Radiographic joint space in rheumatoid glenohumeral joints. A 15-year prospective follow-up study in 74 patients

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Abstract

Objective. To evaluate radiographically the glenohumeral (GH) joint space in patients with long-term rheumatoid arthritis (RA).

Methods. A cohort of 74 patients with RA were followed prospectively for 15 yr. At the end point, 148 shoulders were radiographed using a standard method. The GH joint space was examined from the radiographs using a method developed previously for population studies; the joint space was measured at three different sites and the average of the three measurements, the integral space, was calculated. Destruction of the GH joints was assessed with the Larsen method on a scale of 0–5 and compared with the joint space measurements.

Results. The mean GH joint space in RA patients was 3.1 (s.d. 3.3), range −17.3 to 5.7 mm; 2.7 mm (s.d. 4.5) in men and 3.2 mm (s.d. 2.8) in women. The mean of the affected joints (Larsen grades 2–5), 1.7 mm (s.d. 4.5), was notably narrower than the mean 4.4 mm (s.d. 0.6) of the non-affected (Larsen grades 0–1) joints. Pathological GH joint space, less than 2 mm, was found in five (15%) of 36 joints in men and in 14 (13%) of 112 joints in women. All the joints graded as Larsen 4 and 5 (n = 17) fulfilled this pathological criterion. Joint space narrowing was associated \( r = -0.66 \) with increasing destruction (Larsen grading) of the joint. The narrowing was significant between non- (Larsen 0, 1), moderately (Larsen 2, 3) and severely (Larsen 4, 5) affected joints (\( P < 0.001 \)). However, a remarkable step in this process occurred between Larsen grades 3 and 4 when the mean joint space diminished from 3.1 to 0.3 mm.

Conclusions. Joint space narrowing is a frequent consequence of GH joint rheumatoid affection. However, joint space narrowing is a late phenomenon occurring not until after marked erosive destruction, which should be noted when using the Larsen method for GH joints.

KEY WORDS: Rheumatoid arthritis, Glenohumeral joint, Joint space, Radiography, Larsen method.

Most (67–91%) patients with rheumatoid arthritis (RA) suffer from shoulder pain [1, 2]. In the evaluation of the cause of pain and to follow the course of the disease in RA, plain radiographs continue to be the primary diagnostic means in evaluating the glenohumeral (GH) joint [3, 4].

In RA, diminution of the GH joint space is a common radiographic finding [3, 5–11]. The widely used Larsen grading for GH joints is partly based on joint space narrowing [12]. Joint space narrowing has been proposed to occur uniformly and in various stages of the disease process [3, 5, 6, 8–11]. However, rheumatoid GH joint space measurements from radiographs have not been previously published, to our knowledge, and reported narrowing in rheumatoid GH joints has been based on visual evaluation of radiographs [6–8]. Petersson and Redlund-Johnell have developed a standard method for population studies to measure GH joint space. By measuring normal GH joints they came to the conclusion that a joint space narrower than 2 mm is abnormal [13].

The aim of the present study was to analyse the GH joint space width in a cohort of 74 patients with RA followed up for 15 yr.

Patients and methods

During 1973–1975 a total of 121 patients with recent (<6 months) RA were studied at the Rheumatism Foundation Hospital in Heinola. The selection criteria, data collection strategy, and details of the patients have been described elsewhere [14, 15]. At the 3-yr follow-
up, 102 patients had rheumatoid factor (RF)-positive and erosive RA. After the 3-yr check-up, 24 had died, and four failed to attend the 15-yr follow-up. Thus, 74 patients (18 males and 56 females) were the subjects of the present study. The age at onset ranged from 17 to 66 yr, mean 42 (s.d. 12).

Radiographs of all the 148 shoulders were taken at the 15-yr check-up (mean 15 yr, s.d. 1). The standard positioning was used: patient supine, slightly turned (20°) to imaged side (a support under the other shoulder) and the arm in the external rotation, palm facing upwards. The same radiographer confirmed correct positioning and took the radiographs using a standard technique: the straight anteroposterior projection (distance 0.95 m) was used with exposure factors of 48 kV and −63 mAs. The size of the film (Kodak Lanex Regular) was 18 × 24 cm.

In this position the projection of the joint surface of the humeral head forms a half-circle, the diameter of which is the line joining the two terminal points of the joint surface projection. The mid-point of this line was determined with a ruler. With the ruler aimed at this point and perpendicular to the joint surface of the head of the humerus, the joint space was measured with the ruler from three measuring sites at the glenoid cavity, A, B and C. Points A and C being the superior and inferior edges of the glenoid surface and point B the mid-point (Fig. 1). The joint space at the three sites and the average value, the integral space, were determined as described by Petersson and Redlund-Johnell [13]. With cases of destruction (Larsen 4 and 5) the original articular surfaces were determined and measured from previous radiographs. In these cases, the visually observed joint space between bone outlines was always zero. Therefore, the loss of bone stock was taken into account by superimposing the original anatomical contours of the humeral head and the glenoid labrum. Thus, negative values were recorded when the original humeral articular surface exceeded the original glenoidal articular surface, to describe the continuing bone loss after the actual joint space had disappeared. The number of joints fulfilling the reported pathological criterion <2 mm was calculated [13].

The GH joints were classified according to the standard reference films of six Larsen grades from 0 to 5 [12]. One GH arthroplasty had been performed 13 yr after disease onset and the pre-operative shoulder radiograph (Larsen 5) was evaluated and measured.

Statistical comparison between shoulders with differ-

### Table 1. GH joint space at various measuring sites

<table>
<thead>
<tr>
<th>Measuring site</th>
<th>Women (n = 56)</th>
<th>Men (n = 18)</th>
<th>All (n = 74)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Right mean (s.d.)</td>
<td>Left mean (s.d.)</td>
<td>Right mean (s.d.)</td>
</tr>
<tr>
<td>Superior (A) (mm)</td>
<td>3.6 (2.9)</td>
<td>3.4 (2.7)</td>
<td>2.7 (4.8)</td>
</tr>
<tr>
<td>Middle (B) (mm)</td>
<td>3.3 (3.1)</td>
<td>3.1 (2.9)</td>
<td>2.9 (4.6)</td>
</tr>
<tr>
<td>Inferior (C) (mm)</td>
<td>3.0 (2.9)</td>
<td>3.0 (2.6)</td>
<td>3.2 (2.6)</td>
</tr>
<tr>
<td>Integral (mm)</td>
<td>3.3 (3.0)</td>
<td>3.1 (2.7)</td>
<td>2.9 (3.9)</td>
</tr>
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</table>

Results

There was no systematic right–left difference in either sex. Therefore, the measurements of the two sides were pooled. The mean integral GH joint space was 3.1 mm (s.d. 3.3, minimum −17.3, maximum 5.7). The results of the measurements from different measuring sites for both men and women, separate for right and left, are presented in Table 1. The Pearson correlation coefficient between right and left values was 0.91 [95% confidence interval (CI) 0.86–0.94]. The right and left integral values according to the Larsen grades of the GH joints are shown in Fig. 2.

An integral joint space of less than 2 mm was found in five (14%) of 36 joints in men and in 14 (13%) of 112 joints in women. All the joints graded as Larsen 4 or 5 had a joint space value less than 2 mm. The non-affected, Larsen grade 0 or 1 joints, had no values less than 2 mm. The mean integral joint space of the non-affected (Larsen 0 and 1) GH joints was 4.4 mm (s.d. 0.6), whereas the mean of the affected (Larsen grades 2–5)
T 2. Radiographic assessment of 74 RA patients according to Larsen grading of GH joints and integral joint spaces for each group

<table>
<thead>
<tr>
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<th>4–5</th>
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<tr>
<td>Right GH joint</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of joints (%)</td>
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<td>29 (39)</td>
<td>7 (10)</td>
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<tr>
<td>Integral, mean (s.d.)</td>
<td>4.5 (0.6)</td>
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Jonckheere test for ordered alternatives.

The diminution of the joint space between different stages of destruction was statistically highly significant ($P < 0.001$). The integral joint space had a negative correlation with joint destruction (Larsen grading) $r = −0.66$ (95% CI $−0.56$ to $−0.75$).

**Discussion**

The results of the present study confirm the visually observed joint space narrowing in rheumatoid GH joints [3, 5–11]. The mean GH joint space of patients with RA was noticeably narrower compared with reported normal variation of 4–5 mm [13]. Petersson and Redlund-Johnell used the same standard technique in their series of a normal population and reported that the average GH width was 4.7 mm, and was pathological when under 2 mm, irrespective of the age or sex of the patient. The mean joint spaces of the non-affected joints (Larsen 0 and 1) in RA patients were within 2 s.d. of the reported normal value 4.7 ± 0.7 mm [13].

The pathological limit, less than 2 mm, was fulfilled in every sixth GH joint in men and in every seventh joint in women with long-lasting RA, in this study. All the joints graded as Larsen 4 or 5 fulfilled the criterion (Fig. 3). Only a few joints (2/14) graded as Larsen 3 and none of the joints graded as Larsen 2 or less fulfilled the pathological criterion (Fig. 4). Based on our results, the previously introduced pathological criterion of <2 mm seems to be reasonable, as it was fulfilled with seriously damaged joints and not with slightly or non-affected joints [13].

A significant joint space reduction did not occur until Larsen grade 4 destruction. However, Larsen grading is partly based on joint space narrowing [12]. Even non-affected (Larsen grade 1) joints may have slight joint...

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space narrowing according to Larsen’s definition. On Larsen’s standard reference films of the GH joint, the joint space is narrowed on grade 2. Moreover, the joint space has almost disappeared on grade 3 [12]. According to our results, extensive erosions on the GH joint are followed, not preceded, by joint space narrowing. This finding is supported by the previous visual observations [5, 6, 8, 11]. The shoulder seems to follow a slower course of cartilage destruction than the weight-bearing hip and knee joints in RA [16, 17]. The absence of body weight on the GH joint may protect the articular cartilage from early thinning, but not from erosions on the articular margin. Therefore, we suggest that the grading of destruction on the non-weight-bearing GH joint should be based on erosive destruction, not on joint space narrowing. Joint space narrowing without erosion can be classified as Larsen grade 1. From grade 2 onwards the degree of erosion should be decisive. Joint space narrowing is present in the late stage of destruction, Larsen grades 4 and 5 (Fig. 3). However, classification could easily be based on the remarkable bony changes due to marked erosive destruction at that moment. Larsen also emphasizes that bony erosion and destruction are the main changes when assessing the grade of destruction for all joints [12].

An interesting finding in this study was the slight difference in width at various measuring sites. In normal GH joints, the middle (B) space is the narrowest [13], whereas in the rheumatoid GH joints it is the inferior (C) joint space that is the narrowest. In both normal and rheumatoid GH joints, the superior (A) joint space is the widest [13]. In the previous literature, which is based on visual observations, most authors report joint space narrowing in rheumatoid GH joints being symmetrical or diffuse, but inferior narrowing has been reported as well [3, 5, 9, 10]. This might be explained by the nature of the erosive process in rheumatoid GH joints. The erosions occur most often on the superior joint margin of the humerus [3, 5, 8, 9, 18]. The joint space may increase because of bone destruction on the superior head of the humerus, whereas inferior erosive destruction is less extensive. However, this should have been avoided in our study because we used original bony outlines from previous radiographs when measuring the joint spaces in the destroyed joints (Larsen 4 and 5). This also leads to negative values with joints suffering from severe bone loss; by visual observation the joint space seems to be zero in these cases when sclerotic, eburnated humeral and glenoidal bones are in contact. The negative values were calculated to demonstrate the
continuing destructive pattern of rheumatoid GH joints. It is evident that the joint space between the bones is actually zero in these cases with negative values. However, with these prospectively followed joints we were able to examine how the destruction continues after the loss of articular cartilage by superimposing the original anatomical contours of the GH joint. Joint space measurement values turning negative due to bone loss explains the commonly observed medial displacement or migration of the humeral head in rheumatoid shoulder radiographs (Fig. 3) [6, 7, 11, 19]. According to our results this happens as a late phenomenon from Larsen grade 4 to 5.

We conclude that the joint space narrowing in the rheumatoid GH joint is a late phenomenon and the existence of rheumatoid involvement in the GH joint should be based on erosions, not on joint space narrowing on the radiograph. This should also be taken into account when using Larsen grading for GH joints.

References