European Journal of Orthodontics 20 (1998) 369–374

Bone scintigraphy of human temporomandibular joints during Herbst treatment: a case report

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SUMMARY Bone scintigraphy results were compared with changes shown on orthopantomographic radiographs in a patient with facial asymmetry, before, during, and after Herbst treatment, and followed up with control of growth activity in the temporomandibular joints (TMJs) after long-term retention. The present study showed that new bone formation (modelling) was initiated asymmetrically in TMJs during treatment. The results indicate that late development of right/left asymmetry in the occlusion can be corrected and normalized using the Herbst appliance therapy, stimulating a differentiated 'catch up' growth (modelling) in the TMJ with condyles. After treatment, original growth with asymmetric activity in the TMJ was re-established. This growth activity may re-establish the asymmetry in the sagittal occlusion and the face of the patient. It is therefore recommended that the occlusion should be maintained with an appliance which stabilizes the occlusion until cessation of the primary, endochondral growth.

Introduction

Human temporomandibular joints with condyles are formed through endesmal ossification. Therefore, in theory, the condylar cartilage should possess the capability for differential adaptive growth in contralateral condyles. Bone scans have been widely used to monitor the increased activity of one side of the growing mandible in condylar hyperplasia (Hendersson *et al.*, 1990; Robinson *et al.*, 1990; Gray *et al.*, 1994; Kerscher *et al.*, 1995).

The aim of this study was to identify a biomechanically-induced difference in adaptive growth of cartilage and bone in contralateral TMJs with condyles using bone scintigraphy and to compare results with changes shown on orthopantomographic radiographs in a patient with facial asymmetry. Changes in bone metabolism of between 5 and 15 per cent can be detected scintigraphically (Robinson *et al.*, 1990; Gray *et al.*, 1994). As a functional examination based on the metabolic activity in bone (newly-forming bone), it should complement radiographic findings from orthopantomographs.

Subject and methods

The patient was a girl aged 13^6 years (MP3cap–DP3u; Helm *et al.*, 1971) with an extreme Angle Class II division 1 malocclusion caused by a retrognathic mandible (Figure 1). The left side showed normal molar occlusion, the right side distal molar occlusion, and the midline a discrepancy to the right side. The Herbst appliance was inserted for 6 months to normalize the occlusion. The treatment effects in the TMJs were assessed by means of bone scintigraphy (Figure 2) and orthopantomograms.

Orthopantomograms were taken and bone scintigraphy with ^{99m}Tc-HDP was performed at regular intervals, before, during, and after

