Bone destruction, upward migration, and medialisation of rheumatoid shoulder: a 15 year follow up study

J T Lehtinen, E A Belt, M J Kauppi, K Kaarela, P P Kussela, H J Kautiainen, M U K Lehto

Abstract

Objective—To evaluate bone destruction, upward migration, and medialisation of the glenohumeral (GH) joint in a cohort of 74 patients with sero-positive and erosive rheumatoid arthritis followed up prospectively.

Methods—At the 15 year follow up 148 shoulders were radiographed by a standard method. Bone destruction in the GH joint was examined from the radiographs by four methods, of which three measured the migration and one the remodelling of the humeral head. The distances from the greater tuberosity of the humeral head to the coracoid process (medialisation distance (MD)) and to the articular surface of the humeral head (GA) have been previously developed to evaluate the pre-operative offsets of the arthritic GH joint. Medial displacement index (MI) and upward migration index (UI) have been recently developed to evaluate the destructive pattern of the rheumatoid GH joint. Destruction of the GH joints was assessed by the Larsen method on a scale of 0 to 5. The relation between the measurements and the grade of destruction of the GH joints was examined. UI was compared with our previous measurements of the subacromial space.

Results—Both the MI and the UI had a negative correlation with the GH joint destruction (Larsen grade), r = −0.49 (95% CI −0.56 to −0.66) and r = −0.58 (95% CI −0.66 to −0.68). The UI correlated significantly with the subacromial space, r = 0.90 (95% CI 0.86 to 0.93). The mean MI and UI measurements of the non-affected joints were within the reported normal variation. The mean MD collapsed between Larsen grades 4 (83.0 mm) and 5 (65.5 mm). The morphology of the humeral head began to flatten and erode from the grade 3 onwards and medial head destruction was detected at grade 5.

Conclusions—Medialisation seems to be preceded by upward migration of the humeral head, indicating rotator cuff damage. Symptomatic Larsen grade 3 shoulders should be intensively followed up by clinical and radiological means. If a total shoulder arthroplasty is considered, a pre-operative consultation is worthwhile at a sufficiently early stage (Larsen 3 and 4), when soft tissue structures responsible for function are still in proper condition and timing of the operative procedure can be well planned.

Most (67–91%) patients with rheumatoid arthritis (RA) have shoulder pain, and more than one in five present moderate or severe glenohumeral (GH) joint destruction during the first 15 years from the disease onset. Continuous plain radiographs of the rheumatoid shoulder are the primary diagnostic means of evaluating the glenohumeral joint and planning shoulder arthroplasty. Medial migration and remodelling of the humeral head with medialisation of the GH joint due to bone destruction are common radiographic findings in rheumatoid arthritis (RA). As far as we know, no previous studies have thoroughly measured the relation between GH joint destruction and upward migration and medialisation of the humeral head in patients with RA.

This study aimed at analysing the upward migration and medialisation of the humeral head and their relation to rheumatoid destruction of the GH joint in an inception cohort study of 74 patients with RA followed up for 15 years.

Materials and methods

During the period 1973–75 a total of 121 patients with recent (<6 months) RA were studied at the Rheumatism Foundation Hospital, Heinola, Finland. The selection criteria, data collection strategy, and details of the patients have been described elsewhere. At the three year follow up 102 patients had rheumatoid factor positive, erosive RA. Subsequently, 24 patients died and four patients failed to attend the 15 year follow up. Thus 74 patients (18 men, 56 women) were the subjects of this study; their age at onset ranged from 17 to 66, mean 42 (SD 12) years.

Radiographs of all the 148 shoulders were taken at the 15 year follow up as part of a radiographic survey study. The following standard positioning was used: patients supine, turned 20° to the imaged side, and the arm in external rotation, palm facing upwards. The same trained radiographer confirmed correct positioning and took x-ray pictures by the standard technique: the straight (central beam 90° towards the GH joint) anteroposterior projection (distance 0.95 m) was used with exposure factors of 48 kV and ~63 mA. The

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The size of the film (Kodak Lanex Regular) was 18×24 cm.

