Treatment of Micrognathia with Edentulous Maxilla by Sagittal Split Mandibular Osteotomy and a Subperiosteal Implant Immobilized with Transmaxillary Screws

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Micrognathia complicated by edentulous maxilla was treated by performing sagittal-split mandibular osteotomy and immobilizing a subperiosteal implant using transmaxillary screws. The patient was a 42-year-old man who had a birdlike facial deformity caused by significant hypoplasia of the mandible. He also demonstrated significant malocclusion attributable to micrognathia and edentulous maxilla caused by resorption of the alveolar bone. These conditions impaired his mastication and articulation, making it impossible for him to eat regular food or carry out normal conversation. A subperiosteal implant was placed on the edentulous maxilla, and was rigidly immobilized to the maxilla using five transmaxillary screws. A prosthesis was then attached to the implant, and by using the implant as the point of reference and the anchor, the mandible was moved forward by sagittal-split mandibular osteotomy. Intermaxillary fixation was subsequently performed. The postoperative course has been favorable, and his facial complexion has improved significantly. One and a half years after his surgery, there has been no sign of complications or malocclusion caused by mandibular retraction. He is now able to eat regular food and speak normally.

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In general, micrognathia is treated by moving the mandible forward by sagittal-split mandibular osteotomy. However, when the maxilla and/or mandible is edentulous, there are three problems: 1) because of missing teeth, which generally act as reference points, the degrees of forward shift of the mandible and the location of the occlusal plane cannot be accurately determined; 2) there is no anchor for intermaxillary fixation; and 3) the postoperative recovery of masticatory movement is insufficient. Although mandibular lengthening treatment by bone distraction has been performed in recent years,[1–6] this technique only solves the problem of intermaxillary fixation, leaving the other two problems to be solved.

Compared with dentures, dental implants allow the recovery of more natural masticatory movement. Because of recent technical advances and the development of improved implant materials, dental implants have been established as a safe treatment method.[7–10] Dental implants can be roughly divided into two groups: endosteal and subperiosteal types. Both of these types of implants are effective in restoring masticatory movement with a partially or completely edentulous jaw. However, implants attach to the jaw much more weakly than natural teeth, and are particularly vulnerable to pulling or tractive forces. Therefore, it is impossible to use a dental implant as the anchor for intermaxillary fixation. If an

implant can be attached to the bone more rigidly so that it can withhold greater degrees of tractive force, then a prosthesis can be attached to the implant to perform intermaxillary fixation. When this technique is applied in surgery for micrognathia complicated by edentulous jaw, the mandible can be moved precisely and favorable restoration of masticatory movement can be expected. Thus, this technique overcomes all three of the abovementioned problems. We devised a treatment method that firmly immobilizes the frame of a subperiosteal implant in a bicortical manner using screws that penetrate the jaw bone. We used this method to treat a patient with micrognathia complicated by edentulous maxilla and obtained satisfactory results.

Surgical Technique and Case Report

The patient was a 42-year-old man with micrognathia who had not sought medical treatment for this condition. He presented with a birdlike facial deformity caused by hypoplasia of the mandible (Fig 1) and edentulous maxilla caused by significant resorption of the alveolar bone (Figs 2 and 3). The occlusal relationship between the maxilla and mandible was extremely poor (Fig 4). Because of marked resorption of the alveolar bone, his denture did not fit his mouth properly. Furthermore, because of impaired masticatory movement, the patient could not eat regular food, nor could he carry out normal conversation because of air leakage through his mouth. Consequently, we attempted to correct the birdlike facial deformity, impaired masticatory movement, and articulation simultaneously.

Fig 1 Forty-two-year-old man with micrognathia. Facial profile before surgery.

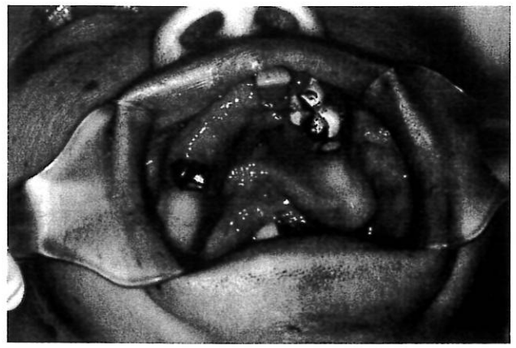

Fig 2 Edentulous maxilla before surgery.

The treatment consisted of four stages: 1) first-stage surgery, 2) casting the frame of a subperiosteal implant and preparing a temporary prosthesis (temporary teeth), 3) second-stage surgery, and 4) removing the temporary prosthesis and inserting a permanent prosthesis (fixed teeth).