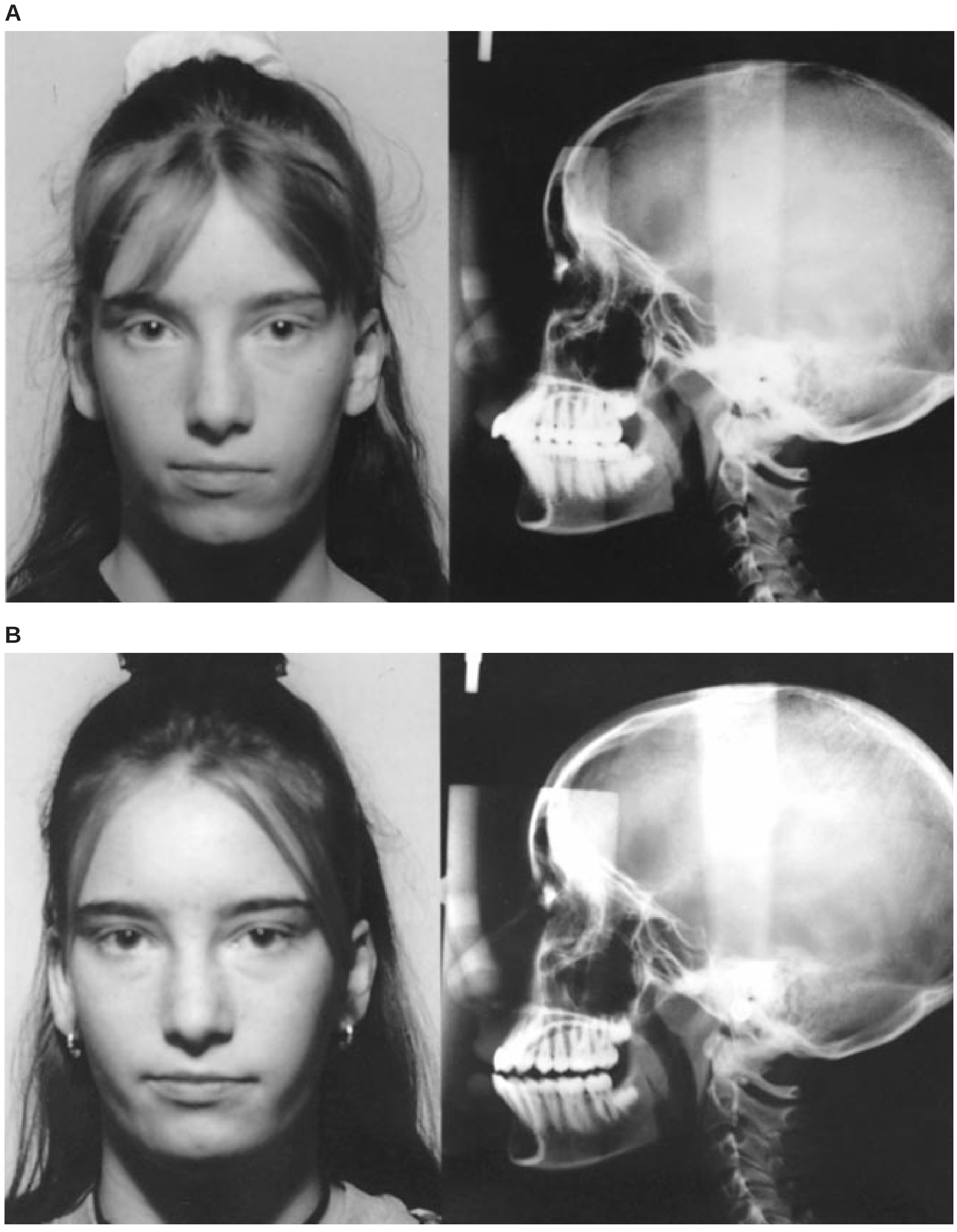

Figure 1 (A) Pre-treatment: the subject aged 13^6 years (MP3cap-DP3u) with an extreme Angle Class II division 1 malocclusion caused by a retrognathic mandible. The left side shows a normal molar occlusion, the right side a distal molar occlusion, and there is a midline discrepancy to the right. (B) Post-treatment: aged 14 years (DP3u) with a normalized jaw relationship. The dental arches have been over-corrected with a tendency to mesial occlusion in both sides. The midline has been normalized during treatment. The occlusion will normalize during retention with a positioner.

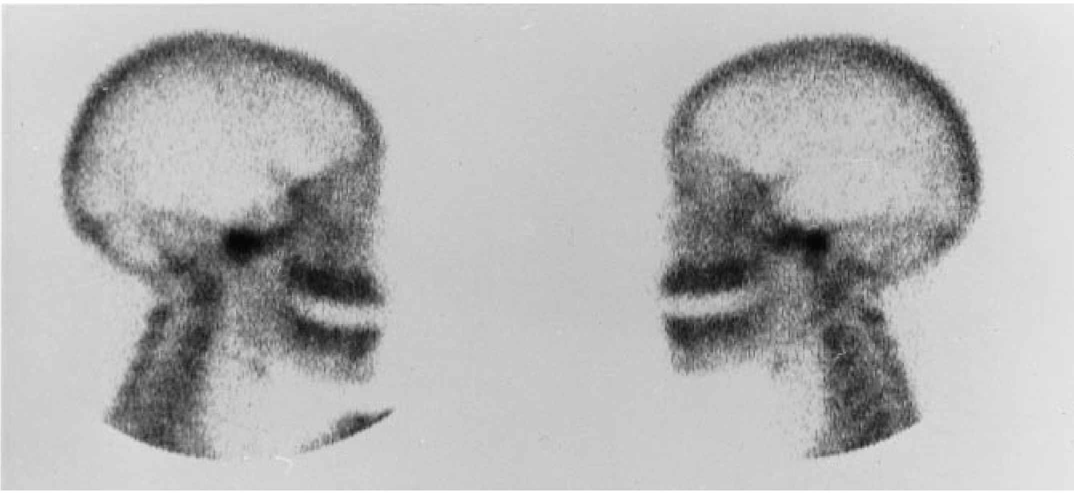

Figure 2 Scintigraphy: TMJ regions show different metabolic activity. Bone scintigraphy with ^{99m}Tc-HDP was performed at regular intervals during treatment.

treatment (Figure 3), and 2.5 years after treatment. Ethical approval was not required as the examinations were performed to monitor the effect of clinical treatment. Orthopantomograms were obtained with a Siemens Orthopan 5 with the incisors in edge to edge contact biting on a 1-cm thick block (Paulsen *et al.*, 1995; Paulsen, 1996). For bone scintigraphy the patient was given an i.v. injection of 500 MBq ^{99m}Tc-HDP 2 hours prior to scanning using a Starcam 300a gamma camera (GE Medical Systems, Milwaukee, USA) with a low energy/high resolution collimator. Resolution of the gamma camera equipment was 5.9 mm (FWHM). Pinhole collimators might increase resolution but sensitivity is decreased. Whilst improving the image contrast, tomograms would result in a loss of resolution. Lateral and antero-posterior skull views were taken, with an acquisition time 300 seconds. The radiation doses were for bone scintigraphy 2–3 mSv per examination (effective dose equivalent) and for orthopantomograms 17 μSv per examination (effective dose equivalent). The regions of interest (ROI) were defined on lateral views centred around maximum count in the TMJ region, ROI size 7 × 7 pixels. Ratios between activity (counts) in the right and left TMJ regions were calculated.

Results

The occlusion was corrected by biomechanically induced adaptive growth. Bone scintigraphy showed a significant rise in the ratio of the right/left TMJ from 0.88 to 1.31 during treatment, indicating increased bone formation in the right mandibular joint. The results confirmed similar findings registered from orthopantomograms. The TMJ cartilage with condyles possessed the capability for differential adaptive growth (modelling; Figure 3, Table 1). Two-and-a-half years after treatment the right/left ratio was 0.79 (2 SD 0.054), indicating increased bone formation in the left mandibular joint, as found before treatment.

Discussion

Herbst treatment elicits adaptive growth in the TMJ. This has been shown using CT-scanning and orthopantomograms before, during, and after treatment (Paulsen 1996, 1997; Paulsen *et al.*, 1995). In the actual study of bone scintigraphy and orthopantomograms, bone scintigraphy showed a significant rise in the right/left TMJ ratio during treatment, indicating increased bone formation in the right TMJ during normalization

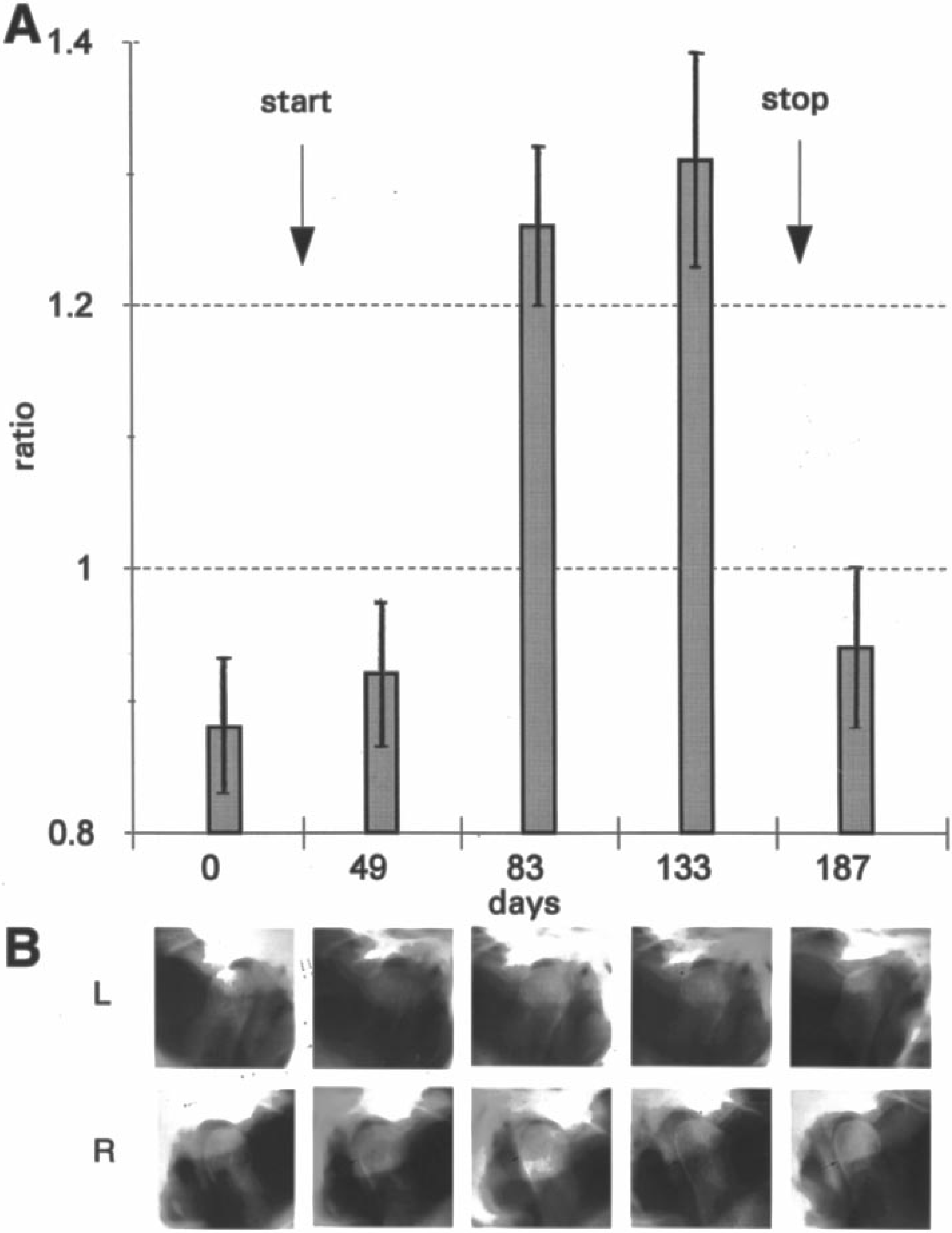

Figure 3 (A) Bone scintigraphy: ratio R/L TMJ during treatment. Pre-treatment. Herbst treatment 49, 83, and 133 days. Post-treatment 187 days. (B) Orthopantomographs showing condylar changes at the same intervals as the bone scintigraphy. Arrows indicate new bone, star indicates bone resorption (remodelling).

Table 1 Activity (count) ratios of the right/left TMJs determined by bone scintigraphy.

Ratio R/L	2 SD
0.88	0.052
0.92	0.046
1.26	0.062
1.31	0.078
0.94	0.056

of an asymmetric sagittal molar occlusion. The orthopantomograms showed a corresponding asymmetric bone formation in the distocranial part of the right/left condyles.

The present study of bone scintigraphy of human TMJs during Herbst treatment has shown that the new bone formation was initiated asymmetrically to normalize the occlusion in a subject with sagittal asymmetry of the mandible. The mechanism of this was by differential growth of the TMJ with condyles to adapt to the new mandibular position. The initial right/left ratio of 0.88 (left/right 1.13) might be taken as an indication of left TMJ or condylar hyperplasia (Robinson *et al.*, 1990; Kerscher *et al.*, 1995), or right TMJ or condylar hypoplasia.

The results of this investigation indicate that late development of right/left asymmetry in the occlusion can be corrected and normalized using the Herbst appliance stimulating a differentiated 'catch up' growth (modelling) in the TMJ with condyles.

The orthopantomographs showed double contours of the TMJ in the distocranial direction, indicating that new bone has developed (Paulsen, 1996). This endesmal bone formation indicates that the straightening out effect of the Herbst appliance may be executed late in pubertal growth and might also be executed after cessation of the primary, endochondral growth.

After treatment asymmetric growth activity in the TMJs was shown. This activity reestablished the underlying asymmetric growth pattern in the sagittal occlusion and the face of the patient.

Conclusion

Skeletal scintigraphy of the condylar regions is a useful indicator of stimulated bone growth. The findings show that Herbst treatment induces significant differences in adaptive growth of cartilage and bone in contralateral condyles. This knowledge may be of value in the treatment of facial asymmetry, as the largest individual asymmetry has been located in the mandible (Holsko, 1967).

As asymmetry in TMJ growth activity was reestablished after treatment, it is advocated that the occlusion is maintained with an appliance until cessation of the primary, endochondral, growth.

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Acknowledgement

This investigation was supported by the Danish Dental Association (Dansk Tandlægeforening), Denmark.

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