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Research Paper
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# Three-dimensional analysis of mandibular condyle position in patients with deviated mandibular prognathism

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*Abstract.* The purpose of this study was to evaluate the bilateral difference in condyle position in patients with deviated mandibular prognathism. Patients with asymmetrical ($n = 28$) and symmetrical mandibular prognathism ($n = 23$) were compared using the three-dimensional (3D) reformatted image from cone beam computed tomography. Significant positional differences in the condyle and subcondyle region (sigmoid notch) were found between the deviated and contralateral sides in the group with asymmetrical mandibular prognathism, but not in the control group. The lateral condyle was more laterally and inferiorly positioned on the contralateral side than on the deviated side ($P < 0.05$). The sigmoid notch was more laterally, superiorly, and posteriorly positioned on the deviated side ($P < 0.01$). Interestingly, condyle width and height on the deviated side was narrower and shorter than on the contralateral side and in the control group. Menton deviation was closely correlated with the bilateral difference in condyle height and 3D position of the sigmoid notch ($P < 0.01$). The degree of asymmetry was more highly correlated with condyle height than with the spatial orientation of the condyle head. The results demonstrated that mandibular prognathism with asymmetry is associated with bilateral differences in 3D morphology and orientation of the condyle. Therefore, clinicians should consider these variations during surgical planning.

Key words: condyle;; mandibular prognathism; asymmetry; chin; deviation.

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The mandibular condyle is one of the key factors that determine the skeletal and occlusal relationship. Previous studies have suggested a close relationship between the temporomandibular joint (TMJ) and facial deformity[1–4]. Facial asymmetry due to mandibular lateral deviation is an important feature in the aetiology of internal derangement of the TMJ[2]. The incidence of internal derangement has been shown to be higher in patients with an asymmetrical class III facial deformity than in symmetrical class III patients[5]. It has also been reported that the deviated side shows a steeper condyle

 

eminence[6]. However, previous studies on the position and morphology of the condyle performed using two-dimensional (2D) imaging, such as linear tomography, panoramic radiography, and open- and closed-mouth transcranial projections, have been subject to the limitations of the 2D imaging technique. Radiological examination of the TMJ is difficult because of the complicated anatomy, magnification errors, and superimposition of the adjacent anatomical structures. Recently, various three-dimensional (3D) imaging techniques have been utilized to evaluate the TMJ morphology to overcome the limitations of 2D imaging[7–11].

The 3D evaluation of deviated mandibular prognathism has shown that the condyle and the body of the mandible are significantly longer on the contralateral side of chin deviation[3,12–14]. These differences in length suggest a major role for the condylar process in the aetiology of mandibular asymmetry. Most previous studies have shown a significant difference in TMJ space and condylar morphology between the two condyles in patients with facial deformity[5,10,15,16]. These studies have focused on the relationship between the condyle and glenoid fossa rather than the spatial orientation and difference in 3D morphology of the condyle. In particular, there have been only a few studies on condylar position in patients with facial asymmetry performed using 3D reformatted images from computed tomography (CT). By comparing the 3D image data of patients with asymmetrical mandibular prognathism to those of control subjects with symmetrical prognathism, more insight could be gained into the potential aetiology of the facial asymmetry in patients with mandibular prognathism. Since orthognathic surgery in cases of facial asymmetry can greatly influence the TMJ position or function and surrounding muscular function, fundamental understanding of the 3D morphological features of the condyles in patients with asymmetrical mandibular prognathism is important in the diagnosis and treatment planning.

This study aimed to investigate whether there is any difference in the condyle and sigmoid notch positions in patients with and without mandibular deviation by using 3D coordinates. Any possible correlation between mandibular deviation and condylar positions was also evaluated. It was hypothesized that: (1) there is a difference between the condylar positions of the deviated and contralateral sides in patients with facial asymmetry, and (2) the degree of mandibular midline deviation is correlated to a larger condylar length on the deviated side. Therefore, an investigation was performed to determine the differences in condylar position in asymmetric and symmetric mandibular prognathism patients and the correlation between mandibular chin deviation and condylar position.

## Materials and methods

### Study subjects

This retrospective study included 51 patients with mandibular prognathism who had undergone orthognathic surgery at the affiliated hospital of Kyungpook National University in Daegu, Korea, between January 2013 and June 2014. The patients had been diagnosed with mandibular prognathism and an Angle class III molar relationship, with an A-point–nasion–B-point (ANB) angle of less than −1°. The cone beam computed tomography (CBCT) images obtained before orthognathic surgery for diagnostic purposes were used in this study. Patients with a history of facial trauma or infection, cleft lip/palate, hemifacial microsomia, previous TMJ surgery, or congenital muscular torticollis were excluded. The subjects were divided into two groups on the basis of the degree of chin deviation from the facial midline. Facial asymmetry was defined as chin deviation (menton or pogonion) of more than 4 mm from the facial midline[17]. In this study, mandibular prognathism patients with menton (Me) deviation of less than 4 mm served as the control group and patients with Me deviation of more than 6 mm from the midsagittal plane formed the asymmetry group.

### Image analysis

CBCT images were obtained to evaluate the condylar position using a CB MercuRay scanner (Hitachi Medical Corporation, Tokyo, Japan) under the following conditions: 19-cm field of view, 120-kVp tube voltage, and 15-mA tube current, resulting in a 0.4-mm voxel size. Patients were scanned in the upright position with their teeth in the intercuspal position. The 3D images were reconstructed using 3D software (Simplant O&O 2012; Materialise, Leuven, Belgium) and multiplanar reformatted images were acquired.

The 3D rendered head models were reoriented to reference planes, as reported in a previous study[18]. The Frankfort horizontal (FH) plane was defined as the plane passing through both orbitales and right porion. The sagittal plane was defined as the plane perpendicular to the FH plane

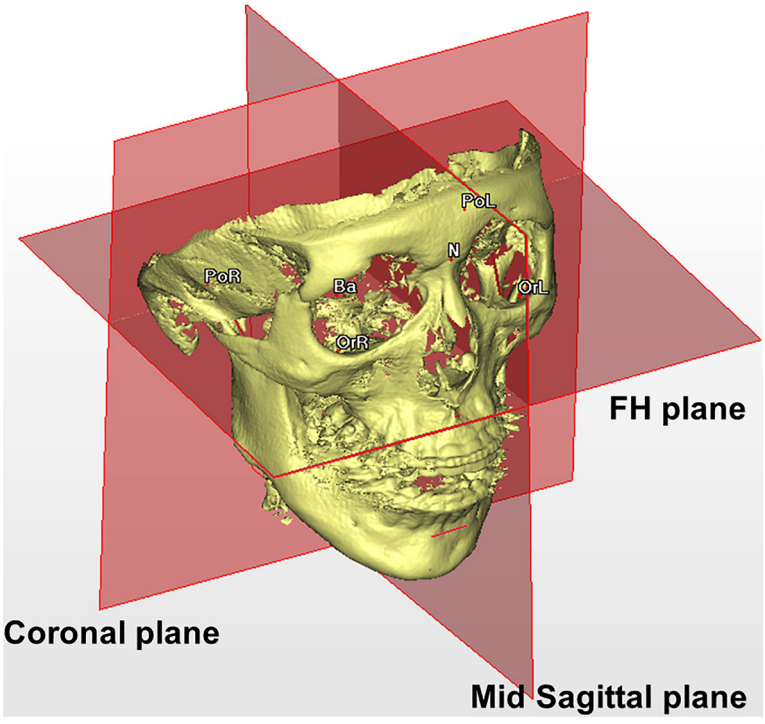


*Fig. 1.* The 3D reference planes. The Frankfort horizontal (FH) plane was defined as the plane passing through the right and left orbitale and the right porion. The sagittal plane was defined as the plane perpendicular to the FH plane that passes through nasion and basion. The coronal plane was defined as the plane perpendicular to the FH plane and sagittal plane that passes through left porion.