reduced to 7 mm, (c) & (d) Radiolucent areas at tooth extraction sites.

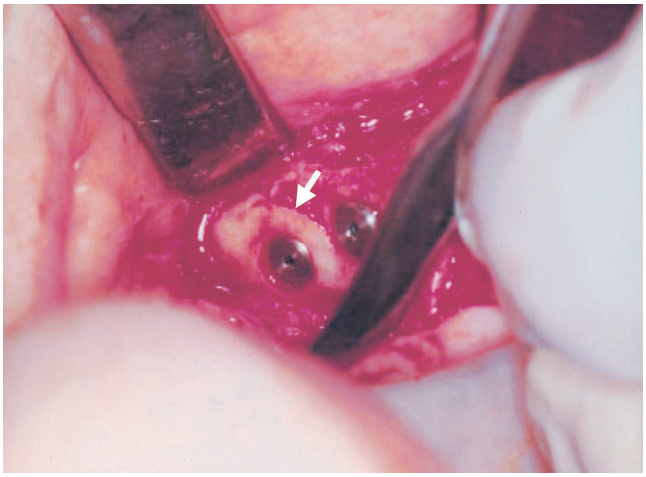

Fig. 2 Inlay bone graft at the right side of the maxillary alveolar ridge with simultaneous placement of self-tapping fixture (indicated by arrow) through a hole drilled in the graft.

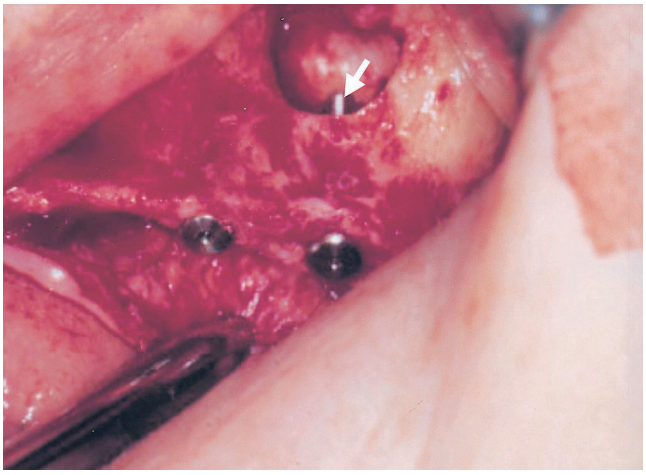

Fig. 3 Sinus augmentation at left side of maxilla, with simultaneous placement of implant fixtures. Arrow indicates exposed tip of a standard Brånemark fixture.

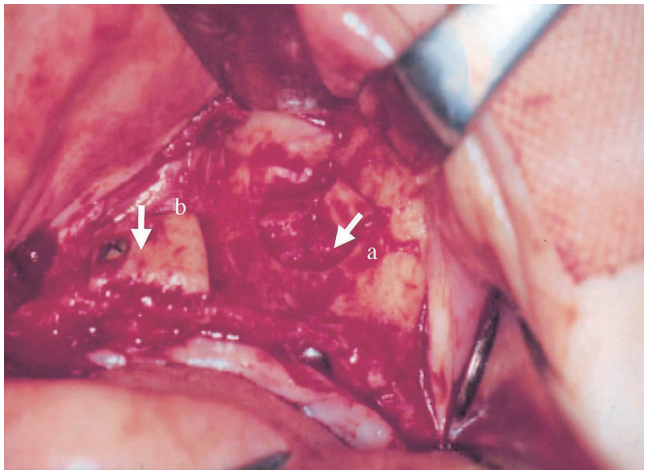

Fig. 4 (a) Cavity in the maxillary sinus is packed with bone chips; (b) labial view of veneer graft fixed with a mini-screw.

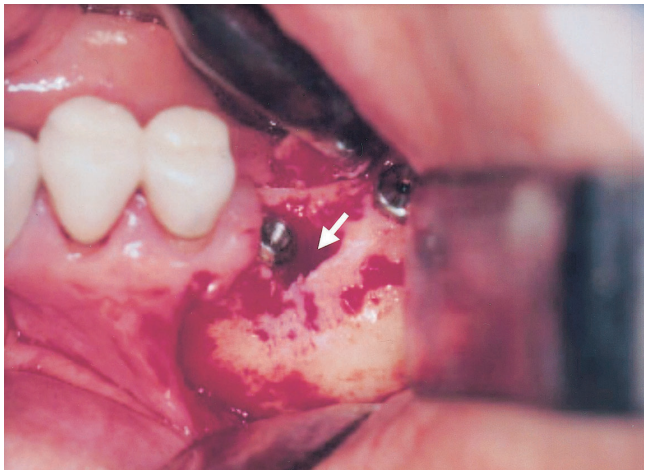

Fig. 5 Two standard Brånemark fixtures are placed in the left-side first molar area of the mandible. Arrow indicates the exposed thread of a fixture.

