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Effects of condylar head surface changes on mandibular position in patients with temporomandibular joint osteoarthritis

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ABSTRACT

Purpose: This study evaluated condylar surface changes in patients after temporomandibular (TMJ) osteoarthritis (OA) treatment, and used cone beam computed tomography (CBCT) to investigate the relationship between condylar surface and mandibular position changes.
Material and methods: Thirty-six patients diagnosed with TMJ OA and receiving non-surgical treatments for TMJ OA were enrolled in this study. Patients were assigned to study groups according to the affected side. Those in the unilateral osteoarthritis (OAU) group (n = 20; 8 males and 12 females; aged 22.0 ± 11.5 years) had a unilateral condyle with TMJ OA, and those in the OAB group had bilateral TMJ OA (n = 16; 1 male and 15 females; aged 25.7 ± 6.4 years). Condylar surface and mandibular position changes were investigated by the superimposition of three-dimensional reconstructed images and CBCT data, respectively.
Results: For condylar surface changes, the average absolute deviation was 0.32 ± 0.08 mm for the OA side and 0.18 ± 0.03 mm for the non-OA side, a significant difference between sides ($p < 0.05$). In the bilateral osteoarthritis (OAB) group, the average absolute deviation was 0.35 ± 0.08 mm for the left side and 0.33 ± 0.09 mm for the right side. For mandibular position changes, measurement points that moved more than 2 mm were Pog, Me, and Mental foramen in both groups.
Conclusion: The study results show that the mandible with both condyles affected moved backward and downward after TMJ OA treatment. In the patient ngroup with unilateral TMJ OA, there was deviation on the affected side and downward movement ($p < 0.05$).

1. Introduction

Temporomandibular joint (TMJ) osteoarthrosis (OA) is defined as a degenerative condition of the joint that is characterised by deterioration and abrasion of articular tissue, with concomitant remodeling of the underlying subchondral bone (Yamada et al., 2004). The surface of the condylar head is affected by erosion, sclerosis, flattening, and the creation of osteophytes, and is diagnosed by clinical signs and radiographic examination (Machon et al., 2011).

The relationship between TMJ condylar pathologic change and dentofacial morphology has often been reported. Arnett et al. (1996) reported that patients with condylar resorption might exhibit a decreased ramus height, progressive mandibular retrusion, or a decreased growth rate during the juvenile years. Matsumoto et al. (2006) recently suggested that individuals with TMJ osteoarthritis/osteoarthrosis had a smaller and significantly more posteriorly rotated mandible in comparison with that in unaffected individuals. Goto et al. (2005) also investigated a correlation between a mandibular midline deviation and TMD clinical symptoms. They reported that the TMJ condyle on the side of the midline shift showed a smaller size and a higher incidence of disc displacement than that on the non-shifted side. However, previous studies on condylar changes in TMJ and dentofacial changes caused by temporomandibular disorders have limitations, in that they were based on 2D images.

Without overlapping structures and image distortions, cone beam computed tomography (CBCT) can be a useful tool for evaluation of the condylar head surface and skeletal changes after TMJ

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OA treatment (Barghan et al., 2010). Park et al. (2012) and Ok et al. (2014) introduced CBCT superimposition methods for evaluating skeletal changes after two-jaw surgery and condylar surface changes in TMJ OA patients, respectively. However, until now, there have been few studies in which three-dimensional (3D) CBCT was used to evaluate the relationship between condylar head surface changes and skeletal changes in patients with TMJ OA. CBCT can be used to investigate these simultaneously.

Therefore, the purposes of this study were to evaluate condylar head surface changes in patients after TMJ OA treatment, and to use CBCT to investigate the relationship between condylar head surface changes and mandibular position.

2. Materials and methods

This retrospective study was performed on 36 patients who were diagnosed with TMJ OA at the Department of Oral Medicine, Pusan National University Dental Hospital, from May 2009 to November 2012. The inclusion criteria were based on clinical (signs and symptoms) and radiographic (panoramic radiographs and CBCT) examinations. The sample was divided into two groups according to the affected side: those in the unilateral osteoarthritis (OAU) group were diagnosed as having unilateral TMJ OA ($n = 20$; 8 males and 12 females; aged 22.0 ± 11.5 years), and those in the bilateral osteoarthritis (OAB) group were diagnosed as having bilateral TMJ OA ($n = 16$; 1 male and 15 females; aged 25.7 ± 6.4 years). The study population received medication, physical therapy, and stabilisation splint therapy for TMJ OA. This study was reviewed and approved by the Institutional Review Board of Pusan National University Dental Hospital (PNUDH-2014-009).

