Injection of sodium hyaluronate compared to a corticosteroid in the treatment of patients with temporomandibular joint osteoarthritis: a CT evaluation

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Objective. Osseous changes in the temporomandibular joint (TMJ) were evaluated using computed tomography (CT) examinations before and after TMJ injections of sodium hyaluronate or a corticosteroid in patients with osteoarthritis (OA).

Study design. Forty patients were randomly allocated into 2 groups for 2 intra-articular injections with either sodium hyaluronate or a corticosteroid. Bilateral TMJ examinations with high resolution CT were obtained in 36 patients before and 6 months after treatment. Treated and contralateral TMJs were evaluated for the presence of osteoarthritic osseous abnormalities by 2 reviewers independently.

Results. Progression, regression, and no changes of osseous abnormalities were demonstrated in 13, 9, and 14 TMJs, respectively, 6 months after treatment. There was no significant difference between the groups.

Conclusions. Progression/regression and no changes of osteoarthritic abnormalities were observed on CT examinations in both the treated and the contralateral TMJs after treatment with intra-articular injection with sodium hyaluronate or corticosteroid. (Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2008;105:e53-e60)

Osteoarthritis (OA) is the most common disease affecting the temporomandibular joint (TMJ). Different terms in addition to osteoarthritis such as arthritis deformans, degenerative arthritis,arthrosis, osteoarthrosis, and degenerative joint disease may be used in the literature and reflect both the inflammatory and non-inflammatory changes that can take place in the TMJ.1,2

Magnetic resonance imaging (MRI) and computed tomography (CT) are most commonly used for the examination of osseous TMJ changes. MRI has been the gold standard for examination of soft tissue changes,3-6 but CT has been found to be superior to MRI in the assessment of bony TMJ components.3-5

In the recent literature, the grading systems of osseous changes vary greatly, thus making comparison of the different findings difficult.3-5,7-12

In the treatment of TMJ disorders, pretreatment imaging and improvement of clinical symptoms have been stressed, with less focus on imaging after treatment. In studies of the effect of TMJ injections with steroids13-16 or sodium hyaluronate,14,15,17-20 function and symptoms have been evaluated, but few radiographic follow-up examinations were performed. Using panoramic and transmaxillary radiography, progression of an existing arthritic joint disease was seen 8 years after steroid injections.21 In a follow-up study, in which no treatment was performed, Voog et al.12 found progression and regression of existing TMJ disease on CT examination of patients with rheumatoid arthritis. Condylar resorption has also been reported in an animal study after only one TMJ injection with dexamethasone,22 and necrosis of the articular tubercle has been reported in a case report after sodium hyaluronate injection when the CT examination was evaluated.23 Both steroids21,22 and sodium hyaluronate23 have been found to give destructive bony changes after intra-articular injections. However, the reported positive clinical effects of steroids13-16 and sodium hyaluronate,14,15,17-20 in various TMJ diseases, may indicate reparative bony changes. It is therefore crucial to find out if intra-articular injections with steroids and/or sodium hyaluronate may lead to reparative or destructive bony TMJ changes in patients with osteoarthritis.

To the best of our knowledge, no studies have evaluated the bony TMJ components on CT examinations in patients with TMJ osteoarthritis before and after.
treatment with intra-articular TMJ injections of sodium hyaluronate or corticosteroids.

In a recent study, Bjørnland et al. evaluated pain relief, function, and complications of 2 intra-articular TMJ injections of sodium hyaluronate or a corticosteroid in 40 patients with osteoarthritis of the TMJ, and found reduced pain and improved function 6 months after treatment. CT examinations were obtained before and 6 months after the treatment. Thus, the aim of the present study was to compare the osseous changes in the TMJ, assessed on CT examinations, before and after 2 intra-articular TMJ injections of sodium hyaluronate or a corticosteroid, in patients with osteoarthritis of the TMJ.

We tested the hypothesis that there were no significant differences between intra-articular injections of the 2 drugs in terms of osseous changes after the treatment.

