

# Shoulder destruction in rheumatoid arthritis

## Classification and prognostic signs in 83 patients followed 5–23 years

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We studied the natural course and the possibility of making prognoses about shoulder joint destructions in 83 patients with rheumatoid arthritis (RA) (166 shoulder joints). For this purpose, we used radiographic patterns and 2 indices (upward migration and medial displacement).

The patterns of joint destruction were classified into 5 groups: 1) non-progressive type (n 74) with normal radiographs, only osteopenia or small erosions even after 15–20 years of RA; 2) erosive type (n 22) showing marginal erosions but no collapse;

3) collapse type (n 34) showing subchondral cysts, followed by collapse; 4) arthrosis-like type (n 12) showing arthrotic features; 5) mutilating type (n 14) showing mutilating bone destructions.

From the radiographic findings and the 2 indices determined at 5–10 years, we could predict the prognosis of shoulder joint destruction after 15–20 years of RA. Our findings may be of value for selecting treatment, including surgery, for the rheumatoid shoulder.

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The shoulder joint is often involved in rheumatoid arthritis (RA) (Cruess 1980, Ochi et al. 1988), and the treatment varies from none to total joint replacement.

If we could predict the progression of the rheumatoid shoulder destruction, it would be easier to adjust the treatment to correspond to the needs. To this end, we studied the natural history of rheumatoid shoulder disease radiographically in order to find prognostic signs.

### Patients and methods

We studied 83 patients with RA (166 shoulder joints), diagnosed according to the revised criteria of the American Rheumatism Association (Arnett et al. 1988). All patients had experienced shoulder symptoms after the onset of RA. The mean age of the patients was 56 (25–83) years. The mean durations of the disease and the follow-up were 15 (5–39) and 14 (5–23) years, respectively.

In all patients, consecutive AP radiographs (564 films/166 shoulders; 3.4 films/shoulder) were examined in detail, with emphasis on the following changes: osteopenia, subchondral sclerosis, subchondral cysts, marginal erosion, osteophytes, joint space narrowing, collapse and mutilating changes.

It is known that, with advanced destruction, the humeral head migrates in the superomedial direction rel-

ative to the glenoid (Weiner and Macnab 1970, Crossan and Vallance 1982, Peterson and Johnell 1984). On this basis, we devised two radiographic parameters: an upward migration index (UI) and a medial displacement index (MI) of the humeral head.

UI was obtained by dividing the distance between the center of the humeral head and the central point of the subacromial surface by the radius of the humeral head (Figure 1). The position of the center of the humeral head was determined with a circle-fitting technique. The mean UI in 108 controls (216 shoulder joints) who had no known disorder of the shoulder joints was 1.40 (SD 0.11).

MI was obtained by dividing the distance between the center of the humeral head and the glenoid surface by the radius of the humeral head (Figure 2). The mean MI in controls was 0.94 (0.09).

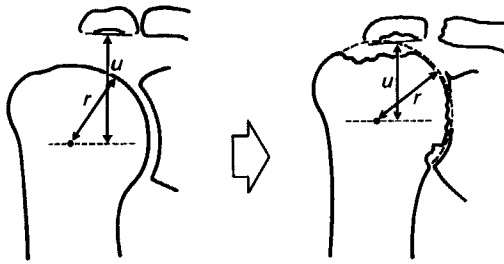
### Results

#### *Pattern of structural joint destruction* (Figure 3)

After screening all radiographs, we classified the pattern of glenohumeral joint destruction into 5 types: non-progressive (N), erosive (E), collapse (C), arthrosis-like (A) and mutilating (M).

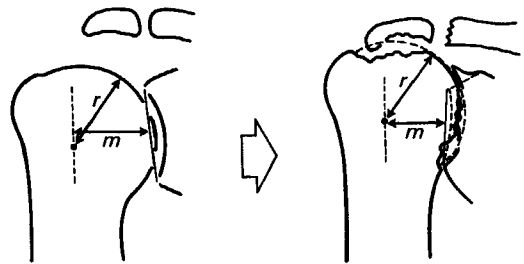
*Type N* (n 74). Normal shoulder or no apparent erosive change was seen, but osteopenia was present.

