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Changes in natural head position in response to mandibular advancement

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Abstract

We investigated the change in the natural head position and its relation to the change in the mandibular position in patients with mandibular hypoplasia. Forty-one patients treated by orthognathic surgery were divided into three groups: bilateral sagittal split osteotomy (BSSO) advancement (n = 8); BSSO advancement with genioplasty (n = 12), and Le Fort I osteotomy with BSSO advancement (n = 21). Cone-beam computed tomographic (CT) datasets were collected preoperatively and six weeks postoperatively. The natural head position was measured using the craniocervical angle and the distance from the second vertebra to the frontal plane, and the mandibular position was measured using the craniomandibular angle and the distance from the mandible to the frontal plane. Repeated measures two way ANOVA was used to assess the significance of differences between the angular and linear measurements, and Pearson's correlation coefficient to assess those between the change in the mandibular position and the natural head position. The craniomandibular angle increased and the mandible to frontal plane distance decreased, as planned; the craniocervical angle increased, and the distance from the second vertebra to the frontal plane decreased in all three groups. ANOVA showed a significant difference (p = 0.00?) in the time factor (preoperative compared with postoperative) but no significant differences between the groups or interaction (time multiplied by group) factors. There was a significant correlation between the change in mandibular position and the change in the natural head position (p = 0.00?). Changes in the natural head position after correction of mandibular hypoplasia are correlated with the change in the mandibular position, regardless of whether a genioplasty or Le Fort I osteotomy was done.

Keywords: Natural head position; Bilateral sagittal split osteotomy; Mandibular advancement; Cranial-cervical angle; Three-dimensional cephalometry; Mandibular hypoplasia

Introduction

The natural head position is the position of the head in relation to the cervical spine when a person stands upright with the eyes staring at infinity at horizontal level, or the mirror image of eyes. It is primarily based on the balancing system of the propriosensitive nerves, can be substituted using the craniocervical angle,[1] and has been proved to vary little over time even in fast-developing adolescents.[2,3] Given its reliability, it serves as an ideal reference in cephalometric analyses in orthodontics and orthognathic surgery.[3]

Previous studies have shown that the developmental pattern of the face is related to the natural head position.[4–6] Patients with a large (more obtuse) craniocervical angle tend to develop a long anterior face and a steep mandibular plane,

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and those with a small (more acute) craniocervical angle to develop a short anterior face and a flat mandibular plane.

In the light of these statements, a reasonable question is: will the position change after orthognathic surgery, as such operations are designed to correct facial pattern? We showed in a preliminary study that there are changes in the natural head position in patients with mandibular hypoplasia after bilateral sagittal split osteotomy (BSSO) for mandibular advancement.[7] However, in most orthognathic cases BSSO advancement with genioplasty or two-jaw surgery are more common than BSSO alone. It was therefore necessary to repeat the previous study in a larger sample of patients in whom the operations included, but were not limited to, BSSO advancement.

The aims of the present study were to answer the questions: is there a similar change in natural head position when the procedures combine BSSO advancement with genioplasty or Le Fort I osteotomy? and is there any correlation between the change in mandibular position and that of the natural head position?

Patients and methods

Forty-one patients (12 men and 29 women, mean (SD) age 25 (13) years) who had been treated by orthognathic surgery to correct mandibular hypoplasia from November 2010 to May 2012 at the Department of Oral and Maxillofacial Surgery/Hospital Dentistry of the Chinese PLA General Hospital Institution of Stomatology, Beijing, were entered into the study. They met the following criteria: they had a non-syndromic oral and maxillofacial deformity; they were free of any pain or dysfunction in the head and neck region; they had normal balancing ability and no obvious skeletal deformity in the cervical vertebra; they were not taking muscle relaxants; and they had no symptoms of obstructive sleep apnoea. All the operations were done by the same senior surgeon, and mandibular advancement was more than 2 mm in all cases. The patients were classified into three groups by operation: BSSO advancement; BSSO advancement with genioplasty; and BSSO advancement with maxillary Le Fort 1 osteotomy. The study was approved by the institutional review board of the University.

Cone-beam computed tomographic (CT) scans of each patient's natural head position were taken before and six weeks after operation, with the mandibles occluding at the maximal intercuspation. Before scanning, the patients were asked to stand upright using their best balancing ability with their eyes looking horizontally at the mirror image in the cone-beam CT machine. Once the natural head position had been reached, the head was fixed with a head support and chin rest to secure the position. Patients were required not to move or swallow during the scanning, and all the head positions were checked by the same radiological technician.

The patients' cone-beam CT datasets were imported to InVivoDental 5.0 (Anatomage Inc., San Jose, CA, USA) and three-dimensional measurements, relevant landmarks, planes, and measurements were defined (Table 1). A three-dimensional coordinate system was established based on the four coordinate system points (N, Or-R, Po-L, and Po-R) by picking these points on volume, and the rest of the landmarks were recorded in the same manner. The natural head position was measured using the craniocervical angle (SNC2) and distance from the second vertebra to the frontal plane (CIP-FrP and CSP-FrP), and the mandibular position was measured using the distance from the craniomandibular angle (SNL) and mandible to the frontal plane (L-FrP). The measurements were recorded on volume and were projected on to the mid-sagittal plane for comparison (Fig. 1). All the measurements were repeated every other week three times by the same investigator, and the mean values were used to decrease errors of measurement.

All the records of every measurement were tabulated and tested using the D'Agostino-Pearson omnibus normality test. The mean (SD) of every measurement were calculated, and the repeated measures two way analysis of variance (ANOVA) was used to assess the significance of differences

Table 1
Landmarks, planes, and measurements in this study.

Landmarks, planes and measurements	Definitions
N	The mid point of the frontal-nasal suture, coordinate system (co-sys) point
Or-R	The most inferior point of the right orbital rim, co-sys point
Po-L	The most superior point of the left external auditory meatus, co-sys point
Po-R	The most superior point of the right external auditory meatus, co-sys point
S	The mid point of sella
L	The most lingual point of the mandibular symphysis
CSP	The most superior-posterior point of the second cervical vertebral body
CIP	The most inferior-posterior point of the second cervical vertebral body
SN	The line passing the points of S and N
C2	The line passing the points of CIP and CSP
FH	The Frankfurt Horizontal plane, passing Po-L, Po-R and Or-R
MSP	The mid-sagittal plane, passing N and perpendicular to the line passing bilateral porions
FrP	The frontal plane, passing N and perpendicular to FH and MSP
SNL	The angle formed by point S, N and L, projected onto the MSP
SNC2	The angle formed by line SN and C2, projected onto the MSP
L-FrP	Distance from point L to FrP, projected onto the MSP
CIP-FrP	Distance from point CIP to FrP, projected onto the MSP
CSP-FrP	Distance from point CSP to FrP, projected onto the MSP