ORIGINAL ARTICLE

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Cervical vertebral column morphology and head posture in preorthodontic patients with anterior open bite

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Introduction: Cervical vertebral column morphology and head posture were examined and related to craniofacial morphology in preorthodontic children and adolescents with anterior open bite. **Methods:** One hundred eleven patients (ages, 6-18 years) with an anterior open bite of more than 0 mm were divided into 2 groups of skeletal or dentoalveolar open bite. The skeletal open-bite group comprised 38 subjects (19 girls, 19 boys). The dentoalveolar open-bite group comprised 73 subjects (43 girls, 30 boys). Visual assessment of the cervical column and measurements of craniofacial morphology and head posture were made on profile radiographs. **Results:** Deviations in the cervical vertebral column morphology occurred in 23.7% of the subjects in the skeletal open-bite group and in 19.2% in the dentoalveolar open-bite group, but the difference was not significant. Head posture was significantly more extended in the skeletal open-bite group compared with the dentoalveolar open-bite group (craniovertical angle [Mx/VER], $P < 0.05$; craniocervical angles [Mx/OPT, Mx/CVT], $P < 0.01$. Only head posture was associated with craniofacial morphology: extended posture was associated with a large cranial base angle ($P < 0.01$, $P < 0.001$), large vertical craniofacial dimensions ($P < 0.05$; $P < 0.01$; $P < 0.001$), and retrognathia of the jaws ($P < 0.001$). **Conclusions:** Cervical column morphology is described for the first time in children and adolescents with open bite. No significant differences in the cervical vertebral column's morphologic deviations were found between the skeletal and the dentoalveolar open-bite groups. Significant differences were found in head posture between the groups and with regard to associations with craniofacial dimensions. This might indicate a respiratory etiologic component in children with anterior open bite. (Am J Orthod Dentofacial Orthop 2014;145:359-66)

Deviations of cervical column morphology are observed in healthy subjects with neutral occlusion and normal craniofacial morphology as well as in patients with craniofacial syndromes, deviating craniofacial morphology, and severe malocclusion traits. A recent study found that fusion between cervical vertebrae C2 and C3 occurs in 14.3% of healthy subjects.[1] Fusions of the upper cervical column within that range are thus considered normal.

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Previous studies have found an association between deviant morphology of the upper cervical vertebrae and cleft lip and palate.[2-4] Recently, an association has also been suggested between deviant morphology of the upper cervical vertebrae not only in patients with condylar hypoplasia,[1] but also in adult orthodontic surgical patients with severe skeletal malocclusion traits.[5-8] Deviations occurred significantly more often in these patients with severe skeletal malocclusion than in the control group. Furthermore, an association has been shown between cervical vertebral column morphology and horizontal maxillary overjet more than 6 mm in children; deviations occurred significantly more often in children with mandibular retrusion compared with children with maxillary dentoalveolar protrusion.[9]

Previous studies of adults and children have found that fusion between C2 and C3 and occipitalization (eg, fusion between the first cervical vertebral unit and the occipital bone) are significantly associated with posture of the head and neck.[1,9] These studies showed that the cervical vertebral column was more curved, the inclination of the upper cervical spine was more backward in adults with fusion, and the head in relation to the cervical vertebral column was more extended in children with occipitalization.

Furthermore, it has previously been demonstrated that the posture of the head and neck is associated with craniofacial morphology. It was found that an extended head posture in relation to the cervical vertebral column was associated with increased vertical craniofacial dimensions and reduced sagittal jaw dimensions.[10-17]

The above-mentioned studies suggest that morphologic deviations of the upper cervical vertebrae are associated with craniofacial morphology, posture of the head and neck, and skeletal malocclusion traits. Furthermore, an association has been shown between head posture and craniofacial morphology, especially in the vertical dimension.

Accordingly, it is relevant to focus on similar associations among cervical column morphology, craniofacial morphology, and head posture in preorthodontic children and adolescents. Seemingly, no studies have yet been performed on cervical column morphology and head posture in relation to craniofacial morphology in preorthodontic children and adolescents with anterior open bite. Furthermore, new results have indicated that 2-dimensional lateral cephalograms (already available in connection with treatment planning, for example) are sufficient for identifying morphologic deviations in the cervical vertebral column.[18]

The aims of this study were (1) to compare morphology of the cervical column and head posture in a group of children with skeletal anterior open bite (skeletal open-bite group) with a group of children with dentoalveolar anterior open bite (dentoalveolar open-bite group) and (2) to analyze the morphology of the cervical column and head posture in relation to the craniofacial morphology in both groups combined.

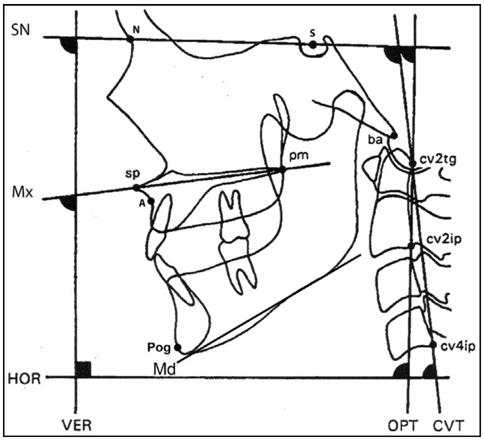

Fig 1. Reference points and lines according to Solow and Tallgren.[10] *SN*, sella-nasion line; *Mx*, maxillary line through sp and pm; *Md*, mandibular line; *OPT*, odontoid process tangent through cv2ip and cv2tg; *CVT*, cervical vertebra tangent through cv4ip and cv2tg; *VER* and *HOR*, true vertical and horizontal lines; *A*, A-point, the most posterior point on the anterior contour of the upper alveolar arch; *Pog*, pogonion, the most anterior point on the mandibular symphysis; *ba*, basion, the most posterior-inferior point on the clivus.

MATERIAL AND METHODS

One hundred eleven profile radiographs were systematically selected according to the inclusion criteria (mentioned below) from patients registered between 1988 and 1997 at the orthodontic clinic, Municipal Dental Service of Farum, Denmark, and divided into 2 groups according to the type of anterior open bite: skeletal open bite or dentoalveolar open bite.

The skeletal open-bite group comprised 38 patients: 19 girls (ages, 6-16 years; mean, 9.8 years) and 19 boys (ages, 7-18 years; mean, 9.4 years). The inclusion criteria were (1) no prior orthodontic treatment, (2) skeletal open bite of more than 0 mm (vertical jaw relationship [Fig 1] larger than 1 SD [Mx/Md >31°] according to the standards described by Björk[19] and assessed by lateral radiographs of each subject), (3) no craniofacial syndromes or systemic muscle or joint disorders, and (4) a profile radiograph taken before orthodontic treatment with the 5 first cervical vertebral units visible. The sagittal jaw relationship (A-N-Pog, Fig 1) ranged between 0.0° and 14.5° (mean, 4.7°), the horizontal overjet was between 0 and 10.5 mm (mean, 4.8 mm), the vertical jaw relationship (Mx/Md, Fig 1) was between 31.5° and 40.0° (mean, 34.3°), and the vertical overbite was between −6.6 and 0 mm (mean, −1.4 mm) (Table 1).

The dentolveolar open-bite group comprised 73 subjects: 43 girls (ages, 7-14 years; mean, 6.4 years), and 30 boys (ages, 7-16 years; mean, 9.5 years). The inclusion criteria were (1) no prior orthodontic treatment, (2) dentoalveolar open bite of more than 0 mm (vertical jaw relationship within 1 SD [Mx/Md >15° and <31°] according to the standards described by Björk[19] and assessed by lateral radiographs of each subject), (3) no craniofacial syndromes or systemic muscle or joint disorders, and (4) a profile radiograph taken before orthodontic treatment with the 5 first cervical vertebral units visible. The sagittal jaw relationship (A-N-Pog, Fig 1) ranged between 0.0° and 11.5° (mean, 3.9°), the horizontal overjet was between −3.0 and 13.0 mm (mean, 5.1 mm), the vertical jaw relationship (Mx/Md, Fig 1) was between 20.5° and 31° (mean, 27.2°), and the