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Erosive and non-erosive hand osteoarthritis. Use and limitations of two scoring systems

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Summary

Objective: To assess the evolution and progression of osteoarthritis (OA) in the finger joints using anatomical changes on standard radiographs.

Methods: Data obtained from 85 patients enrolled in a prospective study were used to evaluate systems to score the morbidity and the progression of the disease over 3 years. Posteroanterior (PA) radiographs of the metacarpophalangeal (MCP) and interphalangeal (IP) joints were obtained at entry and after 3 years. Assessment of the progression of OA over time is based on: (1) the increase in incidence of OA in previously normal joints during the study period, (2) the changes in the OA-associated features (osteophyte growth, loss of joint space, subchondral cysts or sclerosis) in the pathological finger joints (anatomical lesion progression score system), and (3) the recognition of consecutive anatomical phases in the course of 'erosive' OA (anatomical phase progression score system).

Results: Almost 80% of the distal IP and 50% of the proximal IP were affected at study entry. In approximately 40% of the patients, the classical picture of OA of the IP joints was complicated by manifest erosive changes, which were followed by a repair phenomenon in the 'eroded' finger joints. MCP were less affected and showed the non-erosive picture of OA. Numbers of affected DIP, PIP and MCP joints per patient at entry did not differ from those after 3 years of follow-up. Two systems to score the progression of OA (anatomical lesion and anatomical phase progression score system) showed definite progression within 3 years of follow-up, especially in the IP joints. Since changes in both non-erosive and erosive joints were recorded by the anatomical lesion progression system, it was found much more sensitive to change than the anatomical phase progression system which principally recorded the progression through the destructive phases of erosive OA. The results of both progression score systems correlated well.

Conclusion: Conventional radiographs can be used to assess the morbidity and progression of hand OA. The existence of non-erosive and erosive forms of OA of the finger joints necessitates the use of two scoring systems: the anatomical lesion progression score system and the anatomical phase progression score system. © 2000 OsteoArthritis Research Society International

Key words: Hand OA, Disease progression assessment, Radiology.

Introduction

Cataloguing morphological changes in osteoarthritic joints on radiographs is a widely accepted method of studying disease progression in controlled drug trials. Although sensitive methods have been described to assess the evolution of hand osteoarthritis (OA) within rather short evaluation periods,[1,2] conventional radiographs remain the best available method to follow OA patients in daily practice. Single bilateral posteroanterior (PA) hand radiographs are considered sensitive enough to assess the radiological progression of the anatomical lesions in pathological finger joints.[3,4] Radiographs allow for the changes in the numbers of affected distal interphalangeal (DIP), proximal interphalangeal (PIP) and metacarpophalangeal (MCP) joints per subject to be studied. Furthermore, the anatomical progression of the disease [changes in osteophyte growth, loss of joint space (JS), subchondral cysts or sclerosis] can be recorded during follow-up. The anatomical features mentioned above are associated with non-erosive OA of the finger joints. Most of the patients included in drug trials are those who consult their physician with symptomatic OA. During follow up, half of these patients with symptomatic menopausal[5] or inflammatory OA[6,7] show a destructive type of OA of their finger joints.[8] We have reported the anatomical evolution of hand OA in a population consisting almost exclusively of women who sought medical advice for symptomatic OA and who reported first symptoms early in the fifth decade of life.[8] The disease was characterized by rapidly developing symmetrical involvement of the finger joints. The lesions were identical to those described as 'erosive OA' (presence of destructive or remodeled joints) of these finger joints.[9–11] Destructive changes precede a period in which repair phenomena lead to the generation of a new subchondral plate covered by cartilaginous tissue. Huge osteophytes are responsible for the nodular aspect of the affected finger joints. This erosive form of OA affects PIP and DIP joints, whereas a non-erosive type of evolution is seen in MCP joints. It has been concluded that all clinically manifest Heberden and Bouchard nodes with clinical and radiological evidence of hard tissue enlargement[12,13] go through this destructive erosive phase. A 5-year follow-up, with radiographs taken every year, showed that 'erosive OA' represents merely an episode in the evolution of OA, rather than a separate form of OA.[8]

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Table I
Scores attributed to changes in osteoarthritic joints

Osteophytes*		Joint space		Subchondral cysts	
Appearance	+1.0	Narrowing	+1.0	Appearance	+1.0
Disappearance	−1.0	Widening	−1.0	Disappearance	−1.0
Increase in size	+0.5			Increase in size	+0.5
Decrease in size	−0.5			Decrease in size	−0.5

*Small ossification centres at the joint margins were regarded as OA-related changes and they were evaluated as osteophytes.

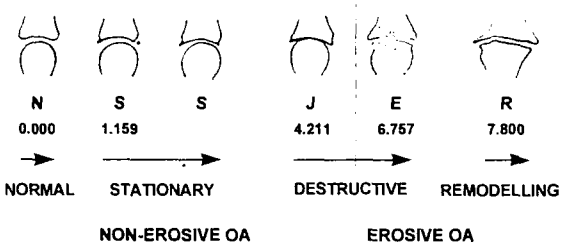


Fig. 1. Evolution of finger joint OA through anatomical phases. Non-erosive 'stationary (S)' OA is characterized by the classical OA-associated features: osteophytes or small ossification centres at the joint margins, joint space narrowing and subchondral bone changes. Erosive OA occurs almost exclusively in PIP or DIP joints and is characterized by destructive changes of the joint: the joint space completely disappears within a relatively short period of time ('J' phase). Concurrently with or shortly after the disappearance of the articular cartilage, the subchondral plate becomes eroded ('E' phase). These destructive phases ('J' and 'E' phases) can last for 1 or more years and are always followed by repair or remodelling ('R' phase). New irregular sclerotic subchondral plates are formed, and in between these a new joint space becomes visible. Huge osteophytes are formed during this phase. The numerical values attributed to each phase[8] are represented in the figure.