First-Stage Surgery

An incision was made in the gingiva at the alveolar ridge, and the periosteum was stripped back from the maxilla until the infraorbital foramen (the buccal side of the maxilla) and the greater palatine foramen (the palatal side of the maxilla) were confirmed.

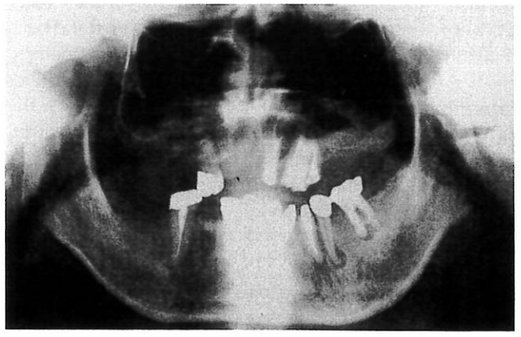

Fig 3 Preoperative orthopantomograph. Marked resorption of the alveolar bone is confirmed.

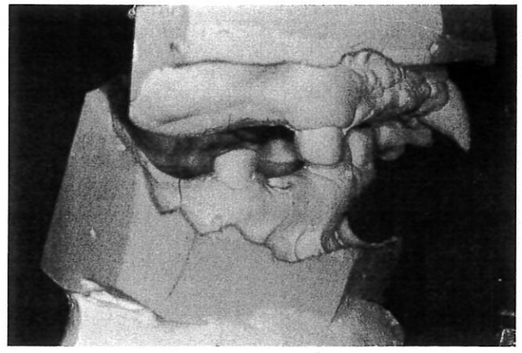

Fig 4 Preoperative occlusal model. Significant malocclusion is confirmed.

Next, using a 2-mm drill, small holes penetrating the maxilla from the buccal side to the palatal side were made (Fig 5A). A total of five holes were made starting about 1 to 1.5 cm from the alveolar ridge at an interval of about 1 cm. Then, a precise impression of the maxilla and the holes was taken (Fig 5B). During this procedure, the buccal and palatal holes made in the maxilla were plugged with small cotton balls so that the impression material would not enter the holes and the precise location of the holes would be identifiable. After confirming that an accurate impression was obtained, first-stage surgery was concluded by suturing the gingiva.

Casting the Frame of Subperiosteal Implant and Preparing Temporary Prosthesis

Using the above impression, a plaster model of the mandible was prepared, and then the frame of a subperiosteal implant was constructed using pure titanium. The frame was made so that about 5 mm of casing in the shape of a basket surrounded the maxilla. The casing of the frame was designed so that it would completely cover all the entrances of the five small holes that were made during the first-stage surgery. In addition, 2-mm holes were made in the frame to match the location of the entrances of the five small holes (Figs 6A and 6B). A tap drill was then used to make a groove matching the 2-mm screws so that the screws penetrating the maxilla from the lingual/buccal side to the palatal side could be tightened.

Next, a temporary prosthesis matching the mandibular occlusion was prepared, and brackets were attached to the lingual and buccal sides of the prosthesis so that intermaxillary fixation could be performed (Fig 6B).

Second-Stage Surgery

Two weeks after first-stage surgery, the maxilla was again exposed by stripping the periosteum. The implant frame was attached to the maxilla, and the frame was immobilized by screwing 2-mm pure titanium screws from the lingual/buccal side to the palatal side through the five holes made during first-stage surgery (Fig 7A). After sufficiently tightening the screws, the excess part of the screws on the palatal side was cut to match the plane of the implant frame, and the gingiva was again sutured.

Next, a sagittal-split mandibular osteotomy was performed to shift the mandible forward. At this time, the prosthesis that was prepared beforehand was attached to the implant frame, and intermaxillary fixation was performed at the appropriate loca-

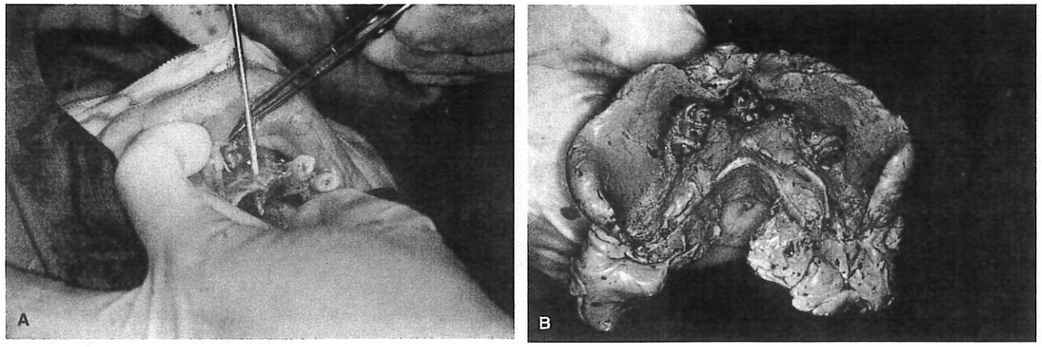

Fig 5 (A) During first-stage surgery, a 2-mm bur is used to make small holes through maxilla. (B) Detailed impression of maxilla and opening of small holes.