Fig. 6 Bone chips are firmly packed around the exposed fixture threads in the mandible. Arrow indicates how fixture thread is covered.

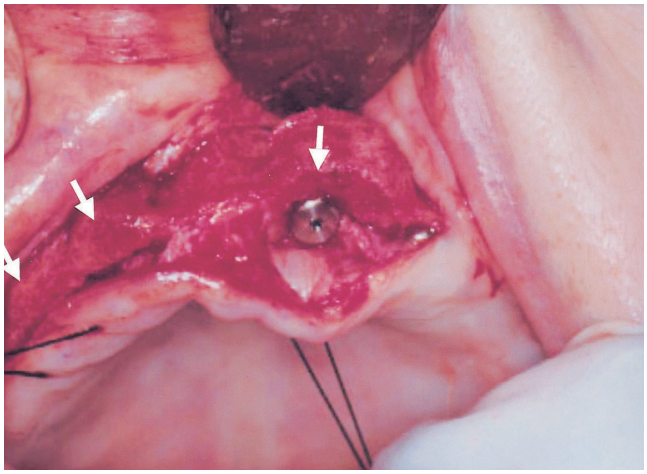

Fig. 7 An additional implant fixture is placed in the maxilla, at the left-side canine area. Arrows indicate the augmented bone volume at the area of the veneer grafts.

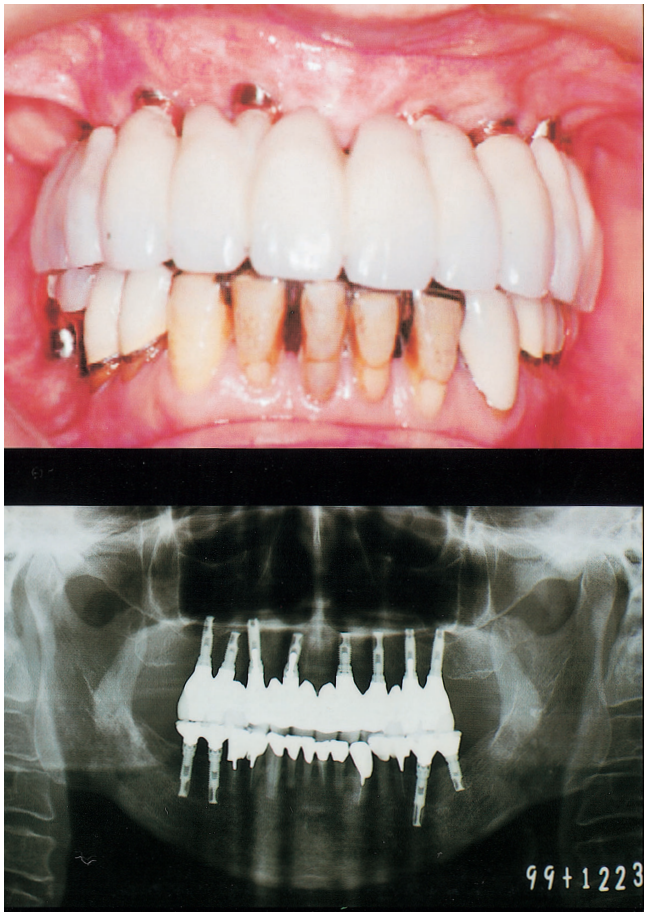

Fig. 8 Three years following placement of the prostheses: (Above): Intraoral view showing full arch prosthesis in the maxilla and two bridge-type prostheses in the mandible. (Below): Panoramic X-ray film showing eight fixtures supporting the full arch prosthesis in the maxilla, and two fixtures on each side supporting the bridge-type prostheses in the mandible.

(10). There are many risk factors that affect survival rates, and the most significant ones have yet to be clearly identified (4).

In combination with implant treatment, most authors report using only one or two types of bone graft, in either or both jaws. The case reported here is unusual, because four different types of bone graft were used. This is because the patient had requested full bridge prostheses to be installed in each jaw to support many implant fixtures. To prepare for this, a variety of problems in both jaws had to be treated: significant bony defects, thin and narrow alveolar ridges, and a lack of alveolar height. In such cases, other authors have reported using a sinus bone graft on both sides of the maxilla (11). However, in this case there was not enough graft material to apply this technique. Another alternative is a Le Fort 1 osteotomy using the sandwich technique with simultaneous placement of fixtures to attach the graft to the residual bone. However, it is difficult to correctly align the implanted teeth following this procedure and lower implant survival rates have been reported compared with other grafting techniques (12). For these reasons, a combination of veneer, inlay and sinus bone grafts was selected for this case, to provide the most suitable solution for each problem area and to increase the likely survival rate of the implants. Because of the complexity of the procedure, special attention was paid to treatment planning and a satisfactory result was obtained for the patient.

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