We made an attempt to explore the possibilities of different systems to assess the morbidity and progression of OA on conventional radiographs. We obtained films from 85 subjects who participated in a 3-year prospective study.

Patients and methods

PATIENTS

Eighty-five Caucasian patients between 40 and 70 years of age with symptomatic OA of the finger joints were selected from the placebo group of patients enrolled in a prospective trial designed to assess the structural modifying effect of a drug used in OA. OA was diagnosed according to the presence of osteophytes and/or joint space narrowing, with or without subchondral sclerosis, on conventional radiographs of the hands. All patients sought medical advice for symptoms (pain, stiffness and hindrance when performing routine daily activities) in and around the DIP and PIP joints. Other rheumatic conditions were excluded by history taking and clinical, roentgenologic and laboratory investigations. All patients were negative for rheumatoid or antinuclear factor. During the study, the patients were dissuaded from taking non-steroidal anti-inflammatory drugs (NSAIDs) for periods longer than 2 weeks.

RADIOGRAPHS

Posteroanterior radiographs of the DIP and PIP joints and of the MCP joints of the second, third, fourth and fifth fingers, and of the interphalangeal (IP) and MCP joint of the thumb were obtained at the start of this prospective study and again after 3 years. The radiographs were independently read by two equally experienced readers. Since the IP and MCP joints of the thumb were found to be in an oblique position on these films, the joints of the thumb were

Table II
Intra- and interreader reliability of systems for grading hand osteoarthritis

	A: Number OA joints	B: Anatomical lesion scores	C: Anatomical phase scores
Intrareader assessment			
I % agreement	81.9	R=0.934	93.1
w.kappa	0.623		0.831
95% CI	0.294–0.952		0.261–1.401
II % agreement	86.9	R=0.666	84.4
w.kappa	0.726		0.645
95% CI	0.327–1.125		0.284–1.005
Interreader assessment			
% agreement	92.3	R=0.815	85.0
w.kappa	0.815		0.702
95% CI	0.681–0.945		0.574–8.835

Readers: I: GV; II: EMV; number of OA joints and anatomical phases: results of kappa statistics. w.kappa: weighted kappa; CI: confidence interval.

Anatomical lesion scores: results of simple regression analysis: R: correlation coefficients between values obtained by both readers.