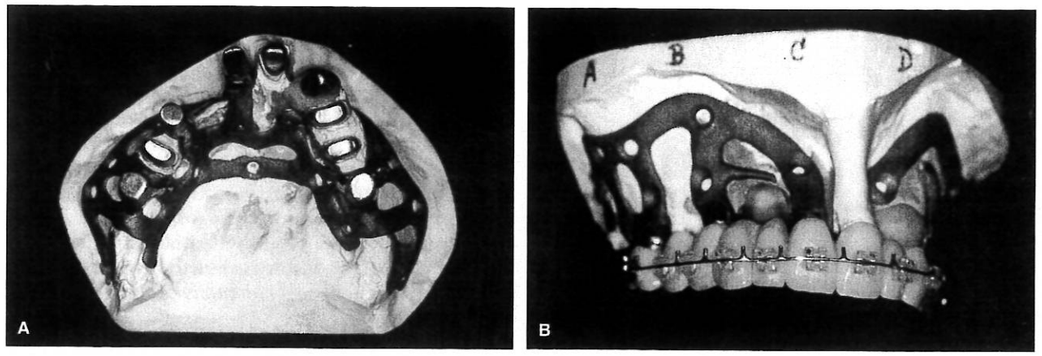

Fig 6 (A) Frame of subperiosteal implant for maxilla. (B) Frame of subperiosteal implant with prosthesis. On anterior surface of denture, brackets for intermaxillary fixation were attached.

tion (Fig 7B). The mandible was shifted forward approximately 12 mm in this case. While maintaining this position, the mandible was immobilized using screws at three positions in the right and left sides. After completing these procedures, intermaxillary fixation was temporarily released, and the mandibular gingiva and mucous membrane were sutured.

Intermaxillary fixation was resumed for 4 consecutive weeks the day after the patient was fully awakened from anesthesia.

Removing Temporary Prosthesis and Inserting Permanent Prosthesis

Intermaxillary fixation was completed 4 weeks after second-stage surgery. The patient was asked to eat with the temporary prosthesis for 4 weeks to detect any sign of mandibular retraction or slight shifts in occlusion. After confirming that the occlusal condition had not changed, the temporary prosthesis was removed (Fig 8A), and another impression was obtained to prepare a permanent prosthesis. The temporary prosthesis was then reattached. It took 3 weeks to make the permanent prosthesis, at which time it was fitted to the patient (Fig 8B).

The patient experienced no complications such as infection, and after releasing intermaxillary fixation, the patient's masticatory movements improved remarkably and he was able to eat regular food. In addition, the articulation disorder caused by air leakage improved sufficiently to allow the patient to carry out normal conversation. At present (one and a

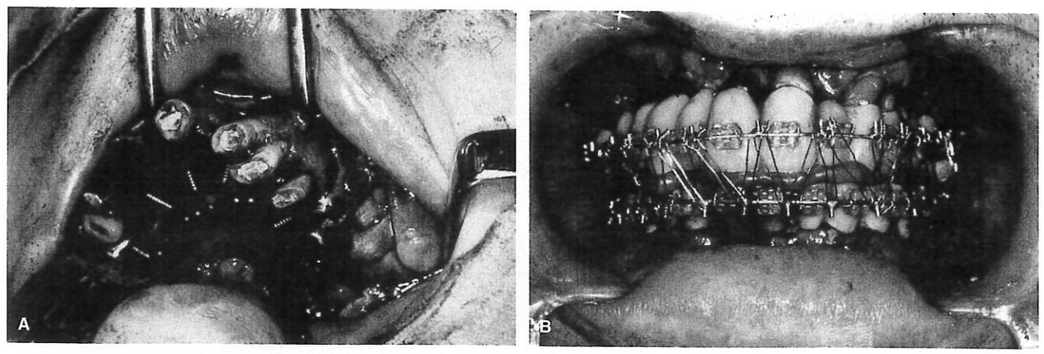

Fig 7 (A) During second-stage surgery, five transmaxillary screws were tightened to immobilize frame of subperiosteal implant to maxilla. (B) After sagittal-split mandibular osteotomy, temporary denture was inserted and intermaxillar fixation was performed.

