Original Article

Association between Björk's Structural Signs of Mandibular Growth Rotation and Skeletofacial Morphology

Julia von Bremen[a]; Hans Pancherz[b]

Abstract: The aim of this study was to apply Björk's structural signs of mandibular growth rotation to answer the questions: (1) Is a hyperdivergent or hypodivergent skeletofacial growth pattern characterized by a specific mandibular morphology? (2) Are severe skeletofacial hyper- or hypodivergencies recognized more easily than mild ones? (3) Are skeletofacial hyper- or hypodivergencies recognized more easily in older than in younger subjects? Mandibular cuttings from lateral head films of 135 Class I or Class II subjects were surveyed twice by nine observers. Of the 135 subjects, 95 subjects exhibited a large (ML/NSL $>$ 38°) and 40 a small (ML/NSL $<$ 26°) mandibular plane angle. Using the structural signs of mandibular growth rotation, the observers had to categorize the subjects as having either a high-angle or low-angle skeletofacial morphology. In 14% (13 of 95) of the subjects with a large ML/NSL angle, the skeletofacial hyperdivergency was recognized in all registrations, but in 19% (18 of 95), the hyperdivergency was identified in less than half of the registrations. In 63% (25 of 40) of the subjects with a small ML/NSL angle, the skeletofacial hypodivergency was recognized in all registrations, whereas in only 2.5% (one of 40), the hypodivergency was identified in less than half of the registrations. There was no association between the degree of hypo- or hyperdivergency or the age of the subjects and the number of correct registrations. Using the structural method of Björk, it was difficult to categorize the subjects as having either a hyper- or hypodivergent skeletofacial morphology. However, hypodivergency was recognized more easily than hyperdivergency. (*Angle Orthod* 2005;75:506–509.)

Key Words: Skeletofacial morphology; Björk's structural signs; Mandibular morphology

INTRODUCTION

Because patients with a posterior mandibular growth rotation (hyperdivergent growth pattern) are assumed to be more difficult to treat than those with an anterior mandibular rotation (hypodivergent growth pattern), it seems important to identify the existing mandibular growth pattern before treatment.

Björk[1] drew attention to the possibility of predicting the mandibular growth pattern by looking at specific anatomic mandibular structures. He suggested seven structural signs seen on lateral head films for the identification of the mandibular growth rotation: (1) inclination of the condylar head, (2) curvature of the mandibular canal, (3) shape of the lower border of the mandible, (4) inclination of the symphysis, (5) interincisal angle, (6) interpremolar or intermolar angle, and (7) anterior lower face height.

In the past, various attempts have been made to assess the reliability of mandibular growth prediction using mandibular anatomic structures. Some authors could find an association between mandibular morphology and future growth direction,[2–5] whereas others reported difficulties and found the method unreliable.[6–11]

To our knowledge, no study exists with respect to the question, whether or not Björk's structural signs of mandibular growth rotation are associated with hyperdivergent or hypodivergent skeletofacial morphology. Furthermore, it remains unclear whether or not these structural signs become more obvious with increasing age.

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Accepted: May 2004. Submitted: April 2004.

Applying Björk's[1] structural signs of mandibular growth rotation, the aim of this radiographic cephalometric study was to answer the following questions: (1) Is a hyper- or hypodivergent skeletofacial morphology detectable? (2) Are severe cases of skeletofacial hyper- or hypodivergency recognized more easily than mild cases? (3) Is skeletofacial hypo- or hyperdivergency recognized more easily in older than in younger subjects?

MATERIALS AND METHODS

Pretreatment lateral head films of all Class I and Class II patients who were treated at the Orthodontic Department, University of Giessen during a five-year period (1998–2003) were screened. Only those subjects having a hyperdivergent (ML/NSL > 38°) or hypodivergent (ML/NSL < 26°) skeletofacial morphology before treatment were considered. A total of 135 subjects fulfilled these criteria, 95 with a large (mean = 41.44°, SD = 2.46°) and 40 with a small (mean = 23.43°, SD = 2.00°) mandibular plane angle (ML/NSL).

All pretreatment lateral head films were duplicated, and the mandibular part was cut out so no reference existed to surrounding anatomic structures. The mandibular cuttings were evaluated twice by nine observers (six postgraduate students and three specialists in orthodontics), resulting in 18 registrations of each radiograph. Without any knowledge of the mandibular plane angle, the observers had to categorize the subjects as having either a hyper- or hypodivergent skeletofacial morphology. This was to be done using the following four structural signs of mandibular growth rotation proposed by Björk:[1] (1) inclination of the condylar head, (2) curvature of the mandibular canal, (3) shape of the lower border of the mandible, and (4) inclination of the symphysis.