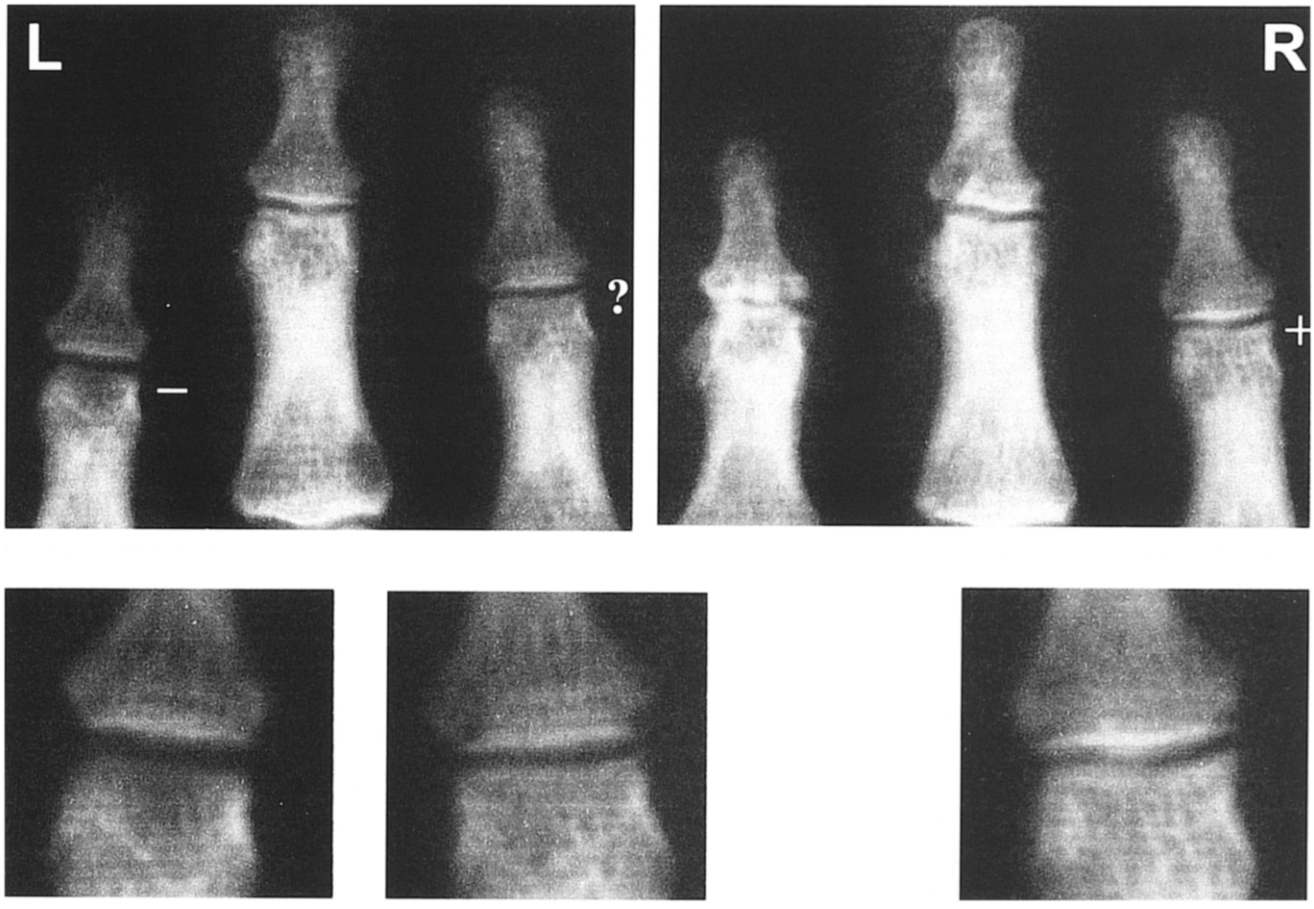


Fig. 2. Non-affected joints or incipient OA. Three DIP joints of the left (L) and right (R) hand of the same patient. The left DIP4 joint at the time of inclusion is not affected (–). DIP2 left at the time of inclusion seems normal (?). Zooming in on the inner joint margin possibly shows osteophyte formation at the top of the medial phalangeal bone. The right DIP4 joint presents an osteophyte at the top of the medial phalangeal bone [outer joint margin (+)].

not considered in the evaluation. Consequently, 24 joints (eight MCP, eight PIP and eight DIP joints) per radiograph were studied. This enabled the investigators to:

(1) define the numbers of the DIP, PIP and MCP joints involved per patient and to quantify the increase in incidence of OA in previously normal joints during a 3-year period;
(2) document the radiological progression of the disease in the pathological finger joints over 3 years.

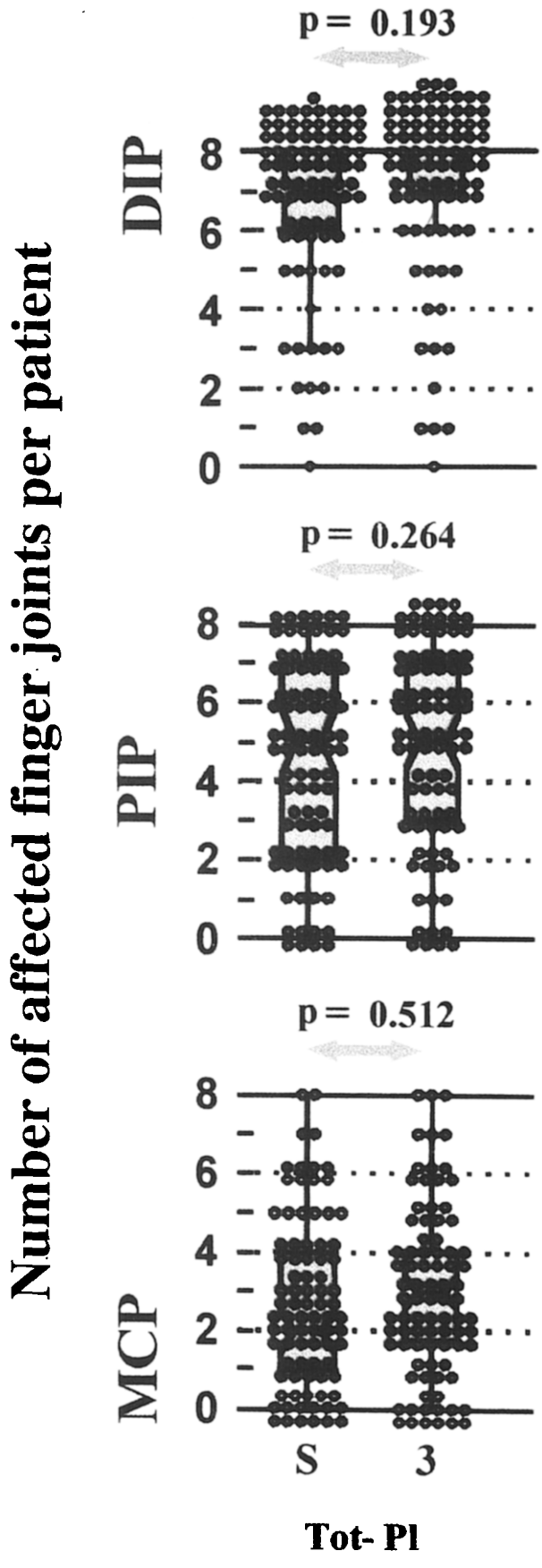
Two scoring systems were used to quantify the radiological progression of finger joint OA: the anatomical lesion progression system and the anatomical phase progression system.

Anatomical lesion progression system

This system was based on the changes in osteophytes or small ossification centres (ossicles) occurring at the joint margins, joint space (narrowing) and subchondral bone (cyst formation). Subchondral sclerosis was not considered because it was difficult to quantify. The condition at the time of patient inclusion was compared with the appearance three years later. Each finger joint was analysed under seven-fold magnification using magnifying glasses equipped with a microscale subdivided into fractions of 0.1 mm. Points were attributed to changes in the aforementioned items as illustrated in Table I. The scores for the eight DIP, eight PIP and eight MCP joints, and those for the 16 IP joints were combined for each patient.

