British Journal of Oral and Maxillofacial Surgery (2004) **42**, 526—531

BRITISH
Journal of
Oral and
Maxillofacial
Surgery
www.bjoms.com

Intraoral distraction osteogenesis to lengthen the ascending ramus
Experience with seven patients

Johan Jansma[a,*], Michiel W.J. Bierman[b], Alfred G. Becking[c]

[a] *Department of Oral and Maxillofacial Surgery, University Hospital Groningen, P.O. Box 30.001, 9700 RB Groningen, The Netherlands*
[b] *Department of Orthodontics, University of Groningen, Groningen, The Netherlands*
[c] *Department of Oral and Maxillofacial Surgery, VU University Medical Center/ACTA, Amsterdam, The Netherlands*

Accepted 9 August 2004
Available online 25 September 2004

KEYWORDS
Facial asymmetry;
Hemifacial microsomia;
Mandible

Summary Seven children with facial asymmetry, mean age 12 years (range 11—14.5) were treated by intraoral distraction osteogenesis to lengthen the hypoplastic ramus.

We achieved a mean increase in length of the ramus of 13 mm (range 10—16). In only one patient did we achieve a posterior open bite on the distraction side. All patients ended with a symmetrical chin.

It was helpful to place an orthodontic bite block on the opposite side either preoperatively or postoperatively to cant the plane of occlusion. The duration of follow-up was too short to allow conclusions to be drawn about the future requirement for bimaxillary osteotomies.

Introduction

In children, facial asymmetry caused by unilateral hypoplasia of the ascending ramus of the mandible is either congenital (hemifacial microsomia) or acquired.[1] Because of the short vertical mandibular ramus, the chin deviates towards the affected side and the plane of occlusion in the maxilla becomes oblique in compensation. These phenomena worsen as growth continues. Since the introduction of distraction osteogenesis for use in the craniofacial skeleton, facial asymmetry has become one of the main indications for this operation.[2,3] Distraction osteogenesis has replaced the costochondral grafts as the treatment of first choice particularly when the condyle is present. The goals of lengthening the hypoplastic ascending mandibular ramus with distraction osteogenesis are to correct the oblique

* Corresponding author. Tel.: +31 5036 12567; fax: +31 5036 11136.
E-mail address: j.jansma@kchir.azg.nl (J. Jansma).

0266-4356/$ — see front matter
doi:10.1016/j.bjoms.2004.08.005

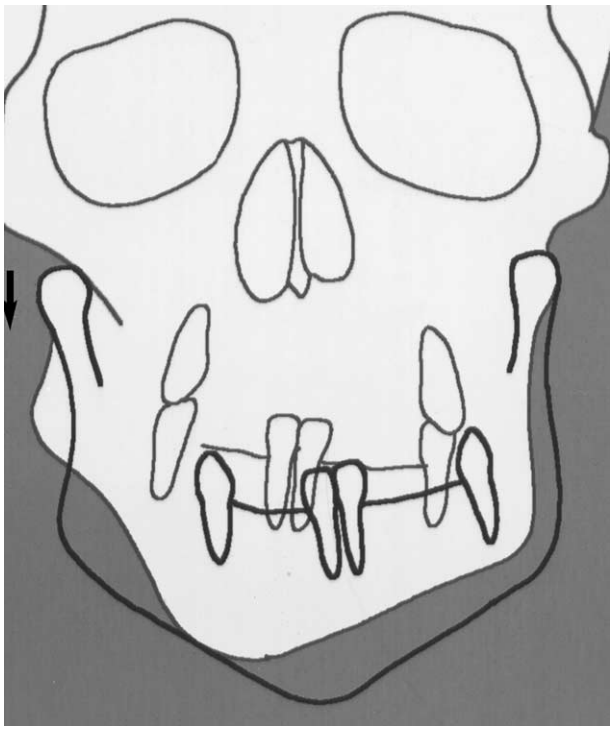

Figure 1. Diagram of intended lengthening of ascending ramus for hemifacial microsomia. By lengthening the shortened ramus the chin shifts towards midline of the face. On the affected side a posterior open bite is created to make a cant of the occlusal plane possible.

plane of occlusion by creating a posterior vertical open bite on the affected side and to move the deviated chin to the midline to restore facial symmetry (Fig. 1). Ideally, particularly in mild cases, distraction osteogenesis in combination with preoperative and postoperative orthodontic treatment would be the correct management of unilateral mandibular hypoplasia.

