Anterior condylar remodeling observed in stabilization splint therapy for temporomandibular joint osteoarthritis

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Objective. To comparatively evaluate condylar surface bone formation and cortical thickening in patients with temporomandibular joint osteoarthritis, with or without stabilization splint (SS) therapy.

Study Design. This retrospective study of 57 OA patients included 18 patients who had undergone SS therapy (SS group), compared with 39 patients that had not received SS therapy (non-SS group). To evaluate osseous changes on the condylar bone formation and cortical thickening, pre- and post-treatment cone beam computed tomography images of each patient were superimposed using voxel registration.

Results. The SS group exhibited a higher ratio of bone formation in the anterior division of the condyle; the non-SS group exhibited mostly no change. The SS group was found to have higher frequencies of cortical thickening in the anteromedial, anterior-intermediate, anterolateral, posteromedial, and posterior-intermediate sections than the non-SS group.

Conclusions. SS therapy in temporomandibular joint osteoarthritis induced favorable bone remodeling in the anterior division of the condylar head. (Oral Surg Oral Med Oral Pathol Oral Radiol 2014;118:363-370)

Signs and symptoms of temporomandibular joint (TMJ) arthralgia often are attributable to TMJ osteoarthritis (OA), a severe form of TMJ disorder marked by degenerative osseous changes accompanied by secondary inflammation.[1] The main cause of TMJ OA is excessive overloading of the articulation surpassing physiologic tolerance. This overload of the joint leads to the degenerative change of the articular surface of the mandibular condyle and subsequent cortical destruction.[2] Resultant gross morphologic changes, such as deviation in form, disk displacement, adhesions, and osteoarthritic processes, can occur with or without the experience of pain or dysfunction.[3]

As the conservative approach to TMJ OA, the therapeutic protocol of physiotherapy, medication, occlusal appliance therapy, and intra-articular injection is well established.[4-6] Among these, the stabilization splint (SS) has been clinically confirmed to effectively protect the TMJ against unintentional overloading and relieve excessive muscular tension while preventing sprain in the mandibular condyle in the case of bruxism.[2] Kuttila et al.[7] reported that the use of SS improved the clinical symptoms of severe TMJ arthralgia, and Al-Ani et al.[8] reported its positive effect of alleviating pain related to TMJ disorder. However, its effect on OA has not been fully investigated despite the increasing clinical need for more research regarding the effects of SS in cases of OA. Moreover, considering that TMJ OA is diagnosed based on signs and symptoms, as well as subsequent clinical tests for the condition and radiographic evidence of degenerative osseous changes in the condylar heads,[2] the radiographic changes from SS should also be confirmed. Among the pertinent radiographic studies, Lee et al. investigated 54 OA-affected TMJs in a 1-year follow-up study to evaluate longitudinal radiographic changes in relation to clinical signs and symptoms based on conventional computed tomography (CT) images of TMJ OA.[9] Liu et al.[10] reported a "double contour" appearance in the medial and intermediate segments of the condyle when an anterior repositioning splint (ARS) was applied using CT images.

Therefore, the purpose of this study was to evaluate the effects of sectional osseous changes arising from SS treatment for patients with TMJ OA, specifically regarding condylar bone formation and cortical thickening. The specific aims of the study were (1) to

Statement of Clinical Relevance

The observed changes in the radiographic appearance of the condyle suggest that stabilization splint therapy in temporomandibular joint osteoarthritis could induce favorable bone remodeling in the anterior division of the condylar head with degenerative condylar changes.

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investigate osseous changes in articular surface bone and cortical bone thickness, and (2) to compare two patient groups that respectively had and had not undergone SS therapy.

