The floating bone technique of the vertical ramus in hemifacial microsomia: Case report

This article describes a case in which distraction osteogenesis of the vertical ramus of the mandible was used for a young woman with hemifacial microsomia. Failure of distraction occurred because of the wrong vector of distraction. The floating bone technique was applied to the vertical ramus and was used to correct the malocclusion and to recover the height of the vertical ramus. Complete skeletal correction of the asymmetry was obtained, with excellent esthetic results. The case shows that the floating bone technique is a valid method to help the surgeon in the management of malocclusion after distraction and also in cases of failure of distraction. The floating bone is possible on both the vertical ramus and on the horizontal ramus. (Int J Adult Orthod Orthognath Surg 2002;17:223–229)

Distraction osteogenesis is a technique for generating new bone by stretching the callus. The method was first described by Codivilla in 1905 to elongate a femur. McCarthy et al applied the concepts of distraction osteogenesis to lengthening of the mandible. This permits the correction of skeletal deformities in hemifacial microsomia.

Mandibular hypoplasia concerns ascending ramus and gonial angle and can be associated with maxillary asymmetry and oblique plane of occlusion, microtia, and soft tissue hypoplasia. Traditional surgical-orthodontic approaches for these patients often do not meet expectations, especially concerning the stability of the results and the achievement of normal facial esthetics and proportions. By distraction osteogenesis, significant skeletal and soft tissue enlargement can be obtained in the hypoplastic area in a short period.

The success of the procedure depends on correct preoperative planning and surgical and postsurgical management. An important biomechanical parameter of distraction osteogenesis is the orientation of the distractor appliance, or the distraction vector, relative to the anatomic axis of the bone segments and maxillary occlusal plane. Complications such as distraction failure or malocclusion can occur.

Hoffmeister et al described the floating bone technique as a method for manipulating the callus formation to guide the mandible into the desired occlusion. The method was described in the treatment of mandibular hypoplasia using distraction in the horizontal ramus.

This report describes a patient in whom the floating bone concept was applied to the ascending ramus and was used to remedy a failure of distraction.

Report of case

A 17-year-old woman was referred to the maxillofacial surgeon for evaluation and subsequent correction of a facial asymmetry caused by right-sided hemifacial microsomia (Figs 1a and 1b). According to the classification proposed by Pruzansky and modified by Murray et al, the patient had hemifacial microsomia grade IIA.

Orthodontic therapy was applied before distraction (Fig 1b). In planning the treatment, an orthopantomogram (Fig 2a), lateral and frontal cephalograms, and 3-dimensional computed tomographic scans...
(Fig 2b) were made to assess the severity of the microsomia, the different heights of the mandibular ramii, and the maxillary asymmetry, so as to calculate the quantity of distraction and the distraction vector needed.

From these images, models were constructed and then mounted on a semiajustable anatomic articulator by a facebow transfer. The occlusal plane inclination was calculated and model surgery was performed (Fig 3a). Unilateral vertical ramus distraction was planned. The distraction vector needed to be vertical because the device is placed perpendicular to the osteotomy (Fig 3b).

The occlusal plane had an inclination of 1.5 cm with respect to the bipupillary plane and the vertical ramus on the right side was 1.5 cm shorter than that on the left side. Therefore, this was the quantity of mandibular ramus lengthening necessary to create an open bite on the lengthened side and subsequently to perform additional maxillary inferior repositioning as a second stage.

Mandibular osteodistraction was performed under general anesthesia. An intraoral distraction device (Martin) was used. The distraction device was positioned in place through a transoral incision, and a preplating was made (holes were made, screws were positioned and then removed with the device). A complete horizontal osteotomy of the ascending ramus was performed over the entrance of the mandibular nerve and the distractor was inserted. Three screws were placed on each side of the osteotomy (Fig 4). An orthopantomogram and lateral and frontal cephalograms
were made immediately postoperatively to verify that the device was placed in the exact position as planned (Figs 5a and 5b). The shape of the available distraction device and surgical difficulties did not permit placement of the device in a correct position, so the vector was not perpendicular to the osteotomy (the vector had an inclination of about 40 degrees with respect to the vertical ramus).

A waiting period of 6 days passed, and then distraction started at a rate of 1 mm daily, activated by an intraoral rod. The distraction device was activated a total of 1.5 cm. However, failure of distraction occurred because of the wrong vector, and the open bite on the right side did not occur. Instead, the mandible moved transversely, and a crossbite occurred (Fig 6a). The condylar segment of the osteotomy underwent a counterclockwise rotation, and osteodistraction occurred only on the anterior border of the mandible (Fig 6b).

As suggested by Hoffmeister et al, the distraction device was removed with the patient under general anesthesia only 2 weeks after the end of the distraction period to manipulate the callus formation and remedy a failure of the distraction.

First, the crossbite was corrected by elastic traction. Then 2 occlusal splints were required: an anterior splint to maintain the interincisal lines centered with each other, and a lateral occlusal splint to create the open bite on the hypoplastic side (Fig 7a). The lateral occlusal splint was made of increasing height (1 to 2 mm daily) to generate the open bite and to maintain a correct maxillomandibular relationship. On the opposite side, elastic traction maintained the bite closed.