Destruction of the glenohumeral joints was assessed by the Larsen method on a scale of 0 to 5. One shoulder arthroplasty was performed 13 years after onset of the disease, and in this case the preoperative radiograph (Larsen grade 5) was assessed and measured.

Medialisation (MD) of the GH joint was measured as the distance from the lateral aspect of the greater tuberosity to the medial margin of the coracoid process as described by Figgie et al (fig 1A). The upward migration index (UI) was obtained by dividing the distance between the centre of the humeral head and the central point of the subacromial surface (U) by the radius of the humeral head (R) (fig 1B). The medial displacement index (MI) was obtained by dividing the distance between the centre of the humeral head and the glenoid surface (M) by the radius of the humeral head (R) (fig 1C), as described by Hirooka et al. The position of the centre of the humeral head was determined with a circle fitting technique. In shoulders with destruction the bony morphology, the radius of the humeral head, and the original glenoidal and subacromial surfaces were confirmed and measured from the earlier radiographs. Subacromial space measurements from our previous study were compared with the UI. The perpendicular distance from the superior aspect of the greater tuberosity to the superior articular surface (GA) was measured (fig 1D), as illustrated by Figgie et al. 17

Statistical comparison between shoulders with different grades of destruction was performed using analysis of variance (ANOVA). Correlations were estimated by Pearson's and Spearman's coefficients. The normality of continuous variables was evaluated by the Kolmogorov-Smirnov statistics. No adjustment was made for multiple testing.

**Results**

There was no systematic right-left difference in any of the measuring methods in either sex, and therefore the measurements of the two sides were pooled. Table 1 shows the distribution of the GH joints (n=148) according to the Larsen grading and the mean measurements of destruction in each group, as well as ANOVA statistics models. The diminution of the MI between different grades of destruction showed a significant trend (p<0.001). The correlation coefficient between MI and Larsen grading was −0.49 (95% CI −0.36 to −0.60). The MI correlated also with the MD, r=0.53 (95% CI 0.40 to 0.64), though the medialisation occurred late...
and had no significant correlation with Larsen grading. The mean MI of the non-affected joints (Larsen grades 0 and 1) was 0.89 (SD 0.04). The mean MD of the non-affected joints was 83.0 (SD 6.7) mm.

The diminution of the UI between increasing grades of destruction had a significant trend (p<0.001). The correlation coefficient between UI and Larsen grading was −0.58 (95% CI −0.46 to −0.68). A remarkable correlation occurred between the subacromial space and UI, r = 0.90 (95% CI 0.86 to 0.93). The mean UI of the non-affected (Larsen grade 0 and 1) joints was 1.26 (SD 0.08).

The GA also decreased with increasing destruction (p<0.001). There was a slight correlation between GA and Larsen grading, r = −0.29 (95% CI −0.14 to −0.43). However, it had no significant correlation with either upward migration index or subacromial space measurements.

Discussion

The results of this study confirm the visually observed medialisation in radiographs of rheumatoid shoulder.4 7 10–12 The mean distance from the lateral aspect of the humeral head to the coracoid process collapsed between Larsen grades 4 and 5 (figs 2 and 3). The medial displacement index (MI) takes into account the size of the bones of the patient by dividing the medial distance by the radius of the humeral head (fig 1C).18 It shows more precisely that medialisation is evident already between Larsen grades 3 and 4, before the remarkable reduction between grades 4 and 5 occurs. The mean MI of the non-affected (Larsen grade 0 and 1) joints was within 2SD of the mean of normal controls, as measured by Hirooka et al.18 An MD <70 mm (mean of non-affected joints − 2SD) could be considered as a sign of definite medialisation of the GH joint when evaluating a shoulder radiograph taken at 0.95 mm distance.