**MATERIAL AND METHODS**

**Patient selection**

The Regional Medical Ethical Committee, East, Norway (S-04224), approved this prospective and blinded randomized clinical trial (RCT) with CT examinations and injections of the TMJ as a treatment of osteoarthritis. The inclusion and exclusion criteria for the study are described in a recent publication where the clinical outcome after injection of sodium hyaluronate was compared to a corticosteroid in the treatment of patients with TMJ osteoarthritis. Fifty-two patients with a clinical diagnosis of osteoarthritis in the TMJ were referred to Department of Maxillofacial Radiology, University of Oslo, for a radiological examination of their TMJs to evaluate if they had radiographic signs of OA (Fig. 1). After an initial panoramic and CT examination, 12 patients were excluded because the CT examination did not reveal any signs of osteoarthritis in either of their TMJs. The subjects fulfilled the criteria for osteoarthritis of the TMJ according to the Research Diagnostic Criteria for temporomandibular disorders by Dworkin and LeResche. The inclusion criteria were subjective pain from the TMJ at function and rest for more than 1 year, restricted mandibular function, and radiographic evidence of osteoarthritis of the TMJ, such as erosions, flattening, sclerosis, and osteophytes of the condyle and/or the articulating fossa, thus both remodeling and degenerative changes were recorded. Only patients older than 20 years could participate in the study. Patients with a history of general arthritis or other connective tissue diseases; treatment with immunosuppressive drugs; any organ disease; general infection; were pregnant or lactating; or had any known allergy or hypersensitivity to eggs, feather, avian proteins, or chicken were excluded from the study. Additional exclusion criteria were injections of any corticosteroids or any sodium hyaluronate preparation within the previous 12 months.

Forty patients demonstrated radiographic signs of osteoarthritis in one or both joints on their first CT examination and were enrolled in the study. The patients were randomly allocated into 2 groups: (1) treatment with sodium hyaluronate, Synvisc (Genzyme Co., Ridgefield, NJ), (S-Group) or (2) corticosteroid, Celestone Chronodose (Schering-Plough, Brussels, Belgium), (C-group). Forty sealed envelopes contained the code for participation in the 2 treatment groups, and the envelopes were not opened before it was determined that the patient was eligible for study inclusion, and that he or she had signed an informed consent for study participation. The patients were given information about the 2 drugs used for this study, without knowledge of which they were given.

Thirty-six patients were radiographically reexamined with CT after 6 months (Fig. 1), 31 women and 5 men. The characteristics of the patients are presented in Table 1. CT examinations before the 2 injections (Fig. 2, A, C and Fig. 3, A, C) and at 6-month follow-up (Fig. 2, B, D and Fig. 3, B, D) were done without knowledge about the TMJ chosen for treatment and the drugs administered. The subjective most painful joint in each patient was treated with 2 injections of either sodium hyaluronate or corticosteroid with an interval of 2 weeks.
Bilateral CT examinations of the TMJs were obtained in 36 patients before and 6 months after treatment. High-resolution computed tomography (HRCT) was performed using a helical CT, GE Lightspeed Ultra 3x (General Electric Medical Systems, Milwaukee, WI). All patients were examined in supine position. Axial scans were performed and coronal and sagittal views were reformatted from the axial scans. The slice variables 120 kV and 80 mA, 0.65 mm slice width, DFOV 16 cm / 11003 / 16 cm, acquisition matrix 512 / 512, and bone detail algorithm were used. Scout views were performed at Az 90 and 180, 100 kV, 10 mA.

CT evaluation
The CT examinations of the treated and contralateral TMJs were evaluated in bone display mode (window width, 4000 HU; window level, 500 HU) by 2 dental radiologists (A.M., B.B.M.) independently without knowledge of the clinical data, the side of injection, or the type of injection administered. Axial reconstructions and multiplanar reformatted coronal and sagittal views with a standard magnification (2.0) were evaluated for the presence of radiographic signs of OA in matching slices before and 6 months after TMJ injections. The evaluation system described by Rohlin and Petersson26 and Voog et al. 12 were modified to be applicable for CT evaluation of osteoarthritis. The assessments were made in the treated joints and the contralateral joints independently. If the evaluations differed between the reviewers, the images were reevaluated by the 2 radiologists together, and only those findings on which both radiologists concurred were recorded. The radiographic signs of OA (erosions, sclerosis, osteophytes, and flattening of the condyle) were localized and registered in 3 parts of the mandibular condyle; the medial, the central, and the lateral part and signs of erosions and sclerosis in the glenoid fossa were registered. The observations for each of the lateral, central, and medial parts were scored using a scoring system, where minor erosion/sclerosis was defined as erosion/sclerosis confined to one third of the upper half of the condyle, moderate erosion/sclerosis confined to two thirds of the upper half of the condyle, and severe erosion/sclerosis confined to the whole condyle (Table 1).

Table 1. Bivariate analysis at the start of study for variables in the 2 groups, treated with either Synvisc (S-group) or Celestone-Chronodose (C-group)

<table>
<thead>
<tr>
<th>Study variable</th>
<th>S-group</th>
<th>C-group</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample size, n</td>
<td>17</td>
<td>19</td>
<td>NA</td>
</tr>
<tr>
<td>Gender – female</td>
<td>16 (94)*</td>
<td>15 (79)*</td>
<td>0.20§</td>
</tr>
<tr>
<td>Duration of TMJ symptoms, y</td>
<td>6.6 ± 8.2†</td>
<td>6.3 ± 11.5†</td>
<td>0.94§</td>
</tr>
<tr>
<td>Radiological variables</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condylar erosions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bilateral TMJ findings, n</td>
<td>9</td>
<td>9</td>
<td>NS§</td>
</tr>
<tr>
<td>Condylar sclerosis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bilateral TMJ findings, n</td>
<td>7</td>
<td>7</td>
<td>NS§</td>
</tr>
<tr>
<td>Condylar osteophytes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bilateral TMJ findings, n</td>
<td>6</td>
<td>7</td>
<td>NS§</td>
</tr>
<tr>
<td>Condylar flattening</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bilateral TMJ findings, n</td>
<td>7</td>
<td>7</td>
<td>NS§</td>
</tr>
<tr>
<td>Glenoid fossa erosions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bilateral TMJ findings, n</td>
<td>2</td>
<td>2</td>
<td>NS§</td>
</tr>
<tr>
<td>Glenoid fossa sclerosis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bilateral TMJ findings, n</td>
<td>2</td>
<td>2</td>
<td>NS§</td>
</tr>
</tbody>
</table>

NS, not significant.
* n (%)
† Mean ± SD
‡ Two-sample t-test
§ Pearson χ²

CT acquisition
Bilateral CT examinations of the TMJs were obtained in 36 patients before and 6 months after treatment. High-resolution computed tomography (HRCT) was performed using a helical CT, GE Lightspeed Ultra 3x (General Electric Medical Systems, Milwaukee, WI). All patients were examined in supine position. Axial scans were performed and coronal and sagittal views were reformatted from the axial scans. The slice variables 120 kV and 80 mA, 0.65 mm slice width, DFOV 16 cm / 11003 / 16 cm, acquisition matrix 512 × 512, and bone detail algorithm were used. Scout views were performed at Az 90 and 180, 100 kV, 10 mA.

Fig. 2. Progression of osteoarthritis. CT of right TMJ, 22-year-old female, injected with Celestone-Chronodose in sagittal (A, B) and coronal views (C, D). Minor abnormality, score 3, is shown in (A) and (C). Progression, score 8, is shown in (B) and (D).

Fig. 3. Regression of osteoarthritis. CT of right TMJ, 51-year-old female injected with Synvisc in sagittal (A, B) and coronal views (C, D). Severe abnormality, score 18, is shown in (A) and (C). Regression, score 14, is shown in (B) and (D).
Table II. Scoring system of radiographic signs of osteoarthritis observed on CT, in the lateral, central, and medial parts of the condyle and the glenoid fossa in patients with osteoarthritis

<table>
<thead>
<tr>
<th>Erosion/sclerosis</th>
<th>Osteophytes</th>
<th>Flattening</th>
<th>Sclerosis/erosion</th>
</tr>
</thead>
<tbody>
<tr>
<td>0. None</td>
<td>0. None</td>
<td>0. No</td>
<td>0. No</td>
</tr>
<tr>
<td>2. Moderate</td>
<td>2. Severe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Severe</td>
<td></td>
<td></td>
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</tbody>
</table>

The scores from the lateral, central, and medial parts of the condyle and the glenoid fossa were summarized, thus giving possible total scores regarding erosions: 0-9, sclerosis: 0-9, osteophytes: 0-6, flattening: 0-3, and regarding erosions or sclerosis in the glenoid fossa: 0-1. Furthermore, the total score for each TMJ was used to grade the joint with regard to severity: normal, score 0; minor abnormality, score 1-5; moderate abnormality, score 6-17; and severe abnormality, score 18-29.

The progression or regression of osseous changes between the CT examination before treatment and at 6-month follow-up was expressed as the numerical differences in scores. After 2 to 4 months the 2 reviewers together reviewed all the examinations a second time. By pairwise comparison, progression and regression of osseous changes and no change was assessed for each patient.

Statistical methods

SPSS for Windows software (version 14.0; SPSS, Chicago, IL) was used for data management and statistical analyses. Paired t-tests were used for continuous variables; and Wilcoxon matched pairs test was used for ordinal scale variables. Between groups’ comparison was made with two sample t-tests and Mann-Whitney tests and χ²-test (depending on the measuring scale of the variable being tested). All tests were carried out at a confidence level of 95%, and probabilities of .05 or less were accepted as significant.

RESULTS

The CONSORT flow diagram for this randomized clinical trial (RCT) is presented in Fig. 1.27 During the study interval, 52 subjects were screened for study eligibility of which 40 (77%) subjects were enrolled in the study. Screening subjects were not enrolled if there was no radiographic evidence of osteoarthritis in either of the TMJs, such as erosions, sclerosis, osteophytes and flattening of the condyle, and erosions and sclerosis of the articulating fossa. Four subjects failed to return for CT follow-up and were excluded from the study. The final study sample comprised 36 subjects who completed the study protocol and follow-up. Table I summarizes the bivariate analyses of the study variables versus treatment group (Synvisc or Celestone-Chronodose). There were no statistically significant differences (P > .05) between the 2 study groups with regard to any of the variables. There was a wide range in the duration of TMJ symptoms, from 1 to 30 years in the S-group and 1 to 49 years in the C-group. The mean values are presented in Table I. There was high agreement between the reported bilateral TMJ symptoms in 8 patients in the S-group and 8 patients in the C-group, and the radiological variables: bilateral erosions, sclerosis, osteophytes, and flattening on the condyles (Table I).

There was no significant difference between the S-group and the C-group with regard to the averaged score of any of the osteoarthritic signs, nor the averaged total score of all the osteoarthritic signs, before treatment and at 6-month follow-up. There were, however, some significant differences both in the S-group and the C-group between the treated and the contralateral joints, but this difference may be because the joint with the greatest symptoms was injected (Table III).

Within the S-group and the C-group the patients had a wide range of radiographic TMJ scores, demonstrating that the patients varied with regard to degree of TMJ abnormality. In the S-group the range of TMJ scores at the initial examination for treated joints was 0 to 22 before treatment and 0 to 21 at 6-month follow-up. The C-group revealed a range of TMJ scores of 0 to 27 both initially and at 6-month follow-up for the treated TMJs. In the S-group the contralateral TMJs had scores of 0 to 15 both before treatment and at 6-month follow-up, whereas the contralateral joints in the C-group had a range of 0 to 25 and 0 to 23 initially and at 6-month follow-up, respectively. The distribution of normal TMJs and TMJs with minor, moderate, and severe abnormality in the 2 groups is presented in Table IV.

The CT evaluation 6 months after treatment with Synvisc or Celestone-Chronodose demonstrated that there was no significant difference between the S-group and the C-group with regard to progression or regression of osseous changes in the TMJs. The percentages of treated TMJs and contralateral TMJs, which demonstrated progression, regression, and no change, are presented in Table V. In the S-group, 6 patients demonstrated progression of osseous changes in their treated joints. These joints had initially a range of 1 to 8 in total radiographic scores. A progression was also seen in 3 contralateral joints in the S-group with scores of 2 to 6 initially. In the C-group, progression of osseous...
changes was seen in 7 treated joints, with an initial range of radiographic scores of 0 to 8. In the contralateral joints, 4 TMJs demonstrated progression, with a range of 1 to 4 initially (Table V). Regression of radiographic osseous changes was seen only in joints with higher scores and more severe abnormality. The treated joints in the S-group and the C-group had initially a range of radiographic scores of 14 to 22 and 9 to 22 respectively (Table V). In the contralateral joints in both groups, similar findings were observed; with regression of the osseous changes only in joints with moderate to severe abnormality initially (range 7 to 25).

**DISCUSSION**

This study clearly demonstrated that both progression and regression of radiographic osseous changes might occur in the TMJ after injection of sodium hyaluronate or corticosteroid after a short-term observation of 6 months. To the best of our knowledge, no comparable studies are available in the literature where a selected group of patients with only osteoarthritis of the TMJ have been evaluated with regard to radiographic osseous changes observed on CT, after treatment with sodium hyaluronate or corticosteroids. Only 2 previous studies have compared the effect of TMJ injections of sodium hyaluronate to corticosteroids, but more heterogeneous patient groups were studied, including arthritis and rheumatoid arthritis,14,15 but radiographic evaluation was only performed in a study of Wenneberg et al.,21 where remodeling and deviation of condylar shape were found, but no erosions 8 years after TMJ injection of a corticosteroid. Interestingly,

**Table III.** CT assessments (mean scores [± SD]) in treated and contralateral joints before treatment, and at 6-month follow-up after treatment of TMJ osteoarthritis with Synvisc (n = 17), and Celestone-Chronodose (n = 19)

<table>
<thead>
<tr>
<th></th>
<th>Synvisc-group</th>
<th>Celestone-group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Treated TMJs</td>
<td>Contralateral TMJs</td>
</tr>
<tr>
<td></td>
<td>Before treatment</td>
<td>6-month follow-up</td>
</tr>
<tr>
<td>Condyle erosions</td>
<td>3.0 (±2.7)</td>
<td>2.8 (±1.8)</td>
</tr>
<tr>
<td>Sclerosis (1)</td>
<td>3.2 (±3.4)</td>
<td>3.1 (±3.2)</td>
</tr>
<tr>
<td>Osteophytes (2)</td>
<td>2.1 (±1.8)</td>
<td>2.2 (±1.6)</td>
</tr>
<tr>
<td>Flattening (3)</td>
<td>1.4 (±1.3)</td>
<td>1.5 (±1.3)</td>
</tr>
<tr>
<td>Fossa Erosions</td>
<td>0.3 (±0.5)</td>
<td>0.4 (±0.5)</td>
</tr>
<tr>
<td>Sclerosis</td>
<td>0.3 (±0.5)</td>
<td>0.3 (±0.5)</td>
</tr>
<tr>
<td>Total TMJ score (4)</td>
<td>10.2 (±8.1)</td>
<td>10.2 (±6.4)</td>
</tr>
</tbody>
</table>

(1) Significant difference in Synvisc-group between treated- and contralateral joints before treatment (P = .022), and between treated- and contralateral joints at 6-month follow-up (P = .013)
(2) Significant difference in Synvisc-group between treated- and contralateral joints before treatment (P = .012), and between treated- and contralateral joints at 6-month follow-up (P = .010)
(3) Significant difference in Celestone-group between treated- and contralateral joints before treatment (P = .047), and between treated- and contralateral joints at 6-month follow-up (P = .030)
(4) Significant difference in Synvisc-group between treated- and contralateral joints before treatment (P = .010), and between treated- and contralateral joints at 6-month follow-up (P = .003)

**Table IV.** Distribution of normal TMJs and TMJs with minor, moderate, and severe abnormality based on CT assessments (total TMJ scores), before treatment and 6 months after treatment of TMJ osteoarthritis with Synvisc (n = 17), and Celestone-Chronodose (n = 19)*

<table>
<thead>
<tr>
<th></th>
<th>Synvisc-group</th>
<th>Celestone-group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Treated TMJs</td>
<td>Contralateral TMJs</td>
</tr>
<tr>
<td></td>
<td>Before treatment</td>
<td>6-month follow-up</td>
</tr>
<tr>
<td></td>
<td>Before treatment</td>
<td>6-month follow-up</td>
</tr>
<tr>
<td>Normal TMJs</td>
<td>1†</td>
<td>1</td>
</tr>
<tr>
<td>Minor abnormality</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Moderate abnormality</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>Severe abnormality</td>
<td>5</td>
<td>3</td>
</tr>
</tbody>
</table>

*Normal TMJs score 0; minor abnormality, score 1 to 5; moderate abnormality, score 6 to 17; and severe abnormality, score 18 to 29.
†Treated joints found to be normal after reevaluation by 2 reviewers.
progression of the radiographic osseous changes in the treated TMJs was seen in joints with less severe initial abnormalities, compared to the joints that revealed regression of the osseous changes. This may be due to the osteoarthritic process, which may have a rapid destruction in the early phases of the disease in susceptible individuals, or due to hypoxia-reperfusion injuries.1 This may also explain why a total of 4 joints with clinical symptoms of OA revealed normal radiographic appearance before treatment, and that 2 of these joints developed visible radiographic osseous changes at 6-month follow-up.

More contralateral joints in the C-group showed regression of the osseous changes than in the S-group; this may be coincidental or due to the possibility that injection of corticosteroids in one joint may have a general anti-inflammatory effect. This has to our knowledge not been reported in previous studies.

Our observations of progression of radiographic signs of osteoarthritis after TMJ treatment are in agreement with de Leeuw et al.,28 who found progression of osteoarthritis 30 years after conservative TMJ treatment. These findings are not supported by Kurita et al.,29 who demonstrated that degenerative changes were arrested after conservative TMJ treatment or arthroscopic surgery, 46 to 138 months after the treatment. Our observations of regression and no change, however, are in agreement with the findings of Kurita et al.29

Bilateral TMJ involvement in a high proportion of patients in the present study is not surprising, and is in agreement with other studies,6,30,31 where a high incidence of bilateral involvement of TMJ degeneration was reported. In our study, not only the treated joint was evaluated on CT, but also the contralateral joint, which thus could serve as a control joint. Interestingly, progression of the osseous changes appeared in both treated and contralateral TMJs in 7 patients: 3 patients in the S-group and 4 in the C-group. To our knowledge, this has not been described before, and may indicate that progression of osseous changes was not caused by the injection in these joints, or that either relief or exacerbation of symptoms in one treated TMJ may alter the joint mechanics of the contralateral joint with unexpected changes as a result.

The female-to-male ratio in our study was 31 women and 5 men. This ratio is comparable to similar studies by Kopp and Wenneberg,13 Kopp et al.,14 Alstergren et al.,16 Hepguler et al.,17 Guarda-Nardini et al.,19 and Wenneberg, et al.21 The difference in the sex ratio between our groups were coincidental, but may have influenced the between-group comparisons. OA, as the other temporomandibular disorders, seems to affect women more often than men,32 and is more prevalent in older age groups.33

Since CT has been found to be superior to MRI in the assessment of bony TMJ components,3-5 we chose CT examination for evaluation of the osseous changes in our study. In a recent publication, cone beam CT (CBCT) has been shown to be valuable in the guidance of TMJ injections.34 In an autopsy study, Honda et al.35 reported that there were no differences between CBCT and CT in detecting osseous TMJ abnormalities. Since CBCT is cost-effective and dose-effective compared to conventional CT, CBCT may be an alternative to CT in radiographic evaluations of osseous TMJ changes.

Interpretation of the outcome after injections of the TMJ may be difficult since the patients in our study had a wide range in the duration of TMJ symptoms and a great variation of radiographic findings initially. However, the onset or duration of TMJ symptoms does not necessarily reflect the actual start of the osteoarthritic process. In other studies where radiographic grading of TMJ osseous findings has been used, great variability in the findings has also been observed.10,12,26,29 In our study, the selection of patients with clinical and radiographic signs of only osteoarthritis was important. To compare with the results of others after TMJ injection may be difficult, since different radiographic methods and different grading systems are used. Since osteoarthritis may appear in different parts of the TMJ,7,36 and we used CT as the radiographic method, we modified the grading systems used by others12,26 to give a more standardized and detailed description of the radiographic findings through the whole joint.

The CT examinations did not reveal any significant improvement after injection in any of the groups, as opposed to the clinical improvement reported by Bjørnland et al.,24 where reduced pain and increased mandibular motion were observed after TMJ injections with sodium hyaluronate or a corticosteroid. In contrast to the clinical symptoms, where only 3 patients}

| Table V. CT assessment of radiographic osseous changes in the TMJs, expressed as progression, regression, and no change, 6 months after treatment of TMJ osteoarthritis with Synvisc (n = 17) and Celestone-Chronodose (n = 19) in treated and contralateral joints |
|-------------------------------------------------|-----------------|-----------------|-----------------|-----------------|
|                              | Synvisc-group   | Celestone-group |
|                              | Treated TMJs    | Contralateral   | Treated TMJs    | Contralateral   |
| Progression, n (%)           | 6 (35.3)        | 3 (17.6)        | 7 (36.8)        | 4 (21.1)        |
| Regression, n (%)            | 5 (29.4)        | 3 (17.6)        | 4 (21.1)        | 6 (31.6)        |
| No change, n (%)             | 6 (35.3)        | 11 (64.7)       | 8 (42.1)        | 9 (47.3)        |
enced increased pain,24 progression of the osseous abnormalities were observed in as many as 13 TMJs. To the best of our knowledge, this discrepancy has not been reported before. Further studies are needed to evaluate the relationship between clinical symptoms and osseous changes observed on CT.

In the literature, very few previous studies have reported complications after TMJ injections such as progression of osseous abnormalities. Iida et al.23 reported erosions of the articular eminence in a case report after sodium hyaluronate injections, and Wenneberg et al.21 reported progression of bony destruction of the TMJ in 1 patient after corticosteroid injection. In the present study, however, progression of OA was seen in more than one third of the treated TMJs after injection with either sodium hyaluronate or a corticosteroid. To our knowledge, this has not been described in previous publications, nor has the findings of both progression and regression of disease in untreated contralateral joints.

In order to evaluate possible progression and regression of OA in future studies, we suggest that the treatment outcome after TMJ injections should be based not only on clinical evaluation,24 but also on evaluation of radiological examinations of treated and contralateral joints before treatment and at follow-up examinations.

In conclusion, this short-term CT study clearly demonstrated that progression, regression, or no changes of osteoarthritic abnormalities may appear in either treated and contralateral TMJs after treatment with intra-articular injections with sodium hyaluronate or a corticosteroid. There were no significant differences between the groups.

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