

## Intra- and interobserver agreement of computed tomography in assessment of the mandibular condyle

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### ABSTRACT

**Purpose** : To study the intra- and interobserver agreement of multidetector row computed tomography (MDCT) in interpretation of degenerative changes of the mandibular condyle.

**Materials and Methods** : Five observers independently evaluated one hundred temporomandibular joint MDCT images for signs of osteophytes, erosion, sclerosis and flattening. The intra- and interobserver agreements were calculated by using Kappa statistics.

**Results** : The intraobserver agreement was substantial for erosion ( $k=0.75$ ), flattening ( $k=0.74$ ) and sclerosis ( $k=0.72$ ) and almost perfect for osteophytes ( $k=0.84$ ). The interobserver agreement was fair for flattening ( $k=0.39$ ), moderate for erosion ( $k=0.58$ ) and sclerosis ( $k=0.48$ ) and substantial for osteophytes ( $k=0.75$ ).

**Conclusion** : This study shows that we can expect good agreement for the presence of osteophytes, but not for flattening in the interpretation of MDCT images of the condyle. (*Korean J Oral Maxillofac Radiol* 2007; 37 : 191-5)

**KEY WORDS** : Mandibular Condyle; Tomography, Spiral Computed; Observer Variation

### Introduction

The temporomandibular joint (TMJ) is a complicated area to image because the bony structures of the joint are small and partially obscured by the larger cranial bones. There are a number of imaging techniques, ranging from plain-film to magnetic resonance imaging. CT has been the method of choice for evaluating osseous abnormalities in the TMJ. In the 1980s, CT began to be applied in the diagnosis of osseous changes of the TMJ.<sup>1-4</sup> Honda et al.<sup>5</sup> reported that CT was highly reliable in evaluation of the bony mandibular condyle. Despite the highly absorbed doses, CT has great potential when osseous TMJ abnormalities are of primary concern.<sup>6,7</sup>

Osteoarthritis of the TMJ is a common clinical problem and most TMJ meniscus dysfunction results in degenerative arthritis. The radiographic signs of osteoarthritis are cortical bone erosions and then flattening of joint components with productive bone changes, such as, sclerosis and osteophytes.<sup>8,9</sup>

The interpretation of TMJ images is very subjective, depend-

ing on examiner experience and familiarity with TMJ anatomy and pathophysiology. However, intra- and interobserver variability of CT for assessment of TMJ osseous changes has not been evaluated. This study was designed to evaluate the intra- and interobserver agreement of MDCT in interpretation of the TMJ. The mandibular fossa was excluded from the study because few changes in this joint component have been reported.<sup>10</sup>

### Materials and Methods

#### 1. Materials

From the CT examination archives at Pusan National University Hospital from 2006 to 2007, 100 sets of TMJ CT images from 50 patients diagnosed with temporomandibular disorder (TMD) were selected. Of these cases, 16 were male and 34 were female. The age of the patients ranged between 25 and 58 years, with a mean age of 38.1.

#### 2. Image acquisition and assessment

CT images were taken with 4-slice, MDCT (LightSpeed QX/I; General Electric Medical Systems, Milwaukee, Wis, USA). CT data were obtained with the following parameters:

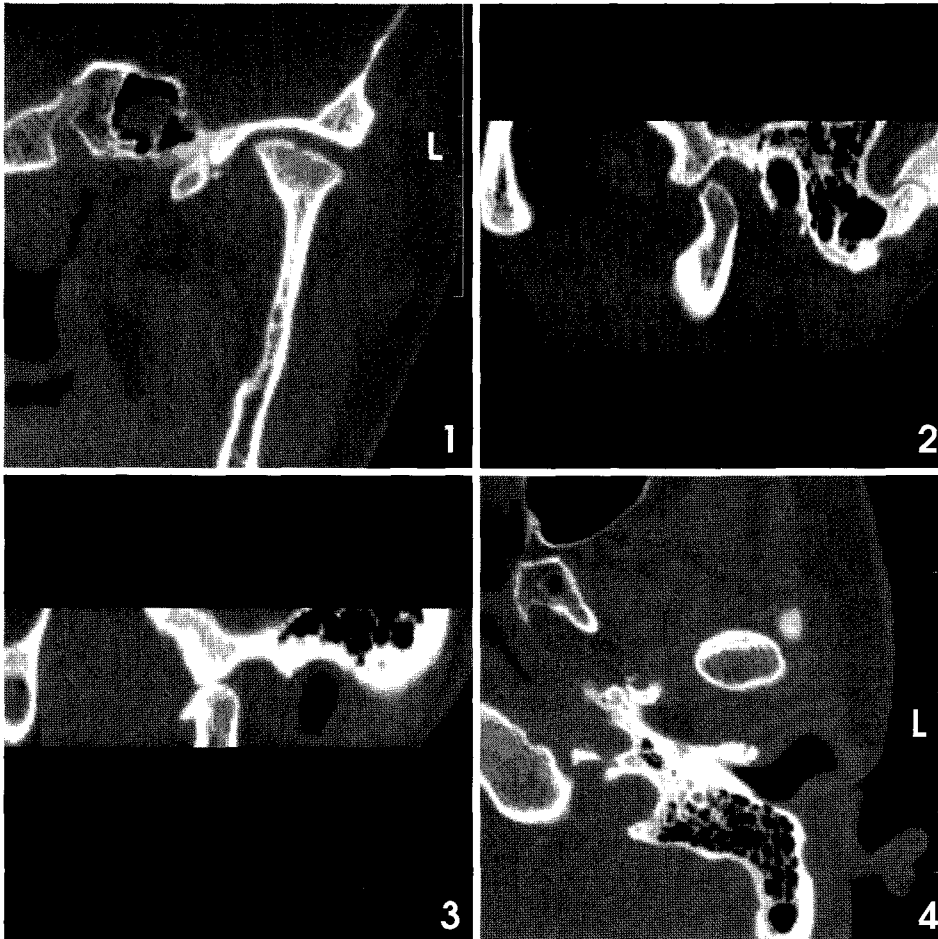
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**Fig. 1.** Coronal CT image showing erosion.

**Fig. 2.** Sagittal CT image showing flattening.

**Fig. 3.** Sagittal CT image showing osteophyte.

**Fig. 4.** Axial CT image showing sclerosis.

120 kVp, 250 mA, 1.25 mm section thickness, and a pitch of 3, and 0.5 mm reconstruction interval. The axial CT image data were reconstructed into sagittal and coronal images perpendicular and parallel to the long axis of the head of the mandibular condyle, respectively. All CT image data were directly interfaced onto our PACS system (M-view; Marotec, Seoul, Korea) which displayed bone window images on monitors (2,048 × 2,560 image matrices, 10-bit viewable gray scale, and 145.9-ft-lambert luminescence).

Each set of images was independently interpreted by 5 observers: 2 oral and maxillofacial radiologists (observers A and B), 1 oral medicine doctor trained in management of TMD (observer C), 1 general dentist with five years clinical experience, but not in the TMJ field (observer D), and 1 dentist in Internship with little clinical experience (observer E). All observers were blind to the clinical information of subjects imaged.

After a calibration session using the written definition and the reference images, observers assessed the CT scans for the degenerative signs of erosion, flattening, osteophytes and sclerosis of the condyle. Interpretation was made using a

combination of all three plane images. For each measure, a score of “zero” equated to no demonstrable change, and “one” represented change. All 5 observers evaluated the CT images twice with at least a 4 week period between the readings.

### 3. The criteria was as follows

Erosion-an interruption or absence of the cortical lining (Fig. 1).

Flattening-a loss of the round contour of the condyle at the load bearing area (Fig. 2).

Osteophyte-a marginal bone outgrowth (Fig. 3).

Sclerosis-an increased density of the cortical lining or the subchondral bone (Fig. 4).

### 4. Statistical analyses

Kappa statistics<sup>11</sup> were computed to assess the intra- and interobserver agreement by using SPSS (version 12.0 for Windows, SPSS Inc, Chicago, III). For agreement between observers, data from the first and second assessment were used and for agreement between examiners data was used from the

first assessment only.

Kappa statistics are commonly interpreted as <0.00, poor agreement; 0.00 to 0.20, slight agreement; 0.21 to 0.40, fair agreement; 0.41 to 0.60, moderate agreement; 0.61 to 0.80, substantial agreement; and 0.81 to 1.00, almost perfect agreement.<sup>12</sup>

### Results

The intraobserver agreement was substantial for erosion, flattening and sclerosis and almost perfect for osteophytes (Table 1). The interobserver agreement was fair for flattening, moderate for erosion and sclerosis, and substantial for osteophytes (Table 2).

### Discussion

Osteoarthritis is very common in TMJ, and has been referred to as a degenerative joint disease.<sup>13</sup> The reported prevalence of osteoarthritis of the TMJ was 22% to 38% of the population within the age range 20 to 90 years.<sup>14-17</sup> Both CT and cone beam CT are excellent imaging modalities for assessment of bony TMJ components.<sup>5</sup> Honda et al.<sup>5</sup> reported that the diagnostic accuracy for helical CT was 0.86. With introduction of MDCT, the interpretation of CT images seemed to get more accurate.

Usually, condylar lesions are detected more frequently than

temporal bone lesions.<sup>5,18</sup> This is the reason why we confined our examination to the mandibular condyle. In this study, the true TMJ status was not verified by microscopic examination. We only assessed the observer agreement without knowing the diagnostic accuracy which was impossible to evaluate in *in vivo* studies.

We considered erosion, flattening, osteophytes and sclerosis to be the significant features in evaluating degenerative condylar abnormalities. Even though cysts and concavity were included in a few studies,<sup>19,20</sup> we excluded them from the list because they were difficult to define and because it was not easily to classify them as being abnormal.

Many of the TMJ studies only included the sagittal images,<sup>5,19,21-23</sup> but several authors have emphasized the importance of also including coronal views.<sup>24-27</sup> We believed that the combined use of all three plane images would be helpful in evaluating bony changes in the joint, so we used axial, sagittal and coronal images in combination. In general, the sagittal plane was valuable for the assessment of osteophytes, erosion, flattening and sclerosis, the coronal plane for erosion, flattening and sclerosis and the axial plane for erosion and sclerosis.

The overall intraobserver agreement ranged from substantial to almost perfect for all variables, which meant there was remarkable consistency between observers. However, the interobserver agreement was lower than that of the intraobserver, varying from fair to substantial agreement. There was high agreement for the presence of osteophytes and erosion, especially among observer A, B and C. This result infers that there was consensus among experienced observers in defining the cortical irregularities. The fact that observer C and D were unaccustomed to CT images might be the reason for low interobserver agreements. The highest agreement between examiners was found for the presence of osteophytes, demonstrating substantial agreement. From the report that the radiographic diagnosis of osteophytes was very accurate,<sup>5</sup> osteophytes seems to be easy to recognize.

**Table 1.** Kappa statistics for intraobserver agreement

Observer	Kappa index				
	Erosion	Flattening	Osteophyte	Sclerosis	Mean
A	0.83	0.77	0.92	0.77	0.82
B	0.81	0.74	0.90	0.81	0.81
C	0.75	0.78	0.83	0.72	0.77
D	0.65	0.71	0.78	0.62	0.69
E	0.69	0.70	0.75	0.67	0.70
Mean	0.75	0.74	0.84	0.72	0.76

**Table 2.** Kappa statistics for interobserver agreement

Observer	Kappa index															
	Erosion				Flattening				Osteophyte				Sclerosis			
	B	C	D	E	B	C	D	E	B	C	D	E	B	C	D	E
A	0.84	0.74	0.47	0.54	0.44	0.51	0.42	0.34	0.82	0.79	0.77	0.74	0.62	0.56	0.38	0.59
B		0.78	0.51	0.46		0.55	0.39	0.26		0.81	0.75	0.61		0.57	0.33	0.44
C			0.50	0.53			0.36	0.28			0.73	0.70			0.42	0.52
D				0.42				0.35				0.74				0.35
Mean		0.58				0.39				0.75				0.48		

On the other hand, we found variation in interobserver agreement in the interpretation of flattening and sclerosis. The reason that flattening showed the lowest agreement might be related to the difficulty in discerning abnormal from normal findings. There were reports that flattening was among the most frequent findings of osseous alteration in asymptomatic persons.<sup>21,28</sup> Brooks et al. reported that minimal flattening of the condyle or articular eminence was seen in approximately 35% of asymptomatic persons without internal derangement. They therefore suggested that it should be regarded as being within normal limits in asymptomatic persons.<sup>21</sup> Even though we selected symptomatic patients as material, many of these had unilateral TMJ problems. Without any preconception of abnormality, it was very difficult to decide whether any flat surface of the condyle was a truly abnormal flattening or just a normal variation in shape. The low agreement for flattening and sclerosis brings into question the accuracy of evaluations of CT images made by single examiners.

This study was performed to determine the intra- and interobserver agreement of MDCT in assessment of degenerative changes of the mandibular condyle. The overall intraobserver agreement was fairly good; from substantial to almost perfect agreement. However, the interobserver agreement was low, showing from fair to substantial agreement. This study shows that, in the interpretation of CT images of the condyle, we can expect good agreement for the presence of osteophytes, whereas the assessment of flattening might be unreliable.

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