Original Contributions

Temporomandibular condylar morphology in diverse maxillary–mandibular skeletal patterns

A 3-dimensional cone-beam computed tomography study

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ABSTRACT

Background. The authors evaluated the morphology and symmetry of the temporomandibular joint in participants with normodivergent and hyperdivergent skeletal class I, II, and III patterns.

Methods. A total of 80 participants were divided into 4 groups on the basis of their sagittal and vertical skeletal patterns. Cone-beam computed tomographic images were used to evaluate the condyle-fossa relationship and the morphology and symmetry of the mandibular condyle. One-way analysis of variance and Tukey post hoc tests were used to compare the mean values among the different groups.

Results. Participants with class II hyperdivergent patterns had the smallest anteroposterior (mean [standard deviation {SD}], 4.4 [1.6] millimeters) and mediolateral (10.5 [3.0] mm) condylar process widths among all 4 groups. The mean (SD) axial condylar angle was flatter in patients with class III hyperdivergent patterns (19.8° [5.1°]) compared with the other groups. The mean (SD) anteroposterior differences of the condylar processes (2.9 [1.4] mm) in patients with class III hyperdivergent patterns were the greatest in all 4 groups.

Conclusion. Participants in the group with class II hyperdivergent patterns have a smaller and narrower condyle compared with the other groups measured. Asymmetry was found among all groups, with participants with skeletal class III patterns having the most asymmetry. The most common condylar morphology in all groups examined was convex.

Practical Implications. These results support the concept that morphology and symmetry of the temporomandibular joint varies in different skeletal patterns, presumably as an adaptive response to functional demands.

Key Words. Cone-beam computed tomography; temporomandibular joint; condylar morphology; symmetry.

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The temporomandibular joint (TMJ) is the joint formed between the mandibular condyle and the glenoid fossa at the base of the cranium. The function of this joint is fundamental to maintain good occlusion and a stable stomatognathic system. The mandibular and temporal components of the TMJ are both thought to maintain a capacity for remodeling even after growth has ceased.[1] The continued capacity for morphologic change is thought to be an adaptive response to functional and mechanical requirements.[2,3] Several factors were found to affect the TMJ morphology and position, including age, sex, pathologic processes, functional alterations, and occlusal forces.[4-6] Several researchers have found an important relationship between joint morphology and various occlusal characteristics,[7,8] whereas other researchers have been unable to find a relationship.[9,10]

Radiographic examination can be a valuable adjunct in reaching a diagnosis for patients with temporomandibular disorder (TMD). Conventional 2-dimensional (2D) radiography has been the mainstay of TMJ imaging in the past. However, the diagnostic value of these 2D techniques is not always adequate due to the superimposition of neighboring structures. This results in a low sensitivity for bony changes of both the condylar and temporal components.[11,12] Advances in 3-dimensional (3D) imaging have allowed a more complete analysis of the TMJ than previously possible. Cone-beam computed tomography (CBCT) has several advantages compared with traditional computed tomographic methods,[13] and a high level of accuracy can be obtained when evaluating the TMJ region.[14,15]

Previous research that used 2D methods indicates that the position of the glenoid fossa plays a role in establishing different craniofacial patterns.[16] Previous 3D/CBCT investigations into the relationship of the TMJ and malocclusion have been focused on the sagittal dimension[17,18] or specific skeletal patterns.[19]

The aim of our study was to investigate the relationship of condyle and glenoid fossa, condyle morphology, and TMJ symmetry in participants with different craniofacial characteristics with the use of CBCT imaging.

METHODS

Participants

Our study was approved by the Ethics Committee at the Nanjing Stomatological Hospital, Nanjing University. A total of 256 untreated participants from the Department of Orthodontics at the Nanjing Stomatological Hospital were screened for eligibility. After applying inclusion and exclusion criteria, 80 participants (32 males and 48 females, aged 14-35 years) were included and divided into 4 groups (20 participants each) on the basis of their sagittal (A point, nasion, and B point [ANB]) and vertical (Frankfort mandibular plane angle [FMPA]) skeletal patterns: class I normodivergent (ANB, 0°-4°; FMPA, 22°-28°), class I hyperdivergent (ANB < 0°; FMPA, > 28°), class II hyperdivergent (ANB, 0°-4°; FMPA > 28°), and class III hyperdivergent (ANB > 5°; FMPA > 28°).

Inclusion criteria included

- full permanent dentition with no missing teeth;
- no history of major dental treatment within the past 3 years, including orthodontics, orthognathic surgery, or restorative treatment;
- no treatment for TMD within the past 3 years;
- CBCT images (obtained as part of an orthodontic diagnosis and treatment plan) of good quality.

Exclusion criteria included

- craniofacial defects, syndromes, or skeletal deformity (for example, cleft lip and palate);
- radiographic signs of condylar or glenoid fossa pathology.

A total of 160 TMJs (right and left) were finally included in the measurements and analyses.

CBCT analysis

All CBCT images were obtained with the same CBCT machine (NewTom VG), and the settings used were in accordance with the manufacturers' recommendations (voxel size, 0.20 millimeters). Evaluation of the joints was performed with Mimics Version 16.0 software (Materialise). Left and right TMJs were evaluated independently for all participants on the basis of methodology described previously. All images were measured digitally and adjusted for scale.

For sagittal measurements, sections with a clear view of the condyle and glenoid fossa with a continuous line of cortical bone were selected for analysis. These measurements were performed in the sagittal plane:

- anterior joint space (AS), the shortest distance between the most anterior point of the condyle and the posterior wall of the articular tubercle (Figure 1A, a);
- superior joint space (SS), measured from the shortest distance between the most superior point of the condyle and the most superior point of the mandibular fossa (Figure 1A, b);
- posterior joint space (PS), measured by the shortest distance between the most posterior point of the condyle and the posterior wall of the mandibular fossa (Figure 1A, c);
- depth of the glenoid fossa, measured from the most superior point of the fossa to the plane formed by the most inferior point of the articular tubercle to the most inferior point of the auditory meatus (Figure 1B).

The axial measurements included

- anteroposterior width of the condylar process, which was the largest anteroposterior diameter of the mandibular condylar processes (Figure 2A, a);
- mediolateral width of condylar process, which was the greatest mediolateral diameter of the mandibular condylar processes (Figure 2A, b);

ABBREVIATION KEY

ANB: A point nasion, and B point.
AS: Anterior joint space.
CBCT: Cone-beam computed tomography.
FMPA: Frankfort mandibular plane angle.
PS: Posterior joint space.
SS: Superior joint space.
TMD: Temporomandibular disorder.
TMJ: Temporomandibular joint.
2D: 2-Dimensional.
3D: 3-Dimensional.