Figure 1. The method for measuring the upward migration index (UI).



Left normal, right destroyed joint. At first the center of the humerus was determined by using a circle-fitting technique, and the radius of the humeral head ( $r$ ) was measured. Then, the distance between the center of the humeral head and the undersurface of the acromion ( $u$ ) was measured. UI is  $u/r$ .

Figure 2. The method for measuring the medial displacement index (MI).



Left normal, right destroyed joint. The center of the humerus and the radius of the humeral head ( $r$ ) were measured in the same way as in the case of the UI. Then, the distance between the center of the humeral head and the glenoid surface ( $m$ ) was measured. MI is  $m/r$ .

There was no further progression and only a small change remained.

**Type E (n 22).** Marginal erosions in the humeral head occurred with disease progression. However, the articular surface was preserved relatively well with subchondral sclerosis until 10 years after onset of the disease, but, subsequently, joint destruction progressed slowly.

**Type C (n 34).** Osteopenia progressed rapidly. Then subchondral cysts developed, which resulted in collapse of the subchondral bone with advanced destruction of both the humeral head and the glenoid fossa.

**Type A (n 12).** Joint space narrowing, subchondral sclerosis and osteophyte formation developed. These changes were similar to those seen in arthrosis.

**Type M (n 14).** Both the humeral head and the glenoid fossa showed extensive osteopenia and bony resorption occurred, which resulted in mutilating changes.

10 shoulders (6%) could not be classified; 8 in patients with unilateral disease and 2 in a patient with bilateral disease. 9 patients had at least one unclassified shoulder. In the 74 patients whose shoulders could be classified, 78 had symmetric shoulder disease but 3 had not; 2 had N and E types (disease duration 5 and 11 years, respectively), and 1 had N and A types (disease duration 14 years).

#### Features of progress of joint destruction assessed on UI and MI

The degree of structural joint destruction as assessed by UI and MI, and the duration of RA were analyzed in each of the 5 types. In type N, both UI and MI remained approximately normal, even 20 years after the disease onset. In type E, the indices remained approximately normal until 5-10 years after the onset; there-

after, both UI and MI gradually decreased. In type C, a tendency to gradual decrease was noted in the early period of the disease, although there was a wide variation among individuals. In type A, both UI and MI began to decrease about 10 years after the onset, although the degree of reduction remained small throughout the observation period. In type M, both UI and MI began to decrease in the early period of the disease and tended to decrease sharply thereafter (Figure 4). The progress of joint destruction assessed by UI and MI was different in each type (Table 1).

The results can be summarized as follows. In type N, in which the joint structure was preserved and no abnormality other than osteopenia was found 5-10 years after disease onset, the disease did not progress thereafter. In type E, in which the joint structure was preserved but marginal erosion of the humeral head appeared with relatively good articular surfaces 5-10 years after disease onset, the structural joint destruction began to advance 10 years after the disease began. In type C, in which the joint structure was destroyed and severe osteopenia and subchondral cysts