Anatomical phase progression system

The anatomical phase progression system was developed after a substantial number of our patients had been found to show erosive changes in the DIP and PIP joints.[8] These changes were characterized by a complete loss of the joint space preceding or coinciding with the appearance of subchondral cysts eroding the entire subchondral plate. These erosive episodes subsided spontaneously and were followed by processes of repair, seen during follow-up. The recognition of well-defined anatomical phases in the progression of finger joint OA enabled the investigators to devise a scoring system for the radiological evolution of this disease. Arbitrary numerical values attributed to each of these phases[8] are presented in Fig. 1. For each patient, the phase values for the eight DIP, eight PIP and eight MCP joints were added to obtain an anatomical phase score. Values at study entry were compared to scores obtained after 3 years. As progression through the anatomical phases appeared to occur almost exclusively in the DIP and PIP joints, the anatomical phase scores of the 16 IP



joints of each patient were also calculated and used to assess differences among the groups at study entry and after 3 years of follow-up.

INDIVIDUAL PATIENT'S RISK OF DEVELOPING OR TO EXPERIENCE PROGRESSIVE EROSIVE OA

Individual patient's risk of developing erosive OA was determined by assessing the number of patients presenting exclusively non-erosive OA joints ('N' or 'S' phases) at study entry, of which at least one IP joint progressed to a destructive phase ('J', 'E') over a 3-year period. Progression of erosive OA was evaluated by looking at the number of subjects suffering from erosive OA at study entry, and whose joints showed further progression through these destructive phases during follow-up.

STATISTICAL ANALYSIS

Intrareader assessments were separately done by two experienced readers scoring the radiographs twice, with a 1-month interval between the two readings. Changes in the OA-associated anatomical lesions were quantified without the readers knowing the chronological sequence. The reliability of the assessments of the anatomical lesion progression scores was tested by calculating the correlation coefficients between values obtained by both readers. Anatomical phases were analysed with the readers knowing the chronological order of the documents since the definition of an anatomical phase is not made by comparison of radiographs. For dichotomous variables (presence/absence of OA, definition of specific anatomical phases), percentage of agreement and weighted kappa statistics were chosen to assess intra- and interreader reliability.

The Wilcoxon rank sum test was used to compare the numbers of OA joints, and the scores of the anatomical phases at entry and after 3 years. Regression analysis was used to compare progression in anatomical lesion and anatomical phase scores. Chi-square tests were used to study the proportions of patients presenting shifts in the anatomical phases of their finger joints during follow-up.

Results

Intra- and interreader reproducibility, the limitations of each assay system, and the results of an estimation of disease progression in the study population using each of the scoring systems will be discussed below. The assessment of individual patient risk of developing or experiencing progressive 'erosive OA' is another important issue.

PREVALENCE AND INCREASE IN INCIDENCE OF OA

The intra- and interreader reproducibility was excellent for a dichotomous variable such as the presence/absence of OA (Table IIA).

Fig. 3. Number of osteoarthritic DIP, PIP and MCP joints per patient. Box-and-Whisker plots represent median values, upper and lower quartiles. Differences (*P*-values) between the condition at the start of the study (S) and after 3 years (3) of follow-up are given.