Once the planned open bite (Fig 7b) and esthetic symmetry of the mandible were obtained, maxillomandibular fixation was applied and maintained for 20 days to stabilize the occlusion. Two months later, traditional orthognathic surgery on the maxilla was performed under general anesthesia. A Le Fort I osteotomy was made with interpositional bone graft (Fig 8), and the maxilla was repositioned inferiorly so that the occlusal plane became parallel to the bipupillary plane. At the same time, a Medpor prosthesis, fixed by 1 screw (Fig 9c), was positioned on the external cortex of the mandible to improve the transverse diameter at the gonial angle.
Figs 5a and 5b Postoperative radiographs show the incorrect position of the distraction device; the distraction vector had an inclination of about 40 degrees with respect to the vertical ramus.

Fig 6a Intraoral view showing the crossbite after distraction, with the mandible moved transversely.

Fig 6b Panoramic radiograph showing failure of distraction. Note the condylar segment with a counterclockwise rotation and the osteodistraction only on the anterior border of the mandible.

Fig 7a The 2 occlusal splints: the anterior splint to maintain the interincisal lines centered with each other, and the lateral occlusal splint of increasing height (1 to 2 mm daily) to generate an open bite at the hypoplastic side and to maintain the right relationship between the maxilla and mandible. On the opposite side, elastics maintained a closed bite.

Fig 7b Intraoral view showing the planned open bite obtained on the hypoplastic side with the floating bone technique of the vertical ramus.
Discussion

Since osteodistraction was introduced in maxillofacial surgery, excellent esthetic results were obtained by this method, because the soft tissues that remain attached to the bone are expanded simultaneously. This is one of the advantages of osteodistraction compared to traditional orthognathic surgery for correction of facial deformities such as hemifacial microsomia.

As suggested by some authors, lengthening of the ascending ramus of the mandible by conventional procedures is unstable, and distraction is proposed for those mandibular hypoplasias in which traditional orthognathic surgery is associated with a high degree of relapse. As in our case, more than 10 mm of lengthening of the ascending ramus, or a small and abnormally shaped ramus as seen in hemifacial microsomia, are some indications to perform distraction osteogenesis.

Mandibular distraction can be done at any age. When mandibular osteodistraction is performed in children, the lateral open bite obtained by the elongation of the vertical ramus is rapidly corrected by vertical growth of the maxilla and by orthodontic compensation. In older patients in whom maxillary growth is completed, orthodontic treatment cannot correct the malocclusion after mandibular distraction. Orthognathic surgery is necessary to correct the maxillary asymmetry and to close the open bite on the affected side. Ortiz-Monasterio et al proposed simultaneous mandibular and maxillary distraction using an extraoral device and showed their results of a series of 7 patients.

In our case we used an intraoral device that was not sufficiently resistant to perform simultaneous distraction of both jaws, so maxillary inferior repositioning was necessary after mandibular distraction. The orientation of the distraction appliance relative to the anatomic axis of the mandible is critical to prevent complications. The length of the vertical ramus is measured from condylium to gonion. If lengthening in the vertical direction is required, the distraction device (the pins) should be placed parallel to the vertical ramus. The distraction vector should be parallel to the vertical ramus and perpendicular to the osteotomy. In our case the failure of the distraction and the subsequent malocclusion occurred because of the wrong distraction vector. In fact, the vector had an inclination of 40 degrees with respect to the ideal vector parallel to the vertical ramus.

We remedied the failure of distraction using the floating bone concept introduced by Hoffmeister et al. According to this concept, the movable callus gives the surgeon and the orthodontist the opportunity to manipulate callus formation and to compensate for the malocclusion that often occurs using distraction procedures. The distraction device must be removed 2 weeks after the distraction period; the mandible is guided into the desired occlusion by means of elastics, and the callus allows the mandible to be floated into the desired position.

Maxillomandibular fixation is required for almost 3 weeks afterward to stabilize the mandibular segments and the occlusion. Hoffmeister et al described this method for the distraction of the horizontal ramus of the mandible. By applying the floating bone concept to the ascending ramus of the mandible, it was possible to solve a distraction failure. The floating bone in this case was utilized as a rescue technique as a second distraction procedure to elongate the vertical ramus where there was no description in the literature. This was possible utilizing occlusal splints of increasing height, which permitted the creation of a lateral open bite and lengthening of the vertical ramus. The height of

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Fig 8  Intraoperative view showing the maxilla repositioned inferiorly by a Le Fort I osteotomy with interpositional bone graft and rigid fixation.
the vertical ramus was controlled daily as a distraction procedure.

As distraction osteogenesis can occur in all directions of space, so can the manipulation of the callus be performed in horizontal and vertical ramus of the mandible. In our case the complete skeletal correction of the asymmetry was obtained, with the occlusal plane parallel to the bipupillary line (Fig 9a). The soft tissues followed the elongation of the mandible, and facial asymmetry was completely corrected with excellent esthetic results. At present, skeletal, facial, and occlusal changes are stable (Figs 9b and 9c), and no relapse has been observed. The distraction of the vertical ramus and the floating bone technique had no influence on temporomandibular joint function. Mouth opening and mandibular movements are in the normal range and there are no articular noises or pain.

The result in this case shows that the floating bone technique can help the management of those situations that require occlusal and skeletal correction and compensation after distraction osteogenesis of the mandible in the vertical ramus.

References