Table 1. UI and MI for 2 disease periods. Mean, SD

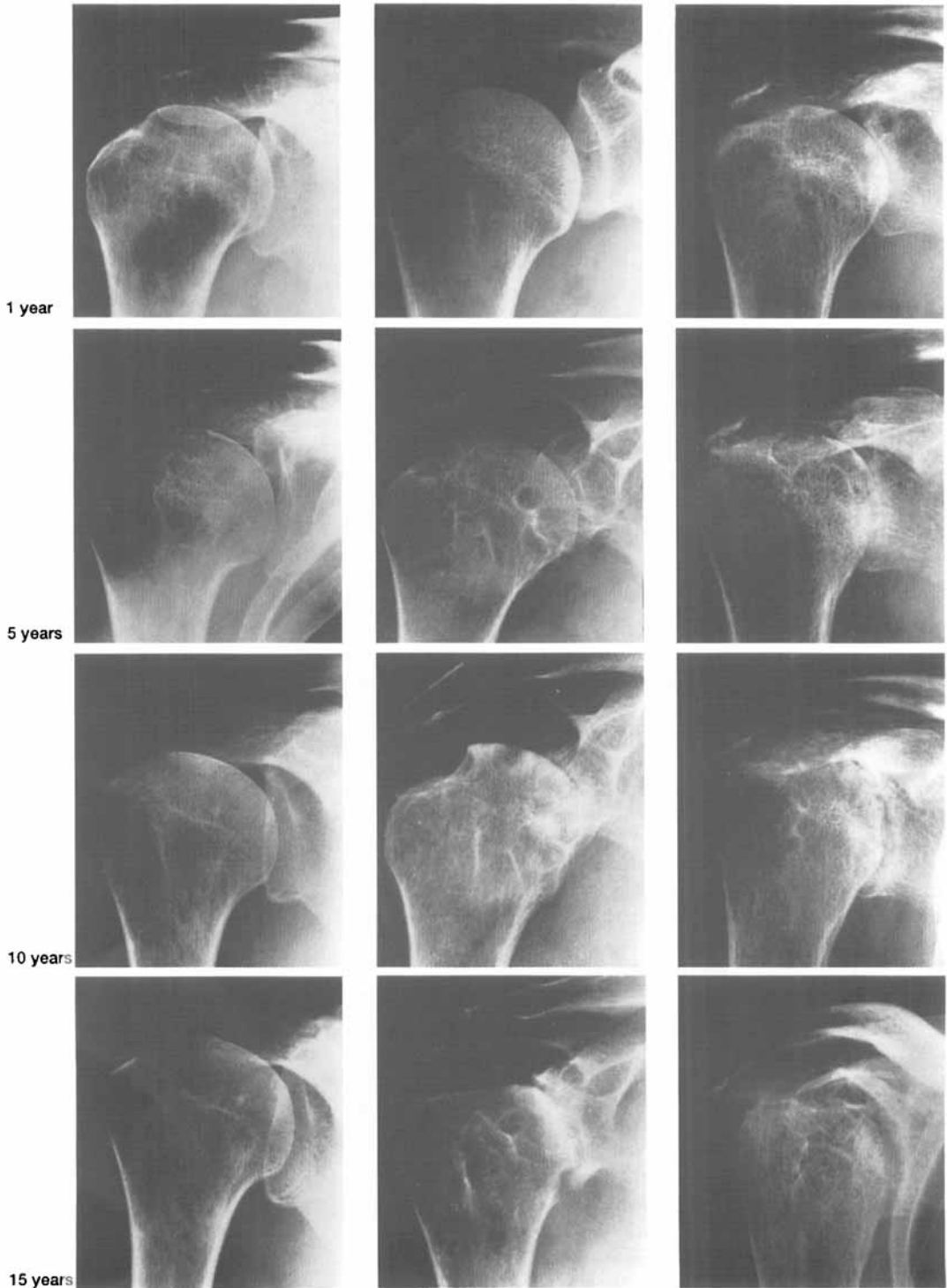
Type	5-10 years		15-20 years	
N, UI	1.39	0.10 (n 29)	1.37	0.10 (n 21)
MI	0.97	0.10	0.91	0.13
E, UI	1.39	0.07 (n 20)	0.91	0.11 (n 18)
MI	0.92	0.11	0.44	0.18
C, UI	1.21	0.18 (n 37)	1.08	0.23 (n 41)
MI	0.74	0.15	0.63	0.21
A, UI	1.31	0.08 (n 21)	1.19	0.10 (n 11)
MI	0.89	0.08	0.80	0.15
M, UI	1.06	0.16 (n 21)	0.42	0.19 (n 4)
MI	0.55	0.18	-0.11	0.08

Figure 3. Representative patterns of RA shoulder destruction at 1, 5, 10 and 15 years after onset of RA.