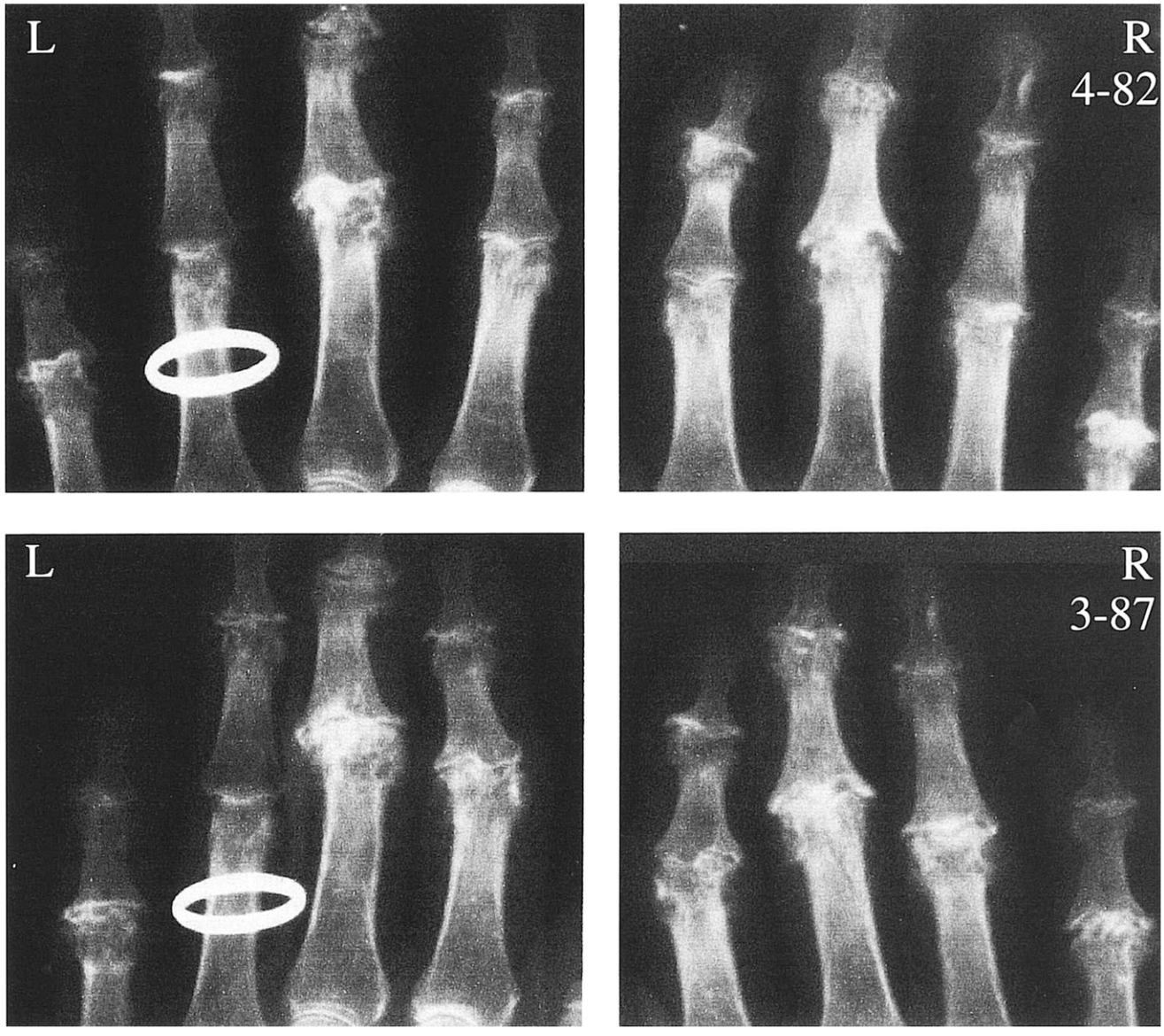


Fig. 4. Erosive OA of IP finger joints. It is difficult to define the morbidity of the disease in finger joints in a destructive phase using a score system simply based on the description of OA-associated features (anatomical lesion progression score system). Radiographs taken within a 5-year time period. Gross changes in the anatomy of the 'erosive' IP joints.

Limitations

Difficulties arose when a differentiation had to be made between unaffected joints and incipient OA. Changes in the anatomy of finger joints becoming osteoarthritic during follow-up are often subtle. Even the use of stringent criteria do not rule out some degree of subjectivity (Fig. 2).

Evaluation of the radiographs at study entry and after 3 years

At entry DIP and PIP joints were predominantly involved. About 80% of the DIP joints and about half of the PIP joints showed radiologic signs of OA. MCP joints were less frequently affected. There were no significant increases in the numbers of affected finger joints per patient during the 3 years of follow-up (Fig. 3).

ANATOMICAL LESION PROGRESSION SYSTEM

Intra- and interreader reproducibility

Recording the presence of osteophytes, changes in joint space and subchondral bone resulted in progression scales with multiple categories. Regression analysis shows good intra- and interreader correlation for the values obtained (Table IIB).

Limitations and difficulties

As long as hand OA remains non-erosive; recording the changes in the OA-associated features is feasible. However, to define the morbidity or progression of OA in finger joints in a destructive phase using a scoring system simply based on the description of OA-associated features can be

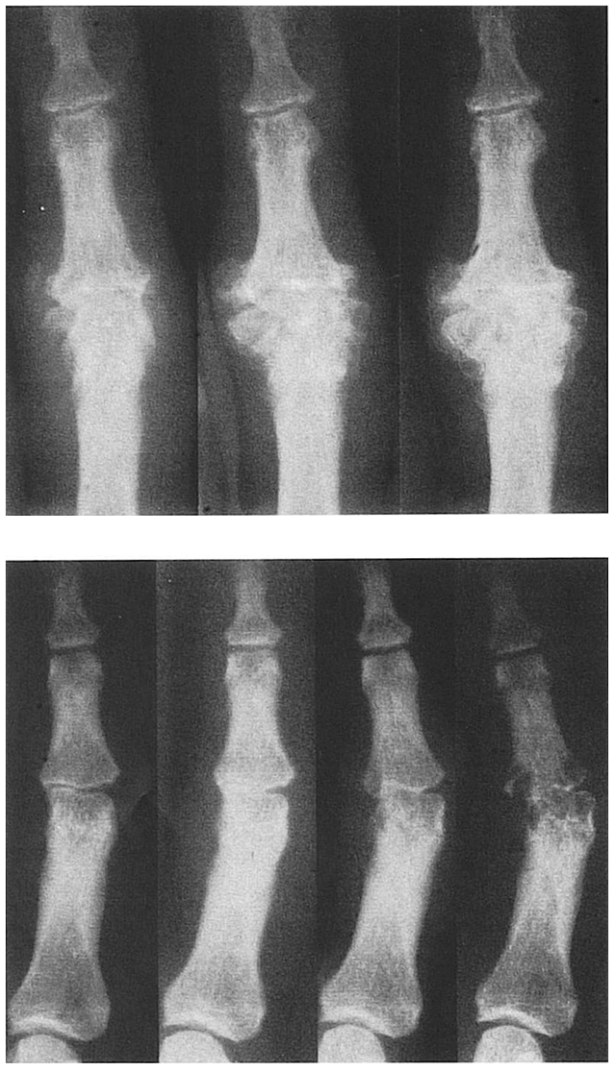


Fig. 5. Gross changes in the anatomy of two different PIP joints occurring simultaneously. Radiographs taken at 1-year intervals.

extremely difficult (Fig. 4). When erosive OA develops in previously non-erosive OA joints, gross changes in the anatomy of these finger joints occur simultaneously (Fig. 5) and the use of scoring systems based on changes in well-defined items becomes puzzling. In particular, changes in joint space occurring during and after an episode of erosive OA hamper the use of the anatomical lesion-based scoring system. Increases in joint space width were seen when the subchondral plate became eroded as well as during remodeling of a destroyed subchondral plate (Fig. 6). In remodeling IP joints, an increase in the anatomical lesion progression score resulting from osteophyte growth may be leveled down by a reappearing joint space (Fig. 7).

Evaluation of anatomical lesion progression

The increases in the anatomical lesion progression score for DIP, PIP and MCP joints in the study population were calculated according to the values presented in Table I and given in Table III. Progression was most obvious in the IP joints. Therefore, anatomical lesion progression scores for the combined 16 IP joints were also calculated [Fig. 8(A)]. The median anatomical lesion progression score was 5.000 with 25 and 75 percentile values of 2.000 and 8.500, respectively.