Distraction osteogenesis for hypoplasia of the ascending ramus is usually done during growth. There is a tendency to treat patients with more severe asymmetries at an earlier age than those with milder ones.[4] As a result of miniaturisation, distraction osteogenesis devices can be placed entirely intraorally. Prevention of extraoral scars and better social acceptance are the main reasons for abandoning transcutanuous pins and extraoral devices.[5] In young children, and for complex movements, extraoral devices still have a place because they allow multidirectional movement. Although distraction osteogenesis is widely accepted for lengthening the hypoplastic ascending mandibular ramus many questions remain unanswered. These include the ideal age for treatment, the influence on growth, the amount of overcorrection that is needed, the creation of the posterior vertical open bite, and the long-term stability.

We report the results of lengthening the ascending ramus by intraoral distraction osteogenesis in a small series of patients with mild facial asymmetry, with special emphasis on the creation of the posterior vertical open bite.

Patients and methods

In the departments of Oral and Maxillofacial Surgery of the University Hospital Groningen and the VU University Medical Centre, from October 1997 to October 2000 seven patients (five girls and two boys) with facial asymmetry caused by unilateral hypoplasia of the mandibular ramus were treated by lengthening the ramus by intraoral distraction osteogenesis. Two patients had a mild type of hemifacial microsomia (Pruzansky grade I), and the other five had an acquired type of relatively mild facial asymmetry. Of these five patients, one had a history of osteomyelitis of the mandibular ramus at the age of 2 years, two patients had an injury when they were young, and in two others the aetiology remained unclear although injury was suspected. One of the patients who had been injured was treated by reconstruction with a costochondral graft at the age of 10 years because he had an osseous ankylosis of the temporomandibular joint. However, the asymmetry remained. The mean age when the distraction device was inserted was 12 years (range 11—14.5). The second stage of dental development was deliberately chosen to combine orthodontic treatment of the permanent dentition with the lengthening procedure. All seven patients had preoperative and postoperative orthodontic treatment with fixed appliances without interruption. In all seven patients conventional radiographs were taken preoperatively and at regular intervals postoperatively. In six patients preoperative three-dimensional computed tomograms were taken.

Operation was carried out under general anaesthesia in all cases. A complete oblique osteotomy of the ascending ramus was done through an intraoral approach. In four patients Zurich paediatric distractors (Martin, Germany), and in three patients Vasquez-Diner distractors (Leibinger, Germany) were placed. In all cases treatment was of the affected ascending ramus only. After a latency period of 3—5 days, active distraction was started. This consisted of twice daily lengthening by 0.5 mm. We aimed to overcorrect in all cases, the dental occlusion being the limiting factor. This means that distraction osteogenesis was stopped in

Figure 2. Patient wearing an orthodontic bite block on the opposite side after distraction to intrude the posterior teeth to cant the occlusal plane.

close cooperation with the orthodontist when the occlusion was still such that a stable orthodontic result could be anticipated. After a stabilisation period of 8—10 weeks the devices were removed under general anaesthesia as day cases. Follow-up after finishing the postoperative orthodontic treatment ranged from 2 to 4 years (mean 29 months).

Results

The mean extent of lengthening of the hypoplastic ascending ramus in the seven patients was 13 mm (range 10—16). No temporary or permanent sensory disturbances were encountered. Two patients needed postoperative physiotherapy to increase the extent of mouth opening. The children did not complain of pain during the active distraction, which was done by one of the parents without any problems. In the relatively short follow-up period there were no signs of relapse. In the first two patients active distraction osteogenesis was done early in the second transitional period. In the other five, the end of this period was chosen.