CBCT images (Zenith 3D; Vatech Co., Seoul, Korea) were obtained at the initial clinical examination (T0) and about 1 year after TMJ OA treatment (T1; mean, 13.0 ± 5.9 months after T0). The study participants were upright with maximum intercuspation (the FH plane was adjusted parallel to the floor).

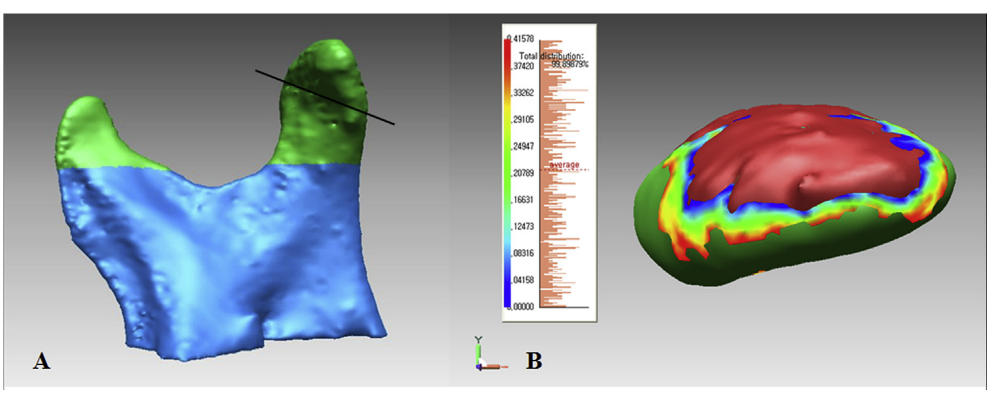

Fig. 1. (A) cone beam computed tomographic three-dimensional condylar image. Blue shows superimposed registration areas, and the upper part of the line shows condylar head surface analysis areas. (B) Superimposed upper condylar head. These are the absolute linear measurements. Green indicates T0, and red T1.

For analysis of the condylar head surface changes, 3D images of the condyle were reconstructed and reformatted into the stereolithography (STL) data format by means of 3D imaging software (Vworks 4.0; Cybermed Co., Seoul, Korea). The condylar head images at T0 and T1 were superimposed by 3D scan data-processing software (Rapidform XOS3; Inus Technology Inc., Seoul, Korea). The registration areas were the condylar neck, mandibular notch, and posterior border of the ramus (Park et al., 2012). The superimposed condylar heads were divided by a plane connecting the median and lateral poles. For calculation of the surface displacements of the condylar heads, the average absolute deviation (averages of the absolute values of the deviation between T0 and T1 images) was used (Fig. 1).

For the analysis of mandibular position change, CBCT data were superimposed on the anterior cranial base. All superimposed images were measured by a single investigator (Y.J.S.). All measurement points at T0 and T1 were obtained with an x, y, z coordinate system (Table 1). In this coordinate, the nasion point was the origin (0,0,0) (Table 1). The x axis was the horizontal axis (right and left sides). The y axis represented the anteroposterior side, and the z axis was the vertical axis (upward and downward). The changes in mandibular position were analysed by Euclidean distance, the direction and distance of landmarks on three axes from the initial examination (T0) to 1 year after (T1).

2.1. Statistical analysis

The data were statistically analysed with SPSS software (version 21.0 for Windows; SPSS Inc., Chicago, IL, USA). The differences were considered to be significant at $p < 0.05$. The changes in condylar head surface and mandibular position were tested by Student's t-test. To analyse the direction of mandibular movement, we performed one-way analysis of variance (ANOVA). To evaluate intra-investigator error, the same investigator re-performed the data analysis 2 weeks after the initial examination; there were no statistically significant differences ($p > 0.05$).

3. Results

3.1. Condylar head surface changes

The average absolute deviation of condylar head surface changes in the OAU group was 0.32 ± 0.08 mm for the OA side and 0.18 ± 0.03 mm for the non-OA side, respectively. There were significant differences in the condylar head surface changes between the OA and non-OA sides ($p < 0.05$). In the OAB group, the average

Table 1
Reference points.

Landmark	Description
Pogonion (Pog)	The most anterior point on the mandibular symphysis
Menton (Me)	The lowest point on the lower border of the mandibular symphysis
Condylion (Cd)	The most superior and posterior point on the head of the mandibular condyle
Coronion (Cr)	The most superior point on the head of the coronoid process
Mn. foramen	The most medial point of the mandibular foramen on the axial plane
Mental foramen	The most superior point of the mental foramen on the coronal plane