The **non-progressive type** showing no apparent destruction but osteopenia only.

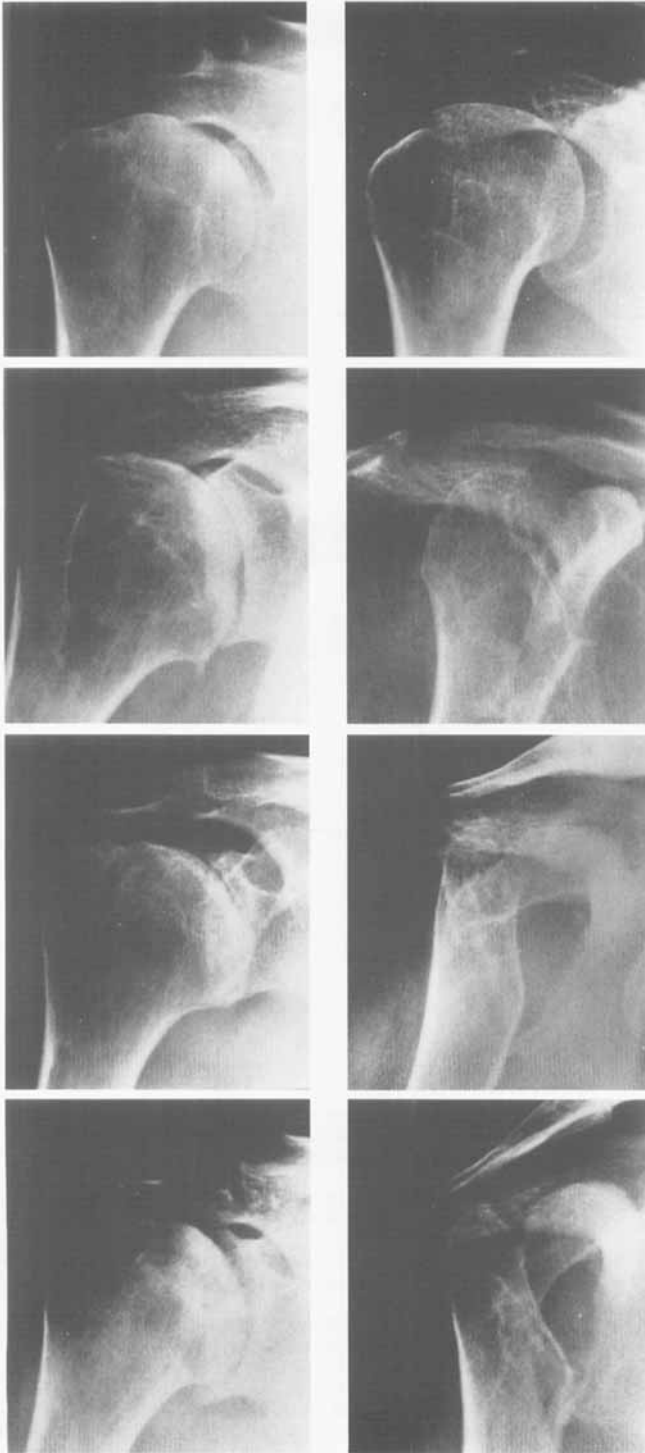
The **erosive type** showing marginal erosion, which finally destroys joints 15 years after onset of the disease.

The **collapse type** showing subchondral cyst, which destroys subchondral bone and leads to joint destruction rapidly.



The **arthrosis-like type** showing subchondral sclerosis and osteophytes similar to those seen in arthritis.

The **mutilating type** showing extensive and rapid bone resorption.



were seen 5–10 years after the onset of the disease, collapse occurred later, resulting in advanced joint destruction. In type A, in which the joint structure was preserved, but osteophyte formation and subchondral sclerosis were seen 5–10 years after the disease started, the severity of structural joint destruction was mild even later and the joint structure was preserved for a long time. In type M, extensive bone resorption resulted in severe joint destruction as early as 5–10 years after the onset of the disease.