In only one patient, a substantial posterior vertical open bite was created on the affected side. In another patient, a posterior vertical open bite was created during active distraction osteogenesis but was lost again at the end of the treatment. In the other patients no posterior vertical open bite of any substance was created. In four of the seven patients an orthodontic biteblock was used on the other side (three times after distraction; once before distraction) to create intrusion of the opposite lateral bicuspids and molars to cant the occlusal plane (Fig. 2).

One patient had to be reoperated on at the end of the first week of active distraction because she developed an anterior open bite and was unable to close her mouth fully. On the radiographs it was clear that the osteotomy in the ramus had opened up at the anterior border and it was considered to be a vector problem. The vector was changed by repositioning the distraction device so that it aimed at the condyle instead of the coronoid process. The distraction was uneventful after this change of the vector (Fig. 3A—F). Aiming the vector of distraction at the condyle leads to a horizontal component in addition to a vertical component. This phenomenon was found in all seven patients, but it was anticipated with preoperative orthodontic treatment by creating an overjet.

In one patient the distraction rod fractured at its intraoral end towards the end of active distraction. Further activation was accomplished by using forceps.

Because distraction osteogenesis was done before the end of growth we aimed to overcorrect by several millimetres at the level of the chin. In all patients the developing opposite cross bite was the limiting factor for overcorrection so that a few millimetres at the chin point could not always be accomplished. Nevertheless, the symphyseal midline ended up in the facial midline in all patients. In patients with unilateral mandibular hypoplasia the symphysis is not symmetrical in itself, and five patients might need a genioplasty for aesthetic reasons when they are older (Fig. 3G).

After finishing the postoperative orthodontic treatment, all patients had an acceptable dental occlusion. The compensatory oblique occlusal plane was influenced in a beneficial way in all patients, in none of whom did it become strictly parallel to the bipupillary line. The follow-up was to short for us to know if any of our patients might need further correction of the occlusal plane with bimaxillary osteotomy when they are older.

Discussion

After the publication by McCarthy et al.[2] the treatment of hemifacial microsomia and acquired hypoplasia of the ascending mandibular ramus have become important indications for distraction osteogenesis.[6—9] It is no longer a question of whether distraction can be done, but whether it is preferable to traditional approaches such as costochondral grafting and bimaxillary osteotomies. The minimal invasiveness, the low risk of secondary problems such as maxillary deformities, the lack of

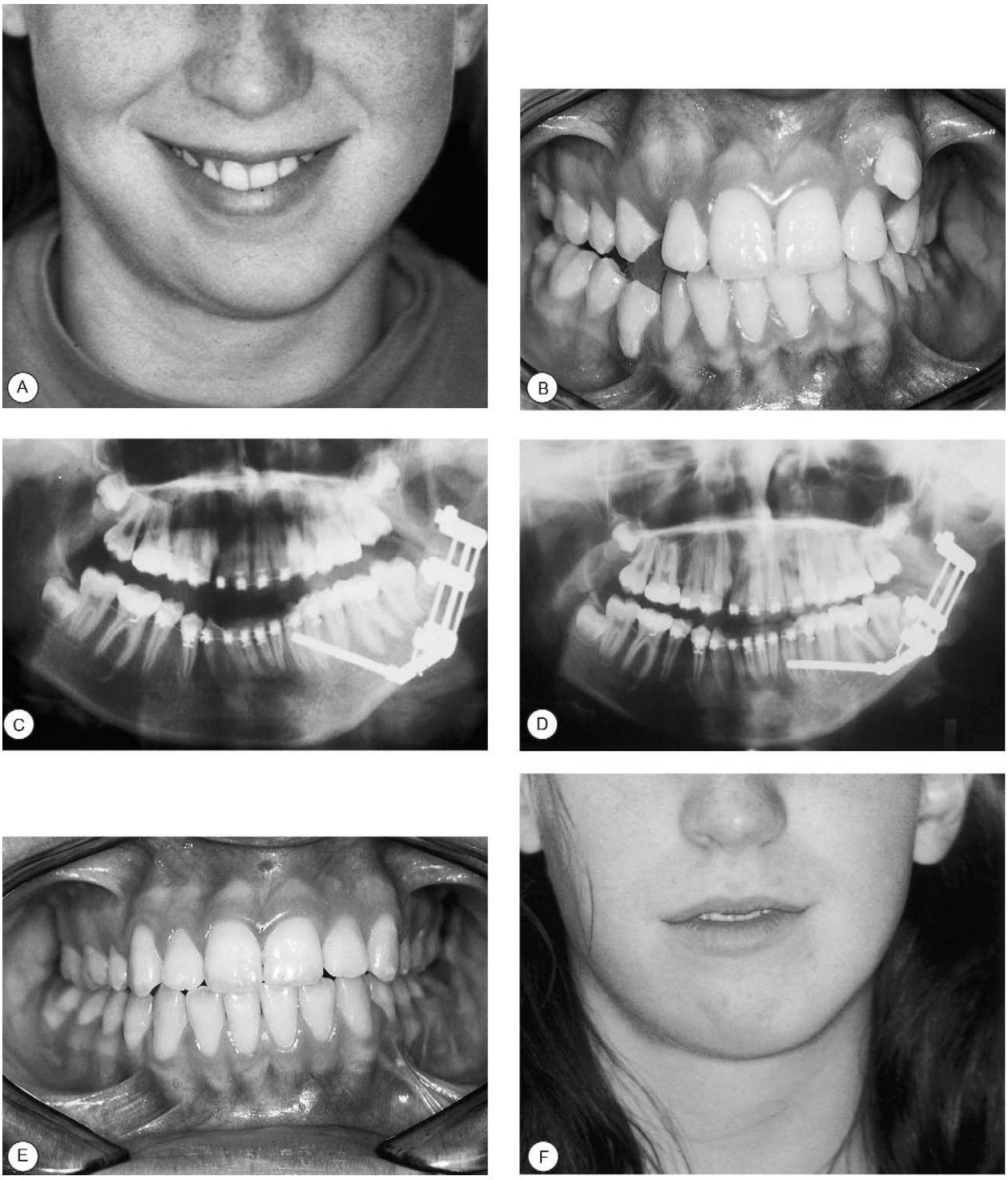

Figure 3. (A) Eleven-year-old patient with a shortened left ascending mandibular ramus resulting from osteomyelitis at the age of 2. Before distraction osteogenesis. (B) Intraoral appearance before distraction osteogenesis. Note compensatory oblique plane of occlusion. (C) Panoramic radiograph after placement of the distraction apparatus. (D) Radiograph immediately after 11 mm lengthening of the shortened ascending ramus. (E) Dental appearance after distraction osteogenesis and orthodontic treatment. The maxillary first bicuspids were removed. (F) Appearance after distraction osteogenesis and orthodontic treatment. The chin is in the midline. The bony chin itself is not symmetrical. (G) Computed tomogram shows the asymmetrical anatomy of the mandible itself. There may be an indication for genioplasty at a later date.

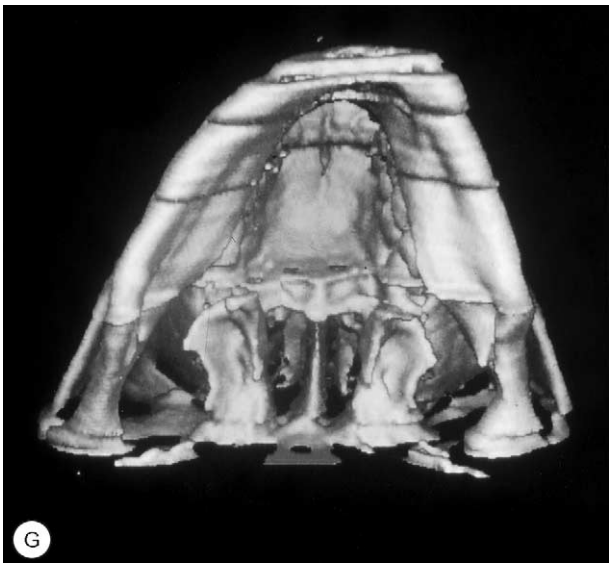

Figure 3. (*Continued*).

morbidity at the donor site, the simultaneous distraction of soft tissues, the good clinical results, the economical advantages, and the satisfaction of the family are all advantages of distraction osteogenesis over conventional techniques in the treatment of hemifacial microsomia.[8,9] If the vertical mandibular ramus and particularly the condyle is missing, the more severe types of hemifacial microsomia are candidates for costochondral grafts, whereas the less severe cases are probably best treated by distraction osteogenesis. Mommaerts and Nagy, however, found no evidence that distraction osteogenesis produced better results and had lower morbidity than conventional transplantation of growth centres and separate soft-tissue transplantation.[4] They found only eight published studies, of which only two had more than 10 patients. The results all pointed towards overcorrection and repeated distraction procedures, because the vertical gain does not seem to be stable during growth. They also disputed the benefits of early intervention and recommended deferring surgical reconstruction in Pruzansky—Kaban types I, IIA and even IIB mandibles until the permanent dentition was established.

Our patients had relatively mild facial asymmetry caused by unilateral hypoplasia of the ascending mandibular ramus. We found the operation easy to do with relatively low morbidity and with a reasonably predictable result. The first main treatment goal, to bring the chin into the facial midline, was accomplished in all patients (Fig. 3A and F). Although overcorrection is often advised, this was not possible in most cases because the developing opposite cross bite became the limiting factor. If this cross bite becomes too severe, the orthodontist may not be able to achieve an ideal occlusion, which was considered of great importance. In their series of 16 patients with mandibular hypoplasia, Rubio-Bueno et al. also achieved good occlusion after lengthening the ascending ramus with distraction osteogenesis with internal devices and giving orthodontic treatment.[5]

To achieve an ideal occlusion we found that distraction osteogenesis is best done after the second stage of dental development in combination with preoperative end postoperative orthodontic treatment with fixed appliances in the upper and lower jaws. The final occlusal result would be much better if full dental arches were present at the time of distraction. This age is in agreement with the recommendations of Mommaerts and Nagy.[4] Both the developing cross bite and the ventral component of distraction osteogenesis have to be considered.

The least predictable feature in our series was the posterior open bite, which is the second main goal of treatment. With extraoral devices a posterior open bite was produced.[10] In only two of our seven children were we able to produce a substantial posterior open bite. In one of these the open bite was lost again at the end of active distraction. Although this corresponded with placement of elastics on the other side this does not seem to be an explanation. It is assumed that unilateral lengthening of the ramus leads to a transverse shift of the mandible to the opposite side, unfortunately minimising the vertical effect in the molar region on the distraction side. This mandibular shift to the opposite side was also described by Diner et al.[9] They stated that this laterognathism often masks the vertical lengthening of the ramus and prevents the creation of the desired unilateral open bite on the distracted side. It is unclear if this finding is a drawback that is related specifically to the use of an intraoral device, and that the use of an extraoral device may produce a better result. In four of our patients, it was possible to cant the occlusal plane of the maxilla with the use of an orthodontic bite block on the opposite side (Fig. 2). With this bite block that can either be used preoperatively or postoperatively, an intruding force is delivered on the bicuspids and molars on the opposite side. It is concluded that this bite block is essential if an intraoral distraction device is used.

An alternative to first lengthening the ramus in combination with orthodontics and doing osteotomies at a later age was published by Ortiz Monasterio et al.[11] They combined a unilateral lengthening of the mandibular ramus with a

simultaneous distraction of an incomplete Le Fort 1 osteotomy, preserving the preexisting occlusion with intermaxillary fixation. Because of the lateral shift that we found, it seems that this procedure is not appropriate with intraoral distraction.

We accomplished a mean lengthening of 13 mm, which was recorded by measuring the number of turns that were made with the distraction rod. This needs further discussion. A full turn of 360° is measured on the screwdriver, which is not a precise measurement. Furthermore, the lengthening measured on the apparatus is not likely to be the same lengthening that occurs at the level of the distraction gap. Asymmetrical opening of this gap, as is often noticed on radiographs and small movements of the pins or screws in the bone contribute to the absence of a one: one ratio. Particularly in asymmetrical patients it seems to be impossible to measure accurately the lengthening on radiographs, but this is not necessarily of clinical relevance. Facial symmetry and the occlusal relations are more important.

During the short follow-up period of our small number of patients we have the clinical impression that the results were stable, but we have no data. There have been no long-term studies on stability after treatment of hemifacial microsomia by distraction osteogenesis. Kusnoto et al. found a 1 mm shortening of the mandibular ramus after distraction osteogenesis with 5—8% overcorrection and referred to this phenomenon as settling of the regenerate.[12] In the same paper, 2% more growth of the mandibular body occurred on the distracted side than on the opposite side.

Many questions remain unanswered. The influence of distraction osteogenesis on growth is not clear, the amount of overcorrection, if needed, requires further investigation and the ideal age of treatment is not certain. However, this study emphasises the preference for fixed orthodontic appliances in the permanent dentition.

References

1. Pruzansky S. Not all dwarfed mandibles are alike. *Birth Defects* 1969;**1**:120—9.
2. McCarthy JG, Schreiber J, Karp N, Thorne CH, Grayson BH. Lengthening the human mandible by gradual distraction. *Plast Reconstr Surg* 1992;**89**:1—8.
3. Rachmiel A, Manor R, Peled M, Laufer D. Intraoral distraction osteogenesis of the mandible in hemifacial microsomia. *J Oral Maxillofac Surg* 2001;**59**:728—33.
4. Mommaerts MY, Nagy K. Is early osteodistraction a solution for the ascending ramus compartment in hemifacial microsomia? A literature study. *J Craniomaxillofac Surg* 2002;**30**:201—7.
5. Rubio-Bueno P, Villa E, Carreno A, et al. Intraoral manbibular distraction osteogenesis: special attention to treatment planning. *J Craniomaxillofac Surg* 2001;**29**:254—62.
6. Molina F, Ortiz Monasterio F. Mandibular elongation and remodeling by distraction: a farewell to major osteotomies. *Plast Reconstr Surg* 1995;**96**:825—40.
7. Diner PA, Kollar EM, Martinez H, Vazquez MP. Intraoral distraction for mandibular lengthening: a technical innovation. *J Craniomaxillofac Surg* 1996;**24**:92—5.
8. Polley JW, Figueroa AA. Distraction osteogenesis: its application in severe mandibular deformities in hemifacial microsomia. *J Craniofac Surg* 1997;**8**:422—30.
9. Diner PA, Tomat C, Soupre V, Martinez H, Vazquez MP. Intraoral mandibular distraction: indications, technique and long-term results. *Ann Acad Med Singapore* 1999;**28**:634—41.
10. Molina F. Mandibular distraction osteogenesis: clinical analysis of the first 10 years. In: Samchukov ML, Cope JB, Cherkashin AM, editors. *Craniofacial distraction osteogenesis*. St. Louis: Mosby; 2001. p. 196—205.
11. Ortiz Monasterio F, Molina F, Irade LA, Rodriguez C, Sainz Arregui J. Simultaneous mandibular and maxillary distraction in hemifacial microsomia in adults: avoiding occlusal disasters. *Plast Reconstr Surg* 1997;**100**:852—61.
12. Kusnuto B, Figueroa AA, Polley JW. A longitudinal three-dimensional evaluation of the growth pattern in hemifacial microsomia treated by mandibular distraction osteogenesis: a preliminary report. *J Craniofac Surg* 1999;**10**:480—6.