ANATOMICAL PHASE PROGRESSION SYSTEM

Intra- and interreader reproducibility

Percent agreement and weighted kappa statistics showed that intra- and interreader reliability was excellent when dichotomous variables such as specific anatomical phases were used (Table IIC).

Limitations

The use of the system did not allow the assessment of progression in non-erosive OA joints.

Evaluation of anatomical phase progression

Anatomical phase values of individual patients' DIP, PIP, IP and MCP joints at start and after 3 years were calculated according to the values presented in Fig. 1 and are shown in Table IV. Anatomical phase progression scores of the DIP, PIP, and MCP joints over 3 years are given in Table V. There was significant progression through the anatomical phases in the IP joints. The individual patients' anatomical phase progression scores for the combined 16 IP joints are shown in Fig. 8(B). The median anatomical phase progression score per patient for the IP joints was 1.159, which corresponds with the development of non-erosive OA in merely one previously normal joint. Twenty-five and 75 percentile values were 0.000 and 7.829, respectively. The low median patient anatomical phase progression score indicated that about 50% of the patients did not present IP joints progressing to erosive OA. Results of anatomical lesion and anatomical phase progression scores agreed well [Fig. 8(C)]. However, patients presenting anatomical phase progression scores of 0.000–1.159 points still showed considerable changes in their anatomical lesion progression score.

THE ASSESSMENT OF INDIVIDUAL PATIENT'S RISK OF DEVELOPING OR TO EXPERIENCE PROGRESSIVE 'EROSIVE OA'

Progression of patients through the different anatomical phases during the 3-year follow-up period is shown in Fig. 9. 45.9% of the patients developed new OA joints. The percentage of patients who developed erosive OA was determined by assessing the number of patients presenting exclusively non-erosive joints ('N' or 'S' phases) at study entry (46 of the 85 patients), and who progressed to a destructive phase ('J', 'E') in at least one IP joint over a 3-year period (Table VI). Seven out of these 46 patients progressed through destructive phases ('J', 'E' or 'R') in one or more previously nonerosive IP joints. Progression of erosive OA was evaluated by looking at the number of subjects already suffering from erosive OA at study entry, and whose joints showed further progression through these destructive phases during follow-up (Fig. 9). Twenty per cent of the 85 patients presented IP joints in the 'S' phase progressing to the 'E' phase while 22.4% of the patients showed 'J' phase IP joints progressing to the 'E' phase.