The UI correlated well with the subacromial space measurements, emphasising our previous results for the rotator cuff involvement in the rheumatoid shoulder.14 The mean UI of the non-affected GH joints was within 2SD of the mean of normal controls, as measured by Hirooka et al.18 The previous subacromial space measurements of the non-affected joints were also normal.32 Although upward migration of the humeral head seems to be an inevitable consequence of rheumatoid affection, there seems to be an evident step in rotator cuff involvement during the course of GH destruction in RA.19 Medialisation of the GH joint seems to be slightly preceded by superior migration of the humeral head according to our results (fig 2) and as reported previously.17

However, if the concavity of the superior glenoidal articular surface is destroyed by erosions, the resultant force from the deltoid and theoretically intact rotator cuff can pull the humeral head into superior subluxation.21 Computed tomography measurements have shown that the medial displacement of the glenoid surface was greatest at the upper and middle levels; the surface was inclined superiority rather than inferiorly.22 Yet, at the time of

<table>
<thead>
<tr>
<th>Larsen grade</th>
<th>Number of GH joints (%</th>
<th>MD, mm (mean, SD)</th>
<th>MI (mean, SD)</th>
<th>UI (mean, SD)</th>
<th>GA, mm (mean, SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>33 (22)</td>
<td>85.4 (6.5)</td>
<td>0.90 (0.04)</td>
<td>1.27 (0.06)</td>
<td>6.6 (1.5)</td>
</tr>
<tr>
<td>1</td>
<td>44 (30)</td>
<td>82.2 (6.6)</td>
<td>0.88 (0.05)</td>
<td>1.24 (0.09)</td>
<td>6.3 (1.7)</td>
</tr>
<tr>
<td>2</td>
<td>40 (27)</td>
<td>87.6 (8.2)</td>
<td>0.87 (0.05)</td>
<td>1.20 (0.08)</td>
<td>6.8 (1.1)</td>
</tr>
<tr>
<td>3</td>
<td>14 (9)</td>
<td>85.6 (8.1)</td>
<td>0.84 (0.08)</td>
<td>1.16 (0.14)</td>
<td>6.1 (2.3)</td>
</tr>
<tr>
<td>4</td>
<td>9 (6)</td>
<td>83.0 (4.9)</td>
<td>0.71 (0.07)</td>
<td>0.97 (0.14)</td>
<td>4.7 (1.8)</td>
</tr>
<tr>
<td>5</td>
<td>11 (7)</td>
<td>66.5 (8.6)</td>
<td>0.49 (0.15)</td>
<td>0.82 (0.16)</td>
<td>2.9 (3.3)</td>
</tr>
<tr>
<td>Total</td>
<td>148 (100)</td>
<td>83.2 (9.3)</td>
<td>0.84 (0.12)</td>
<td>1.16 (0.15)</td>
<td>6.2 (2.1)</td>
</tr>
</tbody>
</table>

ANOVA* p Values between:

- Different Larsen groups <0.001 <0.001 <0.001 <0.001
- Linearity of destruction <0.001 <0.001 <0.001 <0.001
- Eta coefficient 0.64 0.87 0.78 0.49

*ANOVA = analysis of variance.

Figure 2 Radiograph of a rheumatoid shoulder. Extensive erosive destruction on the articular margins, leaving part of the original articular surface still intact (Larsen 4). Evident superior migration of the humeral head is present and the joint space has disappeared. However, there is no evident medialisation of the humeral head.
Bone destruction: the rheumatoid shoulder

and 4 (fig 2).19 Rapid upward migration has
with the subacromial space between grades 3
of 5 (fig 3). A similar phenomenon occurred
when GH destruction reaches the Larsen grade
ing is the collapse of the medialisation distance
diminished radiographic loosening as well as
Restoration of normal glenoid and humeral
and function lag far behind that routinely
However, the improvement in range of motion
relief for the painful rheumatoid shoulder. 24 26
This finding is probably caused by
erosis, which is more common on the superior
joint margin of the humerus.15 16
Shoulder arthroplasty yields excellent pain
relief for the painful rheumatoid shoulder.16 20
However, the improvement in range of motion
and function lag far behind that routinely
expected after hip and knee replacements.21
Restoration of normal glenoid and humeral
anatomy in the arthroplasty is correlated with
diminished radiographic loosening as well as
improved functional results.15 Larsen grades 4
and 5, and sometimes grade 3, have been
widely used as radiological indications for
shoulder arthroplasty.17 18 An interesting finding
is the collapse of the mediatisation distance
during GH destruction reaches the Larsen grade
of 5 (fig 3). A similar phenomenon occurred
with the subacromial space between grades 3
and 4 (fig 3).20 Rapid upward migration has
been considered as a sign of rapid destruction of
the rheumatoid shoulder, therefore early surgical intervention is recommended for these
patients.17 20 Our results support these findings;
upward migration is followed by mediasti-
sation and gross destruction of the GH joint,
which most often is the preoperative state of
unsuccessful arthroplasties.