These findings indicate that the subsequent degree of rheumatoid shoulder destruction can be predicted about 5–10 years after the onset of RA.

## Discussion

We classified the pattern of rheumatoid shoulder structural destruction into 5 types, using serial plain radiographs, i.e., non-progressive (N), erosive (E), collapse (C), arthrosis-like (A) and mutilating (M) types. 71 of our 74 patients had symmetrical shoulder disease. We were able to classify the type of shoulder destruction 5–10 years after the onset, which means that at this time we could also predict the extent of shoulder destruction. This could be helpful in planning the treatment. When destruction of the glenohumeral joint can be predicted to progress slowly (types N, E or A), total shoulder replacement should not be performed, and closed treatment or arthroscopic synovectomy may prove sufficient. On the other hand, when the shoulder joint can be predicted to be rapidly destroyed in the near future (type M or some type C cases), prosthetic replacement can be recommended.

Neer (1985) classified the pattern of structural destruction of the rheumatoid shoulder into wet, dry and resorptive types. We compared these 3 types with the features of our 5 types and found that some of our type E and

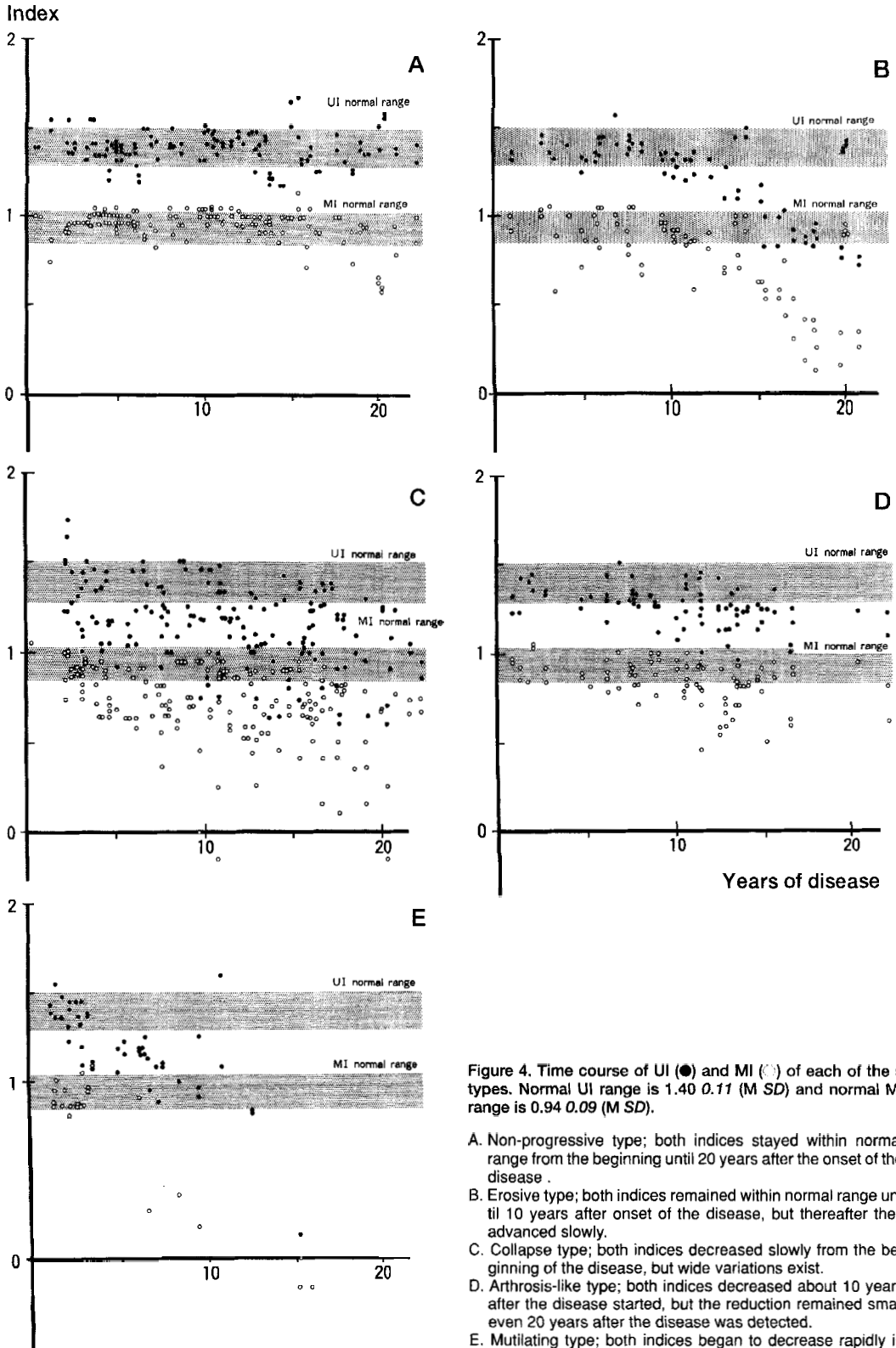


Figure 4. Time course of UI (●) and MI (○) of each of the 5 types. Normal UI range is 1.40 0.11 (M SD) and normal MI range is 0.94 0.09 (M SD).

- A. Non-progressive type; both indices stayed within normal range from the beginning until 20 years after the onset of the disease.
- B. Erosive type; both indices remained within normal range until 10 years after onset of the disease, but thereafter they advanced slowly.
- C. Collapse type; both indices decreased slowly from the beginning of the disease, but wide variations exist.
- D. Arthrosis-like type; both indices decreased about 10 years after the disease started, but the reduction remained small even 20 years after the disease was detected.
- E. Mutilating type; both indices began to decrease rapidly in the early phase of the disease.

type C shoulders were equivalent to Neer's wet type, while some of our type C and type M shoulders were equivalent to Neer's resorptive type. However, the main difference between Neer's and our method is that we can classify the joint at 5–10 years after the onset of RA, and can predict the progression of destruction with reasonable accuracy.