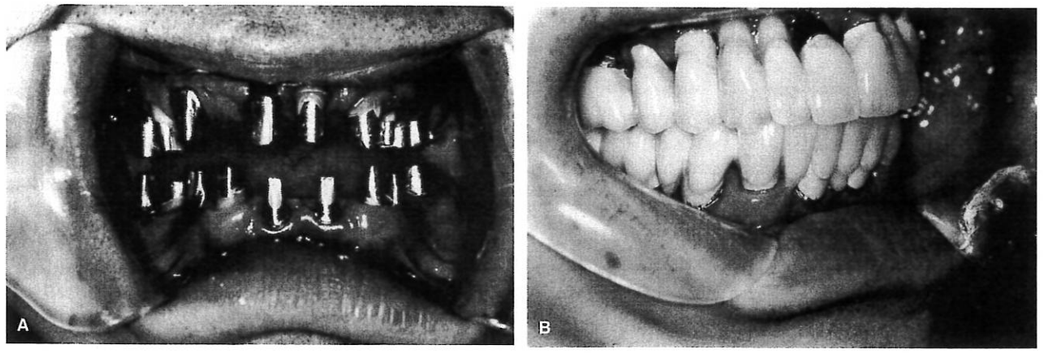

Fig 8 (A) Nine weeks after second-stage surgery, temporary prosthesis was removed to take impression to prepare permanent prosthesis. (B) Twelve weeks after second-stage surgery, permanent prosthesis was fitted.

half years after the completion of surgery), the mandible has not retracted, and he has maintained favorable occlusion (Fig 9A and 9B). The birdlike facial deformity has almost disappeared (Fig 9C), and the patient and his family are very pleased with the surgical outcome.

Discussion

The biggest difference between the conventional endosteal or subperiosteal implant methods and the proposed subperiosteal implant method using transmaxillary screws is that the proposed method is highly resistant to tractive force. In the conventional implant method (either endosteal or subperiosteal methods), implants demonstrate reasonable resistance to compressive force, but are extremely vulnerable to tractive force, particularly shortly after surgery. Therefore, we devised a method in which a subperiosteal implant is immobilized using transmaxillary screws, thus achieving high rigidity between the implant and the jaw bone.

By applying this technique to treat patients with micrognathia complicated by an edentulous jaw, surgery canbe performed safely and accurately and the postoperative masticatory movement can be restored favorably. In general, a denture is used as an anchor in patients with micrognathia complicated by an edentulous jaw or an old facial fracture. However, unlike dentures, implants can restore more natural masticatory movement. Furthermore, because there is no feeling of having a foreign object in the mouth

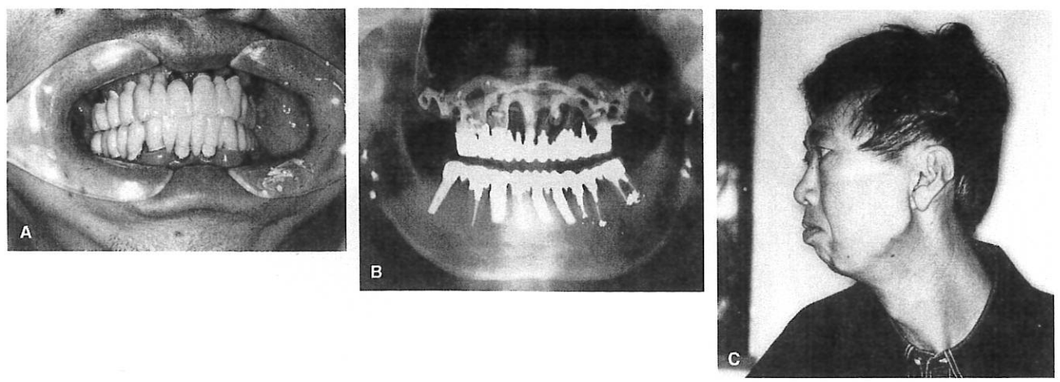

Fig 9 (A) Occlusion one and a half years after surgery. (B) Orthopantomograph one and a half years after surgery. (C) Facial profile one and a half years after surgery.

and the sense of taste is not negatively affected, the present technique significantly improves the quality of life of patients.