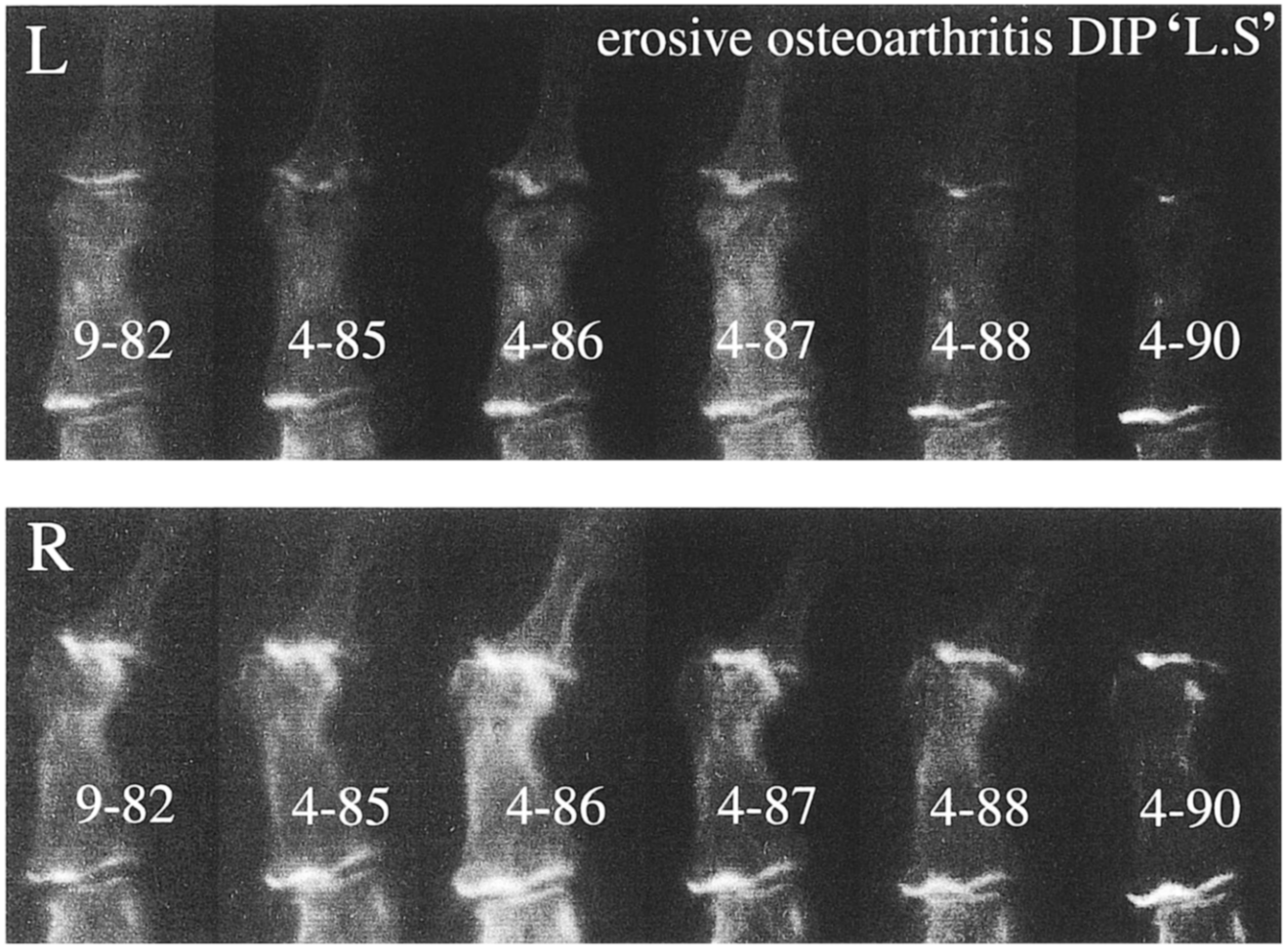


Fig. 6. Erosive OA in the fifth DIP joint of a patient's left (L) and right (R) hand. Evolution was followed from September 1982 over 7 years. Radiographs were obtained at 1-year intervals from April 1985. Right (R) DIP 5: 'J' phase joint remodelling and showing a new joint space (evolution April 1987–1988). Left (L) DIP 5: increase in joint space width (evolution April 1985–1986): score −1 (Table I), or +1 since this increase in interbone distance results from erosion and cyst formation? Decrease in joint space width (evolution April 1986–1987): score +1, or −1 since this decrease in interbone distance results from repair of the subchondral bone plate?

Discussion

The IP finger joints become most frequently affected in hand OA. These IP joints show the destructive changes characteristic of erosive or inflammatory OA. The MCP joints are less affected and the evolution of the disease is non-erosive. Progression of hand OA thus should be studied in the IP joints.

One of the simplest ways to define progression of OA in the finger joints of a patient cohort is to count the normal and affected finger joints at study entry and after a given interval of time. At the time of inclusion, the recognition of OA joints poses no real problem since most of the affected joints show definite OA-associated features. However, an inherent problem of this scoring system may be the recognition of incipient OA joints. Although the changes in the anatomy of finger joints that become osteoarthritic during follow-up are often subtle, the intra- and interreader reproducibility was excellent for a dichotomous variable such as the presence/absence of OA. About half of the patients in this study developed OA in previously normal IP joints. However, the numbers of affected DIP, PIP and MCP joints per patient at entry did not differ from those at the end of the follow-up period. The high numbers of affected finger joints

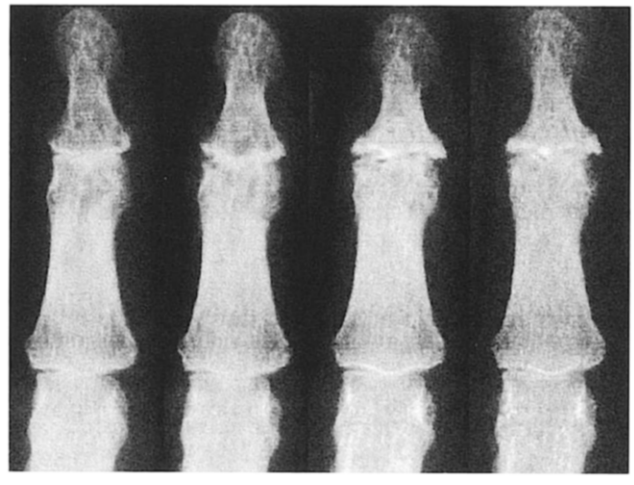


Fig. 7. Erosive OA in a DIP joint. Radiographs taken at 1-year intervals. Evolution during years 1, 2 and 3 showing growth of two osteophytes (2×0.5 points=+1). Joint space width increases simultaneously (score=−1). Overall anatomical lesion progression score=zero.

Table III
Increase in anatomical lesion progression scores during 3 years of follow-up

	Average	Median	LQ–UQ
DIP	3.541	2.500	1.000–4.500
PIP	2.759	2.000	0.500–3.500
MCP	0.459	0.000	0.000–1.000

DIP: distal interphalangeal; PIP: proximal interphalangeal; MCP: metacarpophalangeal; LQ: lower quartile; UQ: upper quartile.

per patient in a population of clinically active patients probably caused this OA joint count to be a less efficient way to score the progression of hand OA.

Attempts have been made to define the clinical criteria for the diagnosis of symptomatic primary OA of the hands,[3] to grade the severity of OA and to score progression of the disease within certain time limits through the changes in OA-associated features.[4,14] Radiographic variables assessed were joint space, osteophytes, sclerosis, cysts, erosions and alignment. However, multiple-point scale systems (normal, mild, moderate, severe) to assess morbidity, as well as the visual analogue scales used to measure progression, leave room for interpretation and could be biased among readers. Moreover, multiple point scoring systems may lose sensitivity when minute anatomical changes occur over short periods of follow-up. Although close agreement between readers was obtained when changes in such OA-associated items as osteophytes were