For further evaluation the subjects were divided into four age groups.

- Group I: <10 years
- Group II: 10–13.9 years
- Group III: 14–18 years
- Group IV: >18 years

Applying the Spearman correlation coefficient, it was determined whether a relationship existed between the degree of hyper- or hypodivergency or the age of the subjects and the number of correct registrations.

RESULTS

In 13 (14%) of the 95 subjects with a large ML/NSL angle, the skeletofacial hyperdivergency was recognized in all 18 registrations, whereas in 18 (19%) of

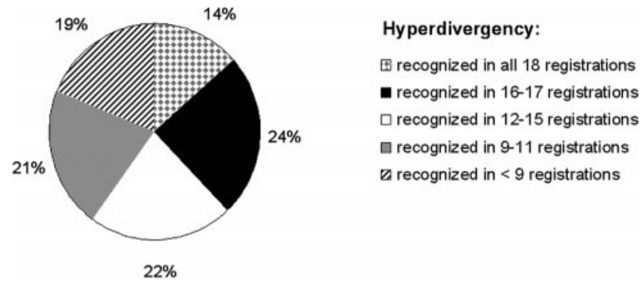

FIGURE 1. Recognition of the existing mandibular growth pattern in 95 hyperdivergent subjects. Distribution (%) of 1710 registrations (18 registrations of each mandible).

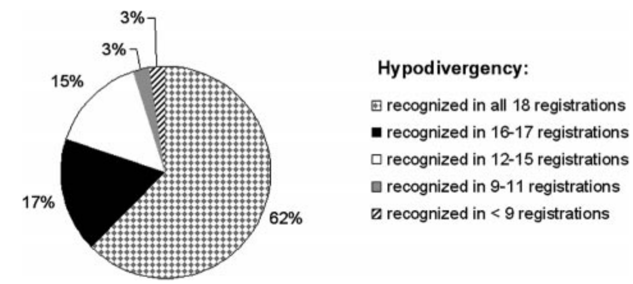

FIGURE 2. Recognition of the existing mandibular growth pattern in 40 hypodivergent subjects. Distribution (%) of 720 registrations (18 registrations of each mandible).

the subjects, the hyperdivergency was identified in less than half of the registrations (Figure 1).

In 25 (62%) of the 40 subjects with a small ML/NSL angle, the skeletofacial hypodivergency was recognized in all 18 registrations, whereas in only one subject (3%), the hypodivergency was identified in less than half of the registrations (Figure 2).

Although the subjects with the highest (55.5°) and with the lowest (14.5°) ML/NSL angle were identified in all 18 registrations, no association existed between the degree of hyper- or hypodivergency and the number of correct registrations (Figures 3 and 4).

Furthermore, there was no association between the age of the subjects and the number of correct registrations (Figures 5 and 6).

DISCUSSION

Using metal implants as references, in 1955, Björk[12] described the phenomena of anterior and posterior mandibular growth rotation. In a later publication, he differentiated between three types of mandibular rotation and described total, matrix, and intramatrix rotations.[13] The total rotation is the angular change of an implant line to SN. The matrix rotation is the angular change of the ML to SN. The intramatrix rotation is the angular change of the ML to the implant line, which expresses the change because of the remodeling process of the mandibular lower border.

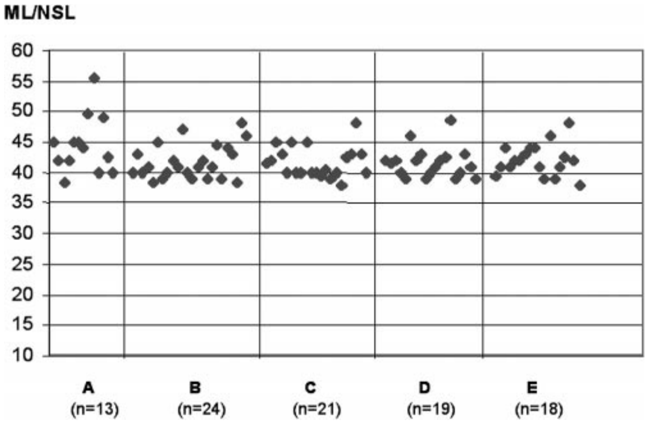

FIGURE 3. Distribution of the ML/NSL angle in 95 hyperdivergent subjects according to the number of correct registrations (hyperdivergency recognized). Group A, recognized in all 18 registrations; group B, recognized in 16–17 registrations; group C, recognized in 12–15 registrations; group D, recognized in nine to 11 registrations; and group E, recognized in less than nine registrations.

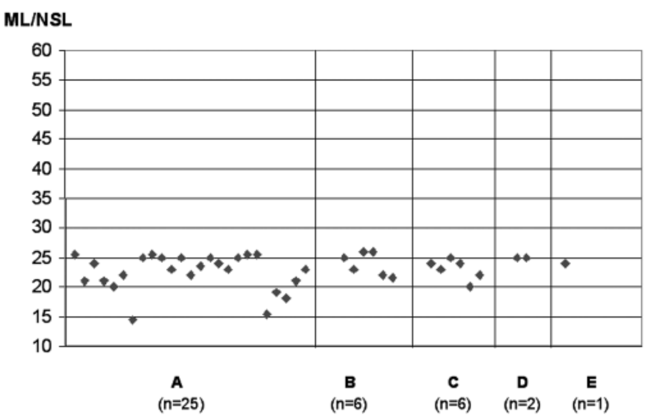

FIGURE 4. Distribution of the ML/NSL angle in 40 hypodivergent subjects according to the number of correct registrations (hypodivergency recognized). Group A, recognized in all 18 registrations; group B, recognized in 16–17 registrations; group C, recognized in 12–15 registrations; group D, recognized in nine to 11 registrations; and group E, recognized in less than nine registrations.

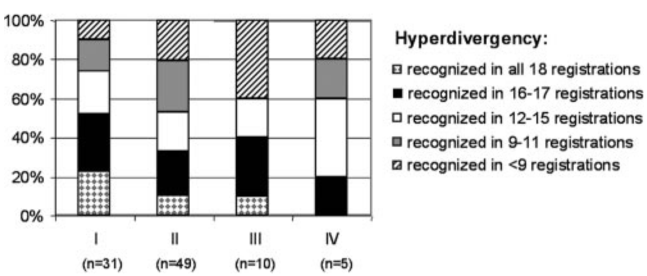

FIGURE 5. Recognition of the existing mandibular growth pattern in 95 hyperdivergent subjects in relation to subject's age. Group I, $<$10 years; group II, 10–13.9 years; group III, 14–18 years; and group IV, $>$18 years.

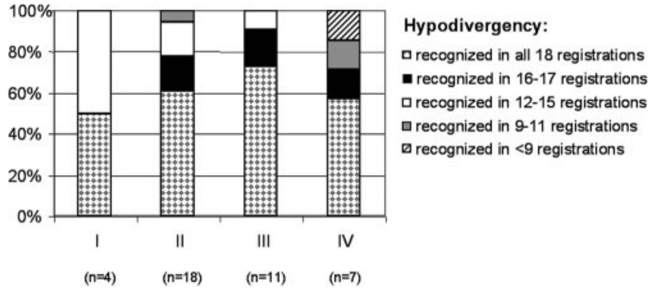

FIGURE 6. Recognition of the existing mandibular growth pattern in 40 hypodivergent subjects in relation to subject's age. Group I, $<$10 years; group II, 10–13.9 years; group III, 14–18 years; and group IV, $>$18 years.

We measured the matrix rotation by the change of the ML/NSL angle. This form of rotation is the difference between the total rotation (angular change of an implant line) and the intramatrix rotation (remodeling process of the mandibular lower border compensating the total mandibular growth rotation). Thus, in case of an anterior mandibular growth rotation, bone resorption takes place at the posterior part of the lower mandibular border and apposition at the anterior part. In case of a posterior mandibular growth rotation, the opposite is true. Consequently, because of the remodeling processes, the growth rotation is masked and what we see on lateral head films with respect to the change of the mandibular plane angle (ML/NSL) is less rotation than what actually takes place.

All previous studies on the validity of Björk's structural method were concerned with the prediction of mandibular growth rotation.[2–11] Indirectly, this study also deals with mandibular growth rotation but focuses especially on the outcome of that rotation on the skeletofacial morphology. Björk based his growth prediction on untreated subjects, and in the present study, the subjects also were evaluated before orthodontic therapy.

Only those subjects were selected who had a clear hyper- (ML/NSL $>$ 38°) or hypodivergent (ML/NSL $<$ 26°) skeletofacial morphology because they were expected to have had an obvious posterior or anterior mandibular growth rotation during the preexamination period. Whether these patients really will grow in the direction implied by the mandibular plane angle during orthodontic intervention was not examined in this study. Because the head films were taken in habitual occlusion, the evaluation of the condylar head was difficult because it was hidden behind the petrosus part of the temporal bone. Furthermore, because of double contours, the curvature of the mandibular canal was also difficult to identify on many radiographs. Consequently, the categorization into the two groups (hyper- or hypodivergent skeletofacial morphology) was done mainly by the evaluation of the inclination of the symphysis and the shape of the lower border of the mandible. This is in accordance with Björk's later recommendations because he also found it difficult to recognize the inclination of the condyle and the shape of the mandibular canal.

In previous studies, the symphysis was found to be a reliable growth indicator.[2,5] Its shape was found to be associated with the direction of mandibular growth. However, the shape of the mandibular lower border as a predictor of growth rotation was found to be less reliable.[9] Furthermore, Mair and Hunter,[10] focusing on the inclination of the mandibular ramus and the gonial angle, found only a weak correlation to the mandibular growth direction. The authors concluded that ''the vast majority of variation in mandibular growth direction during treatment remained unexplained by pretreatment structure.'' Finally, Kolodzielj et al,[11] applying the depth of the antigonial notch as a predictor for facial growth (the notch corresponds to the shape of the lower border of the mandible as described by Björk[1]), concluded that there was no association between this structural sign and the direction of future mandibular growth rotation, especially in a nonextreme population.

Although it might be assumed that subjects with a pronounced skeletofacial hyper- or hypodivergency are identified more easily by their mandibular morphology than mild cases, this could not be confirmed in the present study. Furthermore, with respect to age, Björk[1] stated that the structural signs of mandibular growth rotation are ''not so clearly developed before puberty.'' This implies that older subjects could be recognized more easily than younger subjects because their mandibular morphology would be more characteristic with respect to a specific growth rotation (anterior or posterior). Again, this could not be confirmed in the present study. Thus, morphologic growth prediction using mandibular structural signs has to be regarded with skepticism.

CONCLUSIONS

Using Björk's structural signs of mandibular growth rotation, it was difficult to categorize the present subjects as having either a hyper- or a hypodivergent skeletofacial morphology regardless of the age of the subjects or the degree of hyper- or hypodivergency. However, skeletofacial hypodivergency seemed to be recognized more easily than skeletofacial hyperdivergency.

REFERENCES

1. Björk A. Prediction of mandibular growth rotation. *Am J Orthod.* 1969;55:585–599.
2. Ricketts RM. Cephalometric synthesis. *Am J Orthod.* 1960; 46:647–673.
3. Balbach DR. The cephalometric relationship between the morphology of the mandible and its future occlusal position. *Angle Orthod.* 1969;39:29.
4. Singer CP. The depth of the antigonial notch as an indicator of mandibular growth potential. *Am J Orthod.* 1986;89:528.
5. Aki T, Nanda RS, Currier GF, Nanda SK. Assessment of symphysis morphology as a predictor of the direction of mandibular growth. *Am J Orthod.* 1994;106:60–69.
6. Ari-Viro A, Wisth PJ. An evaluation of the method of structural growth prediction. *Eur J Orthod.* 1983;5:199–207.
7. Lee RS, Daniel FJ, Swartz M, Baumrind S, Korn EL. Assessment of a method for the prediction of mandibular rotation. *Am J Orthod.* 1987;91:395–402.
8. Leslie LR, Southard TE, Southard KA, et al. Prediction of mandibular growth rotation: assessment of the Skieller, Björk, and Linde-Handen method. *Am J Orthod.* 1998;114: 659–667.
9. Halazonetis DJ, Shapiro E, Gheewalla RK, Clark RE. Quantitative description of the shape of the mandible. *Am J Orthod.* 1991;99:49–56.
10. Mair AD, Hunter WS. Mandibular growth direction with conventional Class II nonextraction treatment. *Am J Orthod.* 1992;101:543–549.
11. Kolodziej RP, Southard TE, Southard KA, Casko JS, Jakobsen JR. Evaluation of antegonial notch depth for growth predition. *Am J Orthod.* 2002;121:357–363.
12. Björk A. Facial growth in man, studied with the aid of metallic implants. *Acta Odontol Scand.* 1955;13:9–34.
13. Björk A, Skieller V. Normal and abnormal growth of the mandible. A synthesis of longitudinal cephalometric implant studies over a period of 25 years. *Eur J Orthod.* 1983;5:1–46.