Larsen et al. (1977) described a system for grading the severity of joint destruction on plain radiographs. They classified destruction into 6 stages applicable to all joints. Our classification is completely different from Larsen's, because we try to identify the natural course of the shoulder joint destruction. The main purpose of our system is to assess the prognosis of the rheumatoid shoulder, Larsen's is to evaluate the present status of the joint destruction (Larsen et al. 1977). In our classification, a given type will not change into another when it has once been classified 5–10 years after the onset of RA, although in Larsen's classification, a low grade may progress into a higher grade. For example, in our E type, Larsen's classification changes from grade 0 at the beginning of RA to grade 2 a number of years later, and in our M type it changes from grade 0 at the beginning to grade 5 a number of years later.

The acromiohumeral interval (AHI) and joint space parameters have generally been used as an index of the upward migration and medial displacement of the humeral head (Weiner and Macnab 1970, Crossan and Vallance 1982, Peterson and Johnell 1984). However, these conventional indices are not applicable to rheumatoid shoulders that show serious destruction; further, these indices tend to be affected by radiographic settings (magnifications and other conditions), body size and other factors, resulting in large discrepancies. For these reasons, we introduced 2 new indices, the UI and MI.

The glenohumeral joint is supported by numerous soft tissue structures, impairment of which, such as the rotator cuff, profoundly affect the pattern and severity of the joint destruction. For example, even in

the absence of bone and cartilage destruction, acute upward migration of the humeral head can occur, if the rotator cuff is damaged by RA inflammation. When destruction of the bone and cartilage advances together with degradation of the rotator cuff, the humeral head rapidly migrates in the superomedial direction. Patients with such acute upward migration are likely to develop serious joint destruction (type M). This indicates that the presence/absence of acute upward migration can be utilized as an index for the early prediction of serious rheumatoid shoulder joint destruction.

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