In clinical practice symptomatic Larsen grade 3 shoulders with persisting synovitis
should be monitored carefully and the result of
conservative treatment should be evaluated
regularly. When symptoms continue and radi-
ographic findings are progressive, operative
treatment should not be delayed, because
destruction may develop beyond the possibility
of adequate repair. We emphasise that those
patients with RA, who have glenohumeral ero-
sions and a sign of upward migration of the
humerus on a plain radiograph (fig 4), should
be candidates for a rapid orthopaedic consulta-
tion and advanced soft tissue imaging like
ultrasound or magnetic resonance arthrogra-
phy.

Overall functional results of the arthroplasty
are related to the physical condition as well as
the motivation of the patient and the status of
the rotator cuff.19 Total shoulder arthroplasty
will not survive without sufficient glenoid bone
stock and neither will it function properly
without adequately preserved soft tissue struc-
tures.22 An orthopaedic consultation is worth-
while at a sufficiently early stage (Larsen 3 and
4), so that timing of the operative procedure
can be well planned.

1 Bello A. Epidemiology of shoulder problems. Bullrees Clin
2 Lehntien JT, Kaural K, Belt EA, Karentin HJ, Kaurip MJ, Lahto-
MUR. Incidence of glenohumeral joint involve-
ment in seropositive rheumatoid arthritis. A 15 year
3 Petersson CJ. Painful shoulders in patients with rheumatoid
4 Cueto P, Glisile MI, Esdchenma D. The rheumatoid
5 Groshi A, Niraci TR. Imaging techniques for glenohumeral
arthritis and glenohumeral arthroplasty. Clin Orthop
6 Scandlant PN, Oroniticci C. Rheumatoid arthritis: se-
7 Figgie HE, Inglis AE, Goldbro VM, Ranawat CS, Figgie
AWF, Petersson C, eds. Rheumatoid arthritis surgery of the
8 Dijkstra J, Dijkstra PF, van der Klundert W. Rheumatoid
arthritis of the shoulder. Baillieres Clin Rheumatol 1994;57:
129–197.
9 Jönsson E. Surgery of the rheumatoid shoulder [disserta-
10 Kelly BG. Unconstrained shoulder arthroplasty in rheuma-
11 Levine RB, Sulten KI. Rheumatoid arthritis: skeletal
12 Pado J. The shoulder in rheumatoid arthritis. In: Lutza
AWP, Pearse C, eds. Rheumatoid arthritis survey of the
13 Kyle BG. Shoulder arthroplasty in rheumatoid arthritis. Acra
14 Kaural K. Prognostic factors and diagnostic criteria in early
15 Kaural K, Karentin HJ. Continuous progression of radio-
logical destruction in seropositive rheumatoid arthritis. J
16 Larsen A, Dale R, Eide M. Radiographic evaluation of thou-
sand patients with rheumatoid arthritis and related conditions—by standard
17 Piggie HE, Jersle A, Goldin MK, Ramsey CA, Piggie
AEP, Wilk JM. An analysis of factors affecting the long-term
18 Hishiki A, Wadani K, Yoneda M, Ochi T. Shoulder
arthroplasty in rheumatoid arthritis. Acra Orthop Scand
19 Lehtien JT, Belt EA, Lyhach CO, Kaurit MJ, Kaural K,
Karentin HJ, et al. Subacromial space in rheumatoid
shoulder: A radiographic 15 year follow up study of 148

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Figure 3 Radiograph of a rheumatoid shoulder. Gross bone destruction of the humeral head has occurred (Larsen 5). Superior and medial migration of the humeral head has occurred and remarkable loss of the glenoid bone stock is present.


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