MATERIALS AND METHODS

Study design and population

We developed a case-control study and enrolled a sample of TMJ OA patients from among the population of patients presenting, for TMJ disorder, to Pusan National University Hospital, Department of Oral Medicine, between 2009 and 2012. The inclusion criteria were based on signs and symptoms, subsequent clinical tests for TMJ OA, and panoramic and cervicocranial radiographs. In all of the cases of diagnosed TMJ OA, cone beam CT (CBCT; Zenith 3-D; Vatech Co., Seoul, Korea) was used to confirm osseous change in the condylar surface, satisfying the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD).[11] In addition to TMJ OA patients who were diagnosed based on the RDC/TMD, patients who had shown symptoms of TMJ OA without definitive RDC/TMD-indicated radiologic evidence of it and had been following the pertinent clinical treatment protocol were also included under the "TMJ OA" diagnosis. Patients whose treatment plans included maxillary SS therapy were designated the SS group, and patients who had been treated with the same conventional therapeutic protocol of TMJ OA as the SS group with the exception of SS therapy were designated the non-SS group. This study was reviewed and approved by the Institutional Review Board of Pusan National University Hospital (E-2012056).

Study variables

The predictor variable was SS treatment or non-SS treatment. In this study, based on the clinical examination results and radiographic findings, SS therapy was recommended to all of the participating patients for their TMJ OA. Patients decided whether or not to undergo the recommended SS therapy. All of the patients in the SS and non-SS groups also received physical and cognitive behavior therapy. At the first clinical exam, pain, noise, limitation of mouth opening (LOM), and maximum comfortable opening (MCO) were recorded for all patients. They were asked to rate their TMJ pain, noise, and LOM on a numerical rating scale of 0 to 10, where 0 represented "no unpleasantness at all" and 10 represented "the most unpleasantness imaginable." The MCO was measured between the upper and lower incisors in millimeters (Table I). The SSs were fabricated in acrylic resin of 2 mm thickness at the molar area and covered all of the maxillary teeth. Based on a maximum intercuspation record, the occlusion was provided to create uniform points of contact for the centric cusps against the splint on all occluding teeth (Figure 1).

Table I. Study variables' baseline characteristics

Variable	Group size (%)	SS therapy: Presence (SS group)	SS therapy: Absence (Non-SS group)	P value
All patients	57 (100.0)	18 (31.6)	39 (68.4)	
Gender				
Female	48 (84.2)	14 (77.8)	34 (87.2)	.366
Male	9 (15.8)	4 (22.2)	5 (12.8)	
Signs & symptoms*				
Pain		4.0 ± 2.2	3.2 ± 2.2	.491
Noise		4.2 ± 2.6	3.3 ± 2.0	.649
LOM		2.8 ± 3.0	2.3 ± 2.6	.305
MCO (mm)		42.8 ± 9.7	43.4 ± 8.4	.580

SS, stabilization splint; *LOM,* limitation of mouth opening; *MCO,* maximum comfortable opening.
P values higher than .05 indicate no statistically significant difference between the SS and non-SS groups at the 95% confidence level.
*LOM was assigned the numerical rating scale from 0 to 10. MCO is given in millimeters.

The outcome variables were sectional osseous changes to the condylar surfaces, specifically the following categorical variables: condylar bone formation and cortical thickening. CBCT images were obtained at the initial clinical examination and at the end of treatment. The comparison of images obtained at these 2 time points revealed improved signs and symptoms. Preparatory to an evaluation of osseous changes in condylar heads,[12] pretreatment (T0) and post-treatment (T1, 10.9 ± 4.4 months after initial treatment) CBCT images from each patient were superimposed using voxel registration (Figure 2). The voxel registration areas were the neck of the condyle, the mandibular notch, and the posterior ramal area.[13] For area-specific evaluation, the superimposed condylar heads were divided by a plane parallel to the axis of the neck of the condyle and passing through both the median and lateral poles to form anterior and posterior divisions; each division was isometrically partitioned into lateral, intermediate, and medial segments, thereby delineating the anterolateral (AL), anterior-intermediate (AI), anteromedial (AM), posterolateral (PL), posterior-intermediate (PI), and posteromedial (PM) sections in the head of the condyle (Figure 3). For each section, the osseous change was evaluated with respect to (1) articular surface bone changes at T1 relative to the T0 baseline (visibly apparent increase in the volume = "bone formation"; visibly apparent decrease in the volume = "bone loss"; no apparent change in the volume = "no change"); and (2) cortical thickness (visibly apparent cortical thickening = "cortical thickening"; visibly apparent cortical thinning = "cortical thinning"; no evident change = "no change") (Figures 4 and 5). All of the radiographic interpretations were based on visual evaluation and not metrically quantified. For the purposes of CBCT image superimposition and