One of the disadvantages associated with subperiosteal implants is their weak attachment to the bone, particularly shortly after surgery.[11,12] The movement of subperiosteal implants in the mouth can lead to infection. As a result, the endosteal implant method is being more widely performed. The cause of weak attachment can be explained in part by the fact that a subperiosteal implant is supported only by the periosteum and the undercut of the bone, and that a gap is likely to form between the frame and bone. To solve these problems, we developed a transmaxillary screw fixation method. In this method, because the implant frame is immobilized in a bicortical manner, it is attached to the bone very firmly. Also, by using four to six screws, the frame and the jaw bone are united. Furthermore, by sufficiently tightening the screws, the frame is pushed against the bone surface, thus decreasing the risk of gap formation (Fig 10). At our institution, the proposed technique has been used on 13 jaw bones of 12 patients with partially or completely edentulous jaw complicated by significant resorption of the alveolar bone, and all 12 patients were able to eat regular food within 2 weeks after surgery. The postoperative period ranged from 8 months to 3 years and 8 months (average: 2 years and 4 months). None of these patients required removal of the implant because of postoperative infection, and all 12 patients are now eating regular food. These findings suggest that the safety of subperiosteal implants can be improved significantly by using a titanium implant frame, markedly increasing the attachment strength of implants to the jaw bone and eliminating the gap between the implant and jaw bone.[13] However, long-term follow-up is necessary in these patients.

Other advantages of using subperiosteal implants rather than endosteal implants are that subperiosteal implants can be directly used in patients with alveolar bone resorption and that it can be performed without surgical invasiveness to the donor site and the maxillary sinuses.[14–16] In the present patient, long-term use of an ill-fitting denture caused significant resorption of the alveolar bone in the molar region (Fig 3). As a result, it would have been necessary to graft the iliac bone and perform sinus lift before attempting the use of an endosteal implant. Considering the surgical invasiveness to the donor site and maxillary sinuses and the length of this type of treatment (more than 6 months after surgery), the present method using transmaxillary screw fixation is a rational and effective method for patients with significant resorption of the alveolar bone, because the present method made early normal masticatory movement (within 2 weeks after surgery) possible with no invasiveness to the donor site.

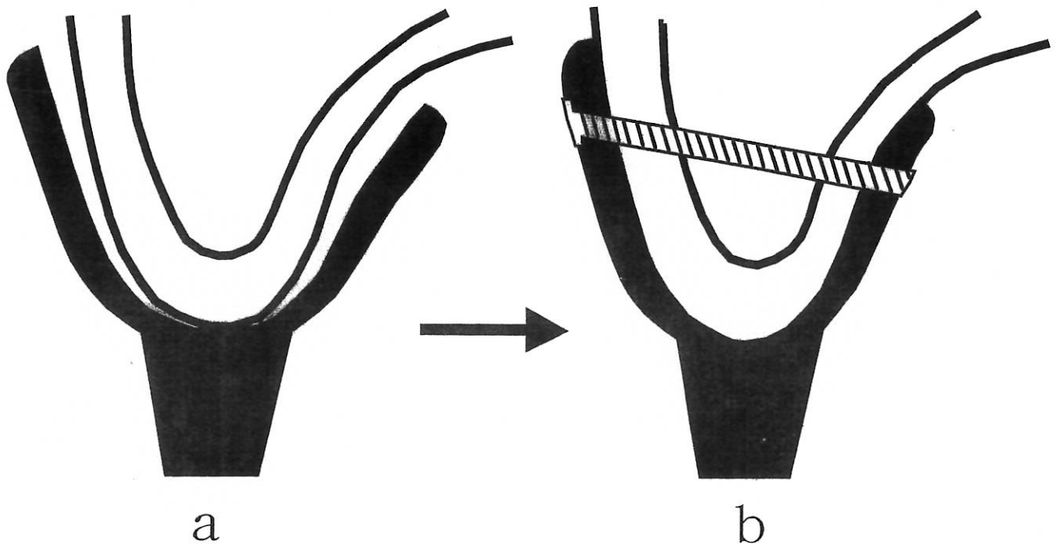

Fig 10 The rigid fixation method for subperiostal implant using transmaxillary screws.

Conclusion

The present study examined a treatment method for micrognathia complicated by edentulous maxilla through the use of a subperiosteal implant immobilized with transmaxillary screws and sagittal-split mandibular osteotomy. This subperiosteal implant method is a rational and effective technique not only for micrognathia complicated by edentulous jaw, but also for other conditions complicated by edentulous jaw requiring osteotomy, because the location of the occlusal plane and the degree of shift of the jaw bone after osteotomy can be determined accurately, intermaxillary fixation can be performed just after the osteotomy, and normal masticatory movement can be restored favorably within a short period after the operation.

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