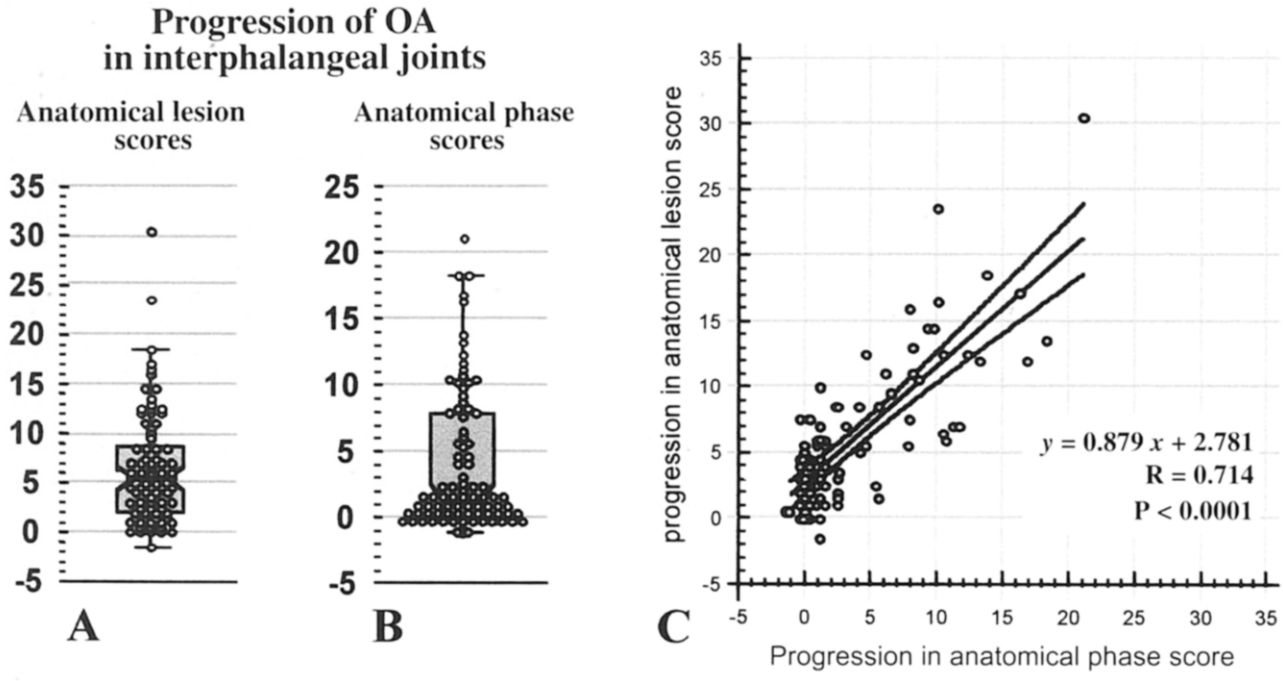


Fig. 8. Increase of anatomical lesion progression scores (A) and of anatomical phase progression scores (B) over 3 years of follow-up of the DIP and PIP joints of each patient. Box-and-Whisker plots represent median values, upper and lower quartiles. (C) Correlation between anatomical lesion and anatomical phase progression scores.

Table IV
DIP, PIP and MCP joint anatomical phase values at study entry and after three years

	Average	L	25%	Median	75%	H	*P*-value
DIP							
0	13.708	0.000	8.113	9.272	17.922	40.400	
3	16.275	0.000	8.113	12.324	21.551	49.501	<0.0001
PIP							
0	6.915	0.000	2.318	5.795	8.113	39.317	
3	8.351	0.000	3.477	5.795	9.272	46.955	<0.005
MCP							
0	3.199	0.000	1.159	2.318	4.636	9.272	
3	3.547	0.000	2.318	3.477	4.636	12.324	<0.05
IP							
0	20.624	0.000	11.590	16.226	25.185	81.180	
3	24.636	0.000	12.749	18.544	30.823	94.952	<0.0001

L: lowest value; H: highest value; 25%: lower quartile; 75%: upper quartile; 0=study entry; 3=3 years; statistics: two-tailed paired *t*-test.
DIP: distal interphalangeal; PIP: proximal interphalangeal; MCP: metacarpophalangeal; IP: interphalangeal.

Table V
Increase in anatomical phase progression scores during 3 years of follow-up

	Average	Median	LQ–UQ
DIP	2.567	0.000	0.000–4.211
PIP	1.436	0.000	0.000–1.159
MCP	0.348	0.000	0.000–0.000

DIP: distal interphalangeal; PIP: proximal interphalangeal; MCP: metacarpophalangeal; LQ: lower quartile; UQ: upper quartile.

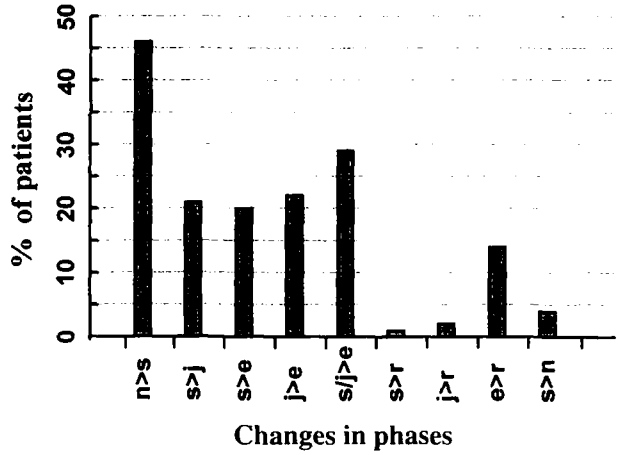


Fig. 9. Proportions of patients presenting a change in anatomical phases in an IP joint during the 3 years of follow-up. N: unaffected; S: stationary OA; J: OA joint with disappeared joint space; E: erosive OA joint; R: remodelled OA joint.

Table VI
Patients with 'erosive' and 'non-erosive' interphalangeal joint OA

	N (%)
Total	85 (100.0%)
Erosive	39 (45.9%)
Non-erosive	46 (54.1%)
Non-erosive>erosive	7/46 (15.2%) within 3 years

considered, no agreement was reported on the changes in other OA features, e.g. subchondral bone changes.

An attempt was thus made to score the progression of disease by assessing only the changes in the appearance of OA-associated features. For instance, