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The relationship between a dolichofacial morphology and bone adaptation of the articular tubercle

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ABSTRACT

Objectives: Against the background of a possibly compromised functional adaptation, the relationship between the height of the articular tubercle was analyzed as a function of the amount of divergence between the maxilla and the mandible.
Design: These parameters were obtained retrospectively from orthopantomograms and lateral radiographs produced in a standard procedure before orthodontic treatment.
Results: The height of the articular tubercle appeared to be significantly smaller in a group of patients with a dolichofacial morphology, with respect of those with an average (mesofacial) morphology. Furthermore, there was a significant correlation between the height of the articular tubercle and the mandibular angle.
Conclusions: These results suggest that bone remodeling in selected parts of the orofacial skeleton can be compromised giving rise to an altered craniofacial morphology.

1. Introduction

In orthodontics and oral surgery the problem of relapse is prominent. After the teeth have been positioned correctly by orthodontic treatment often the newly created configuration appears not to be stable. In such a case after some time the teeth migrate to a less favorable configuration. To prevent this unwanted migration a permanent restrain is used. Generally, this restrain does not cause adverse effects, but occasionally allergic reactions can be raised. In oral surgery bilateral split osteotomy is performed for mandibular set-back or advancement when the upper and lower jaw do not occlude normally. Years after this surgical intervention the mandible may have the tendency to remodel towards the original adverse shape. In oral surgery there is presently not a method to prevent the occurrence of this relapse.

The problem of relapse seems to be related to craniofacial morphology. Patients with a so-called dolichofacial (long-face) morphology appear to suffer from relapse more than patients with a mesofacial (average) or even brachyfacial (short-face) morphology (Joss & Vassalli, 2008, 2009; Zaher, Bishara, & Jakobsen, 1994). Dolichofacial morphology is characterized by a relatively large lower face height in relation to the upper face height. This relatively strong elongation of the lower face is already developing at the age of 6 years (Ha, Park, & Lee, 2014). From a sagittal perspective the mandibular angle (the angle between the posterior border of the mandibular ramus and the inferior border of the mandibular body) is much wider and, therefore, the mandibular body is rotated forward (clockwise in a right sided view). Herewith, the inclination of the lower border of the mandibular body diverges substantially from the Frankfort horizontal plane (the plane through the infraorbital margins and the roof of the external auditory meatus – Tweed, 1946). This is also indicated as a divergent relationship between upper and lower jaw (Proffit, Fields, & Sarver, 2012).

The biological background of a dolichofacial morphology is presently not known. It is associated with reduced strength of the masticatory muscles (van Spronsen, Weijs, Valk, Prahl-Andersen, & van Ginkel, 1992; Weijs & Hillen, 1984). This may indicate that the postnatal development of the area lining the oral cavity has been disturbed. The postnatal growth of the mandible is predominantly performed by bone remodeling (Enlow, 1992; Sperber, 1976). This process normally leads to optimization of bony structures in

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relation to their functional demands (Huiskes, 2000). If orthodontic treatment or oral surgery is performed in relation to bone from which the remodeling process is not adequately executed, it could give rise to unfavorable effects regarding stabilization of the newly created situation. However, whether the bone remodeling process is compromised or not in the lower facial area of especially subjects with a dolichofacial morphology is not known.

It is likely, that when the bone remodeling process of the mandible is compromised this also accounts for other structures in the orofacial region. This could be reflected by alterations of the outgrowth of the lower face which mainly occurs during childhood. In this period also the articular tubercle (or articular eminence) of the temporomandibular joint, which is virtually absent at birth, gets its shape. It comes into existence after birth under influence of the loads of the temporomandibular joints (Iwasaki et al., 2010), to become a prominence of about 7 mm in height (İlgüy et al., 2014). Consequently, if the process of bone remodeling is attenuated in the craniofacial region, it is most likely that also the outgrowth of the articular tubercle will be reduced. If a dolichofacial morphology is (partly) the result of a compromised process of bone remodeling the size of the articular tubercle may be reduced in these subjects. It is, therefore, hypothesized that the size of the articular tubercle will be reduced in subjects with a dolichofacial morphology characterized by a more forwardly rotated mandibular body and divergent relationship between maxilla and mandible.

2. Materials & methods

Geometrical data was obtained retrospectively by cephalometry of 94 subjects available from the records present in the department of Orthodontics at ACTA. This material consisted of both orthopantomograms (OPG) and lateral radiographs. They had been produced in a standard procedure before any orthodontic treatment had been performed using a OP100 Orthopantomograph (Instrumentarium, Tuusula, Finland) at a "panorama" setting (70 kV, 16 mA, 17.6 s recording time). For the present study the radiographs were applied anonymously: no other data (except for gender) from the subjects was available. Inclusion criteria were: good visibility of the mandibular condyle, articular tubercle and mandibular fossa on at least one side in the OPG and less than 3 months between production of the OPG and the related lateral radiograph. Selection of the subjects was based upon a variety of mandibular angle by visual inspection of the lateral radiographs.

The mandibular angle was determined from the lateral radiographs. It was defined by the angle between the Frankfort horizontal plane (defined by the points Porion and Orbitale) and the line connecting the mandibular angle (point Gonion) and the inferior border of the mandibular symphysis (point Menton). The height of the articular tubercle was determined from the OPG by the vertical distance between the superior-most point of the mandibular fossa and the inferior-most point of the apex of the articular tubercle. The vertical distance was defined perpendicular to the line connecting the superior-most points of both mandibular condyles. Also the posterior slope angle of the articular tubercle was quantified. This angle was defined by the tangent of the posterior aspect of the articular tubercle at the location where it crossed the line connecting the two condyle tops (Fig. 1). All measurements were performed using custom made computer software.

Subjects with a mandibular angle less than 32° were considered normal or nearly normal, whereas a dolichofacial morphology was defined by a mandibular angle of 35° and more (Tweed, 1946). Since a mandibular angle between 32° and 35° is considered not so favorable, but neither a mesofacial or dolichofacial morphology, subjects showing this amount were not included in the analysis.

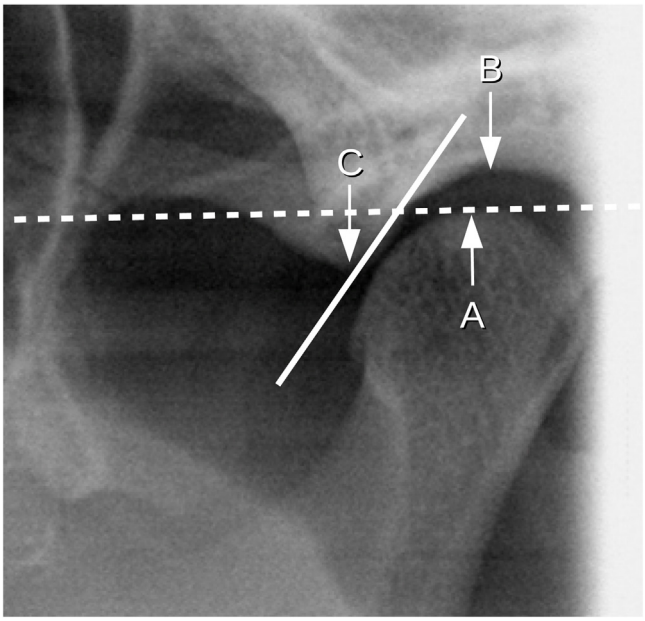

Fig. 1. Details of the left jaw joint in an orthopantomogram. (A) Superior-most point of the mandibular condyle. (B) Superior-most point of the mandibular fossa. (C) Inferior-most point of the apex of the articular tubercle. Dashed line: line connecting the superior-most points of both mandibular condyles. Solid line: tangent the posterior slope of the articular tubercle.

Unfortunately, for a number of subjects not all relevant structures were unambiguously visible in the OPGs. If this considered one side of a subject, only its other side was included in the analysis. If this considered both sides, the subject was excluded from the analysis. In all other cases the data from the left and right side were averaged (*vide infra*).

All measurements were conducted by two individuals independently.

2.1. Statistical analysis

The height of the articular tubercle and its posterior slope angle was correlated to the mandibular angle in a Pearson rank correlation test. A number of tests were performed to analyze the distribution of the various parameters. They included differences between male and female subjects and differences between left and right side. Furthermore, the normality of the distribution of the various parameters were tested with a Shapiro-Wilkinson test. The difference in height and posterior slope angle of the articular tubercle between the two groups (mesofacial and dolichofacial) was tested with an independent sample T-test. Finally, the reliability of the independent observers was tested by the intraclass correlation coefficient. All statistical tests were performed using R version 3.2.2 (www. r-project.org). The level of statistical significance was defined at a probability value of 0.05.

3. Results

3.1. Subjects

The records consisted of 46 normal to nearly normal subjects and 32 subjects with a dolichofacial morphology. After exclusion of radiographs where the relevant structures could not be recognized unambiguously, 39 normal or nearly normal subjects (14 male, 25 female) and 26 subjects with a dolichofacial morphology (7 male, 19 female) remained suitable for analysis.