Hemifacial microsomia treated with the Herbst appliance

Report of a case analyzed by means of roentgen stereometry and metallic implants

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The effect of Herbst appliance treatment on facial growth of one patient was recorded in terms of displacement of the mandible and the maxillary bones in relation to the frontal bone. The recordings were made with an accuracy of 0.1 degree and 0.05 mm. (S.D.). Before treatment the jaws were displaced posteriorly and to the affected side with growth, increasing the degree of retrognathia and facial asymmetry. During treatment facial growth was redirected and the jaws were displaced anteriorly and to the unaffected side, decreasing the degree of retrognathia and asymmetry. At the same time, however, the tilt of the mandible to the affected side was increased, possibly because of the morphologic and functional conditions of the jaws in hemifacial microsomia. The dental malocclusion was corrected partly through displacement of the jaws and partly through dentoalveolar adaptation.

Hemifacial microsomia is characterized by deformities of the ear and the mandible. Other structures may also be involved. These include the maxilla, malar bone, zygomatic arch, and soft tissues.\textsuperscript{1,2} The appearance of the patient is dominated by asymmetry. The condyle and the ramus of the mandible on the affected side are hypoplastic or missing, and the dental arches are asymmetric with a midline deviation and a tilted occlusal plane in most patients.

Treatment with a functional appliance, such as the activator, has been recommended for improving muscle function and stimulating growth of the skeletal and soft tissues.\textsuperscript{3-5} The effect of the recommended treatment on skeletal growth has not been documented, however.

With the use of the Herbst appliance\textsuperscript{6} in treatment of Class II malocclusions, Pancherz\textsuperscript{7,8} found that successful treatment was a result of an increased amount of mandibular growth concomitant with dentoalveolar remodeling processes. To stimulate growth of the mandible and, if possible, redirect growth of both jaws toward a more favorable pattern, we decided to use the Herbst appliance in a child with hemifacial microsomia and to assess the effect of treatment by means of roentgen stereometry and metallic implants.\textsuperscript{9,10}

MATERIAL AND METHODS
Subject

Our patient was a boy with hemifacial microsomia, affected on the right side. The mandibular deformity was moderate (Fig. 1). A lateral cephalogram obtained when the boy was 8 years 4 months of age showed bimaxillary retrusion and a steep mandibular plane angle (s-n-ss, 78.5 degrees; s-n-sm, 72.5 degrees; NSL/ML, 38.5 degrees). At the age of 14 years the face was asymmetric with tilting of the jaws and the occlusal plane (Fig. 2). The dental arches were in a Class II relationship on the affected right side and in a normal relationship on the left side (Fig. 3, a). The midline of the mandibular dental arch deviated to the affected side by 3.5 mm. in relation to the midline of the maxillary dental arch, the overbite was 2.0 mm., and the overjet was 5.0 mm. At this time treatment with the Herbst appliance was started. The appliance was removed after 224 days and an activator was used for retention.

The herbst appliance works as an artificial joint between the maxilla and the mandible (Fig. 4). The appliance is fixed to the teeth by means of orthodontic bands. A telescope mechanism on either side of the jaws keeps the mandible continuously in the desired position. The design of the appliance has been described elsewhere. In our patient the appliance was constructed to displace the mandible anteriorly and to the unaffected left side for correction of the mandibular retrusion and asymmetry. The construction bite was taken with the incisors in an edge-to-edge position and with the midline overcorrected by 3.5 mm. (Fig. 3, b).

Implants

Three tantalum implants were inserted in the frontal bone, the mandible, and the right and left maxillary bones (Fig. 5) at the time of surgical reconstruction of the outer ear under general anesthesia. The implant insertion technique has been described earlier.

Roentgenographic examination

Two stereoroentgenograms (observations I and II) were obtained prior to treatment, with an interval of 405 days; one roentgenogram (III) was obtained immediately after the Herbst appliance had been inserted; and one (IV) immediately before the appliance was removed. The interval between examinations III and IV was 224 days. A final stereoroentgenogram (V) was obtained 14 days after termination of treatment.

Calculations

Facial growth was presented in terms of displacement of the mandible and the maxillary bones in relation to the implants in the frontal bone. In the calculations of displacement, each bone was represented by the implant triangle described by the three implants inserted in the
bone (Fig. 5). Displacement of the bones was calculated in terms of rotations about and translations along the three cardinal axes of the head (Fig. 6).

The standard deviation for calculated rotations about any coordinate axis is about 0.1 degree, and for calculated translations along any coordinate axis, about 0.05 mm., as determined from tests of accuracy of the method. These values apply, provided the implants remain stable in their original positions in the bone. At each examination the implant stability was checked.9

RESULTS

Implant stability

The implants remained stable in their original positions in the bone during 713 days of observation. The measure of implant movement within the bone, as expressed by the mean error of rigid-body fitting,9 was 0.016, 0.208, 0.281, and 0.124 mm. for the implant triangle in the frontal bone, the mandible, and the right and left maxillae, respectively.

Displacement of the mandible and the maxillary bones (Fig. 7, Table I)

In observations covering about 2 years between the ages of 12 years 8 months and 14 years 8 months, displacement of the jaws was recorded during a pretreatment period of 405 days (I-II) and during a period of 308 days (II-V) which included 224 days of treatment.

Frontal projection, XY plane (Fig. 7). In the pretreatment period the mandible was translated to the affected right side (along the X axis) together with the maxillary bones, increasing the degree of facial asymmetry. In the treatment period this movement was reversed. At the same time, however, the mandible was rotated about the sagittal (Z) axis to the affected side, increasing the tilt of the jaw.

Axial projection, XZ plane. In the pretreatment period the mandible and the maxillary bones were translated posteriorly (along the Z axis), increasing the bimaxillary retrusion, and the maxillary bones were rotated about the vertical (Y) axis to the affected side. During treatment these movements were arrested or reversed, and at the same time the mandible was rotated about the vertical (Y) axis to the unaffected side, decreasing the degree of asymmetry.

Lateral projection, ZY plane. In both observation periods the mandible was rotated anteriorly about the transverse (X) axis while the maxillary bones were rotated posteriorly.

In summary, in the pretreatment period the mandible and the maxillary bones were displaced to the affected side and posteriorly, increasing the degree of asymmetry and retrognathia. In the treatment period this development was reversed or arrested, but at the same time the tilt of the mandible to the affected side was increased.
A detailed analysis was made of the displacement of the mandible before treatment (I-II), with insertion of the Herbst appliance (II-III), during the time the appliance was in place (III-IV), and with removal of the appliance (IV-V). Mandibular displacement related to degree of asymmetry is given in Table II.

Prior to treatment (I-II) the mandible was translated along the transverse (X) axis to the affected right side. With insertion of the appliance (II-III) the mandible was rotated about the vertical (Y) axis and translated along the transverse (X) axis to the unaffected left side, decreasing the degree of asymmetry. While the appliance remained in place (III-IV) a small relapse of these movements took place, and at the same time the mandible was rotated about the sagittal (Z) axis to the affected side, increasing the tilt of the jaw. With removal of the appliance (IV-V), the mandible was translated slightly further along the transverse (X) axis to the affected side while the tilting movement was arrested.

Mandibular displacement as projected on the sagittal (ZY) plane is shown in Fig. 8. With insertion of the Herbst appliance, the mandible was rotated posteriorly. While the appliance remained in place, this rotation was reversed and the mandible was translated anteriorly. With removal of the appliance, the mandible was translated posteriorly.

In summary, with insertion of the appliance and during the time it remained in place, complex movements of the mandible occurred. Movements decreasing the degree of asymmetry were to some extent coordinated with increased tilting of the mandible to the affected side.

**Dental occlusion (Fig. 3, c)**

At the time of the last examination (V) the dental occlusion was normal on both sides, the midline was overcorrected by 1.0 mm., and the overbite and the overjet were 1.0 mm., respectively. Thus, during treatment the Class II relationship on the affected right side was corrected, the midline of the mandibular dental arch was shifted to the unaffected side by 4.5 mm. in relationship to the midline of the maxillary dental arch, the overbite was reduced by 1.0 mm., and the overjet was reduced by 4.0 mm.

**DISCUSSION**

This study was undertaken to stimulate growth of the mandible in a boy with hemifacial microsomia by means of Herbst appliance treatment and to record the immediate effect of treatment. The use of implants and roentgenographic examinations is a recognized method which was used after informed consent was obtained from the patient and from his parents. Possible risks have been evaluated and discussed elsewhere. Continued observations are planned for the recording of relapse and long-term effects with growth.

**Implant stability**
As the implants remained stable in their original positions in the bone, rotations larger than 0.4 degree and translations larger than 0.2 mm. were regarded as significant.\textsuperscript{10}

**Displacement of the jaws**

The recorded displacements were small and mostly insignificant from a clinical point of view. However, the displacements represent the mode of articular growth of the jaws and the recordings provide a basis for objective assessment of pretreatment growth and the effect of treatment on growth.

During treatment with the Herbst appliance, articular growth of the jaws was redirected and the degree of facial retrognathia and asymmetry was reduced. At the same time, however, the tilt of the mandible to the affected side was increased. A similar combination of mandibular movements (that is, rotation about the vertical [Y] axis to the unaffected side with rotation about the sagittal [Z] axis to the affected side) was found in a previous study of growth in hemifacial microsomia.\textsuperscript{11} We suggest that this pattern of displacement, with growth and with treatment, may be explained by the morphologic and functional conditions of the jaws in hemifacial microsomia, especially right- and left-side differences in the configuration of the condyles and the articular fossae.

The recorded effects of treatment in our patient differed in some respects from the findings reported by Pancherz in his cephalometric study of Class II malocclusions treated with the Herbst appliance.\textsuperscript{7} We found no indication of accelerated growth of the mandible in terms of total mandibular displacement during treatment. However, in response to the forward and lateral displacement of the mandible by the appliance, growth of the condyle on the affected side may have been accelerated relative to growth of the condyle on the unaffected side. This would agree with the redirection of mandibular growth which was accomplished by treatment.

Also, growth of the maxillary bones was influenced in the same direction as that of the mandible in our patient. This tendency of the maxillary bones to follow the displacement of the mandible with growth corresponds with earlier findings in hemifacial microsomia.\textsuperscript{11}

The discrepancies between the findings reported by Pancherz\textsuperscript{7} and those of the present study may indicate actual differences in treatment effects in hemifacial microsomia compared with treatment effects in children who have no such defect, or they may reflect the use of different measurement methods in the two studies.

**Dental occlusion**

Correction of the dental malocclusion was accomplished by dentoalveolar remodeling to some extent, a finding which agrees with those reported by Pancherz.\textsuperscript{7} In our patient dentoalveolar remodeling allowed displacement of the mandible to the affected side while the
appliance remained in place (Table II, observation period III-IV). Indeed, the greater part of the skeletal relapse took place during the treatment period. This observation indicates that a distinction should be made between the orthopedic and the orthodontic responses to treatment.

In summary, with the roentgen stereometric method, we have obtained highly accurate information on the orthopedic effect of Herbst appliance treatment in a boy with hemifacial microsomia. The movements of the jaws were small and complex and might not have been recorded with a conventional cephalometric method. During treatment articular growth of the jaws was redirected toward a more favorable pattern. The malocclusion was corrected partly by dentoalveolar remodeling and partly by displacement of the jaws.

The spectrum of severity in hemifacial microsomia is considerable. This spectrum includes interrelated variants involving the base, orbits, maxilla, mandible, dentition, and neuromuscular and vascular development in contiguous areas. Therefore, a single case presentation does not describe the population of hemifacial microsomia.