Distraction osteogenesis for reconstruction after mandibular segmental resection

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Distraction osteogenesis with the shortening and lengthening method is a well-established procedure for repairing extremities. We used this technique for reconstruction after mandibular segmental resection. A 74-year-old woman underwent distraction osteogenesis with an intraoral device, initially shortening the mandible after a 20-mm-long segmental resection, followed by lengthening at a rate of 0.8 mm per day for 21 days. Eight weeks after the distraction, the device was removed and a dental implant was placed at the site of distraction. Radiographic observation showed new bone formation, and the implant was completely osseointegrated. Although the follow-up period is relatively short, the clinical course was uneventful. Distraction osteogenesis with the shortening and lengthening method seems to be a feasible option for reconstruction after segmental resection of the mandible. **(Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2002;93:21-6)**

Distraction osteogenesis of the mandible is a promising method, not only for correcting mandibular hypoplasia—such as hemifacial microsomia[1]—but also for reconstructing the bone defect after segmental resection of the mandible.[2] The bone transport technique and compression osteogenesis have been used for mandibular reconstruction in gunshot defects[3] and resected bone defects.[2]

Distraction osteogenesis with the shortening and lengthening method, or resective distraction osteogenesis, is a new approach to treat segmental diaphysial bone defects by initial limb shortening with secondary distraction osteogenesis from the same site.[4] Meffert et al[5] demonstrated that the bone regeneration characteristics of this technique are not different from those of simple lengthening procedures. Although this method is well established for repairing extremities, there is, to our knowledge, no report of its use for mandibular segmental bone defects. This method seems to be clinically useful because there is no need to transport bone and no scar formation of the skin by the use of the extraoral devices. Here we report a case in which this method was applied for reconstruction after segmental resection of the mandible.

CASE REPORT

A 74-year-old woman was referred to us for swelling and pain from the left mandibular body to the submandibular region. At the initial visit there was a fistula on the skin in the left submandibular region. She was edentulous in both the upper and lower jaws. In her oral cavity there was also a fistula in the left canine region of the alveolar ridge. A panoramic radiograph and computed tomography scan showed radiolucency and sequestration from the crest to the rim of the left canine region of the mandible (Fig 1). A biopsy specimen showed chronic osteomyelitis of the mandible. The initial treatment plan was to perform a segmental osteotomy and bone graft. However, she refused to undergo bone grafting.

We then performed distraction osteogenesis with the shortening and lengthening method. With the patient under general anesthesia, a mucoperiosteal flap was raised and the affected bone was exposed (Fig 2). Because the infectious bone was evaluated as 16-mm-long, a segmental osteotomy 20-mm-long medially to the mental foramen including the safety margin was then performed with a reciprocating saw. A fresh infectious-free bone was identified at both ends of the mandible. Subsequently, we shortened the mandible. Simultaneously, fistulectomy of the fistulas in both the skin and oral mucosa was performed, and the affected periosteum was also removed. Both ends of the mandible were approximated, and an intraoral titanium mandibular distraction device (horizontal type; Medicon eG, Tuttlingen, Germany) was installed (Fig 3).

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Fig 1. Preoperative x-ray view. **A**, Panoramic x-ray; **B**, computed tomography scan.

After a 10-day period to allow healing of the periosteum, distraction was performed at a rate of 0.8 mm per day (0.4 mm in the morning and 0.4 mm in the evening). After 21 days of distraction for a length of 16.8 mm, postlengthening fixation was performed for 8 weeks. The distraction device was then removed, and a double-Y-type titanium miniplate (Stryker Leibinger, Freiburg, Germany) was placed to stabilize the distracted mandible. Simultaneously, 2 screw-type 15-mm-long dental implants (Astra Tech AB, Göteborg, Sweden) were placed, one in the distracted area and the other in the canine region of the contralateral side (Fig 4). Although the distracted site included fibrous tissue aligned in the direction of distraction, elastically hard tissue was felt during the drilling procedure, and the tip of the implant body was firmly placed into the hard bone (Fig 4), and the initial stability of the implant was sufficient.

Consecutive occlusal radiographs taken immediately after distraction, 4 weeks after distraction, and 8 weeks after distraction are shown in Fig 5. Immediately after distraction, there was no sign of bone formation (Fig 5, *A*). Four weeks after distraction, a few parallel columns appeared at both edges of the mandible (Fig 5, *B*). These parallel columns began to grow. At 8 weeks when the distraction device was removed and the implant was placed, there was a small radiolucent area in the central area. Interestingly, a new bone formation was achieved in the curved structure similar to the original mandibular arch (Fig 5, *C*). The parallel columns from both edges were almost in contact 24 weeks after distraction. After consolidation for 10 months when the radiolucent area completely disappeared, the titanium miniplate was removed and the abutments of the implants were installed (Fig 6). The distracted area was completely consolidated, and the implant placed in this area was completely osseointegrated (Fig 7).

During distraction there were no signs or symptoms of infection or recurrence of osteomyelitis. Moreover, there were no signs or symptoms of temporomandibular joint (TMJ)

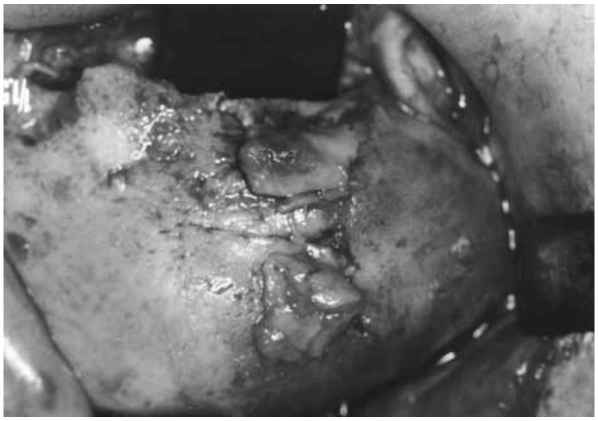

Fig 2. Affected bone subject to mandibular segmental resection.

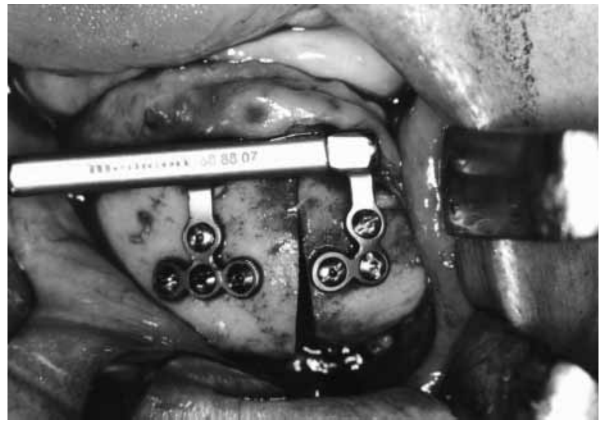

Fig 3. Approximation after segmental resection followed by installation of an intraoral mandibular distraction device.

Fig 4. Panoramic radiograph immediately after the distraction device was removed and an implant was placed in the distracted area.

dysfunction. Eighteen months after the distraction, the clinical course was uneventful. The patient has been using an implant-supported overdenture-type prosthesis with excellent satisfaction and function.

DISCUSSION

Although distraction osteogenesis is a promising method for mandibular reconstruction, it seems to have some limitations. First, because the mandible is a three-dimensional curved structure, a curved distraction appliance is necessary. Second, when the bone transport technique is applied, a bone graft may be required to obtain continuity of the mandible at the end stage of the distraction. Sawaki et al[2] used an extraoral, three-dimensional curved distractor for segmental mandibular defect. In their study, small free bone transplants were required for complete continuity. This new method of shortening and lengthening may overcome these limitations. As shown in Fig 5, *C*, the newly formed bone at the distracted site showed a curved structure similar to the original arch of the mandible. In addition, this method did not require any additional bone transplant to reconstruct the continuity of the mandible. Furthermore, use of an intraoral device also circumvents a hypertrophic facial scar formation.

However, this study raised several questions that must be answered before the technique can be applied in a clinical setting. First, how long of a resected mandible could be reconstructed by using this method? The extent of the distraction seems to be related to the following factors: the regions of the mandible, the distraction devices, and the effects of the TMJs. In this

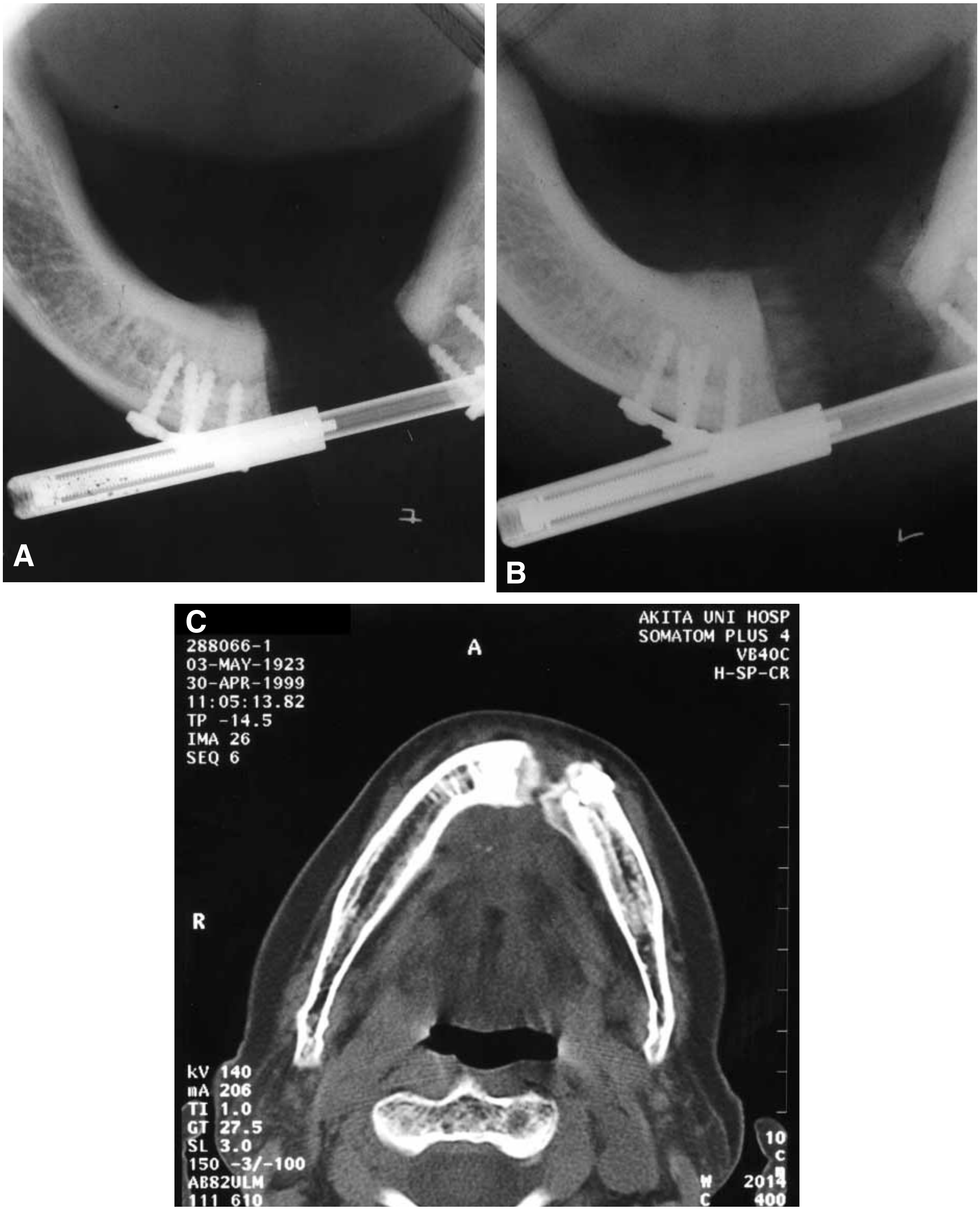

Fig 5. X-ray findings during the distraction period: (**A**) immediately after distraction and (**B**) 4 weeks after distraction. Note that a few parallel columns appeared at both edges of the mandible, extending beyond the lingual plate of the mandible. (**C**) Eight weeks after distraction, before removal of the distraction device and implant placement.

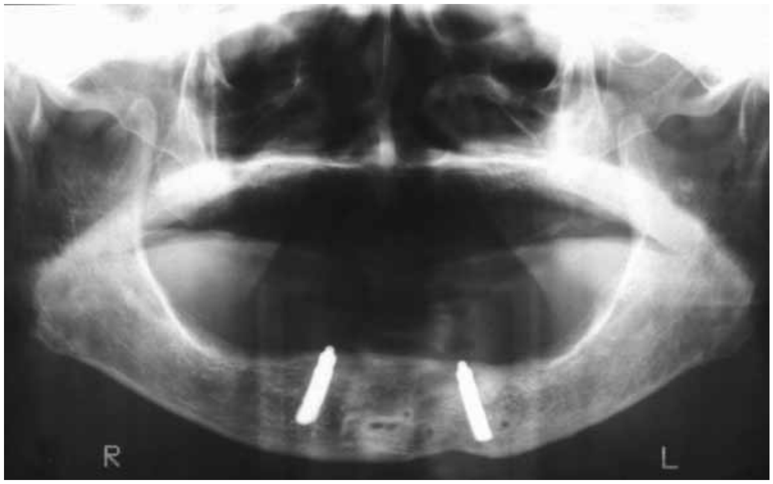

Fig 6. A panoramic radiograph 10 months after distraction, showing complete continuity of the mandible with bone formation. Note that the implant placed in the distracted area was osseointegrated.

study, 20 mm was resected medially to the mental foramen. We used an intraoral straight device. Nonetheless, the curved structure similar to the original mandibular arch was achieved. However, there seems to be a limitation to the length of distraction by using the straight device for the reconstruction of the mandible to the full extent with three-dimensional structure. The development of intraoral curved devices according to the regions of the mandible will be necessary for the full arch reconstruction of the mandible with this method.

Next, in what regions of the mandible could this method be applied? In this study, resection was performed medial to the mental foramen. Practically, the anterior region medial to the mental foramen is the most applicable region. However, the use of this method in other regions such as body and angle seems to be feasible only if an appliance is applicable and both ends of the mandible could be approximated.

Shortening of the mandible seems to have direct effects on the TMJ. Clinically, there were no signs or symptoms in the TMJ after 20-mm shortening followed by lengthening in this study. Furthermore, magnetic resonance imaging findings before, immediately after, and 10 months after distraction showed that there was no disk displacement or condylar dislocation during the treatment period (data not shown). However, there are no data available, so far, as to the effects of the TMJs when we use this technique for the reconstruction of other regions of the mandible such as angle. Therefore, more precise study will be necessary as to what extent a particular region of the mandible could be distracted with this method without any problem to the TMJs.

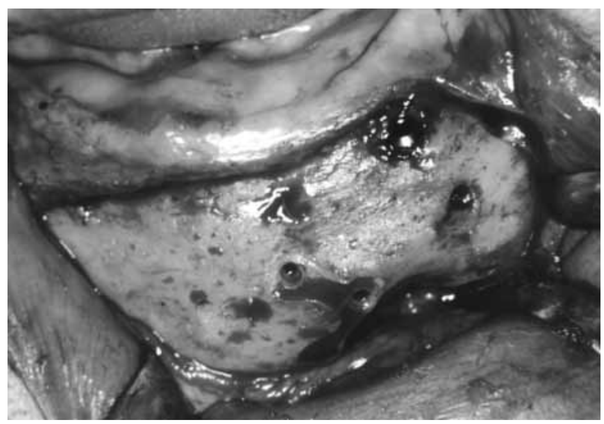

Fig 7. Distracted area was completely consolidated.

It also remains to be determined whether the distracted bone develops a normal mature structure in elderly patients, or whether the rate of distraction and the fixation period should be changed in this group. In this study the patient was 74 years old, and the consolidated bone was strong enough to support a dental implant–supported prosthesis. Therefore, this method appears to be useful clinically, even in elderly patients.

An implant was placed 8 weeks after the distraction, when the distraction device was removed. At this time the distraction site was filled with fibrous soft tissue and hard tissue was felt during the drilling procedure, and the tip of the implant body was firmly placed into the solid bone. One could suspect that the stability of the implant was insufficient and the osseointegration was hardly obtained when an implant was placed during the consolidation period. However, on radiographic evaluation, the direction of the implant immediately after placement was identical to that on the image 24 weeks and 10 months after implant placement. Furthermore, osseointegration was confirmed in the distracted area. Because there are few reports on implant placement in a distracted site,[6,7] the optimum timing of implant placement is still unclear. Nosaka et al[8] demonstrated by using dogs that the optimum time for placing implants in the distraction site was 3 weeks after the completion of distraction. This case report supports their study, in that osseointegration of the implants placed in the distraction site was achieved during the consolidation period. The discrepancy between the study of Nosaka et al and this study in the interval after completion of the distraction may reflect a species difference or the age of the implant recipient. Further study is necessary to determine the optimum time for implant placement.

In conclusion, distraction osteogenesis with the shortening and lengthening method seems to be a viable option for mandibular reconstruction. The advantages of this method for mandibular reconstruction are as follows; there is no need for (1) a bone transport technique, (2) bone grafting at the end stage of the distraction when free bone transplants are needed for complete continuity, or (3) a curved extraoral device. However, care should be taken to prevent possible damage to the TMJ and to limit the length of distraction. Therefore, more precise study is needed to determine the application and limitations of this method for maxillomandibular reconstruction.

REFERENCES

1. McCarthy JG, Schreiber J, Karp N, Thorne CH, Grayson BH. Lengthening the human mandible by gradual distraction. Plast Reconstr Surg 1992;89:1-10.
2. Sawaki Y, Hagino H, Yamamoto H, Ueda M. Trifocal distraction osteogenesis for segmental mandibular defect: a technical innovation. J Craniomaxillofac Surg 1997;25:310-5.
3. Shvyrkov MB, Shamsudinov AK, Sumarokov DD, Shvyrkova II. Non-free osteoplasty of the mandible in maxillofacial gunshot wounds: mandibular reconstruction by compression-osteodistraction. Br J Oral Maxillofac Surg 1999;37:261-7.
4. Betz AM, Stock W, Hierner R, Baumgart R. Primary shortening with secondary limb lengthening in severe injuries of the lower leg: a six year experience. Microsurgery 1993;14:446-53.
5. Meffert RH, Tis JE, Inoue N, McCarthy EF, Brug E, Chao EY. Primary resective shortening followed by distraction osteogenesis for limb reconstruction: a comparison with simple lengthening. J Orthop Res 2000;18:629-36.
6. Chiapasco M, Brusati R, Galioto S. Distraction osteogenesis of a fibular revascularized flap for improvement of oral implant positioning in a tumor patient: a case report. J Oral Maxillofac Surg 2000;58:1434-40.
7. Urbani G, Lombardo G, Santi E, Consolo U. Distraction osteogenesis to achieve mandibular vertical bone regeneration: a case report. Int J Periodontics Restorative Dent 1999;19:321-31.
8. Nosaka Y, Tsunokuma M, Hayashi H, Kakudo K. Placement of implants in distraction osteogenesis: a pilot study in dogs. Int J Oral Maxillofac Implants 2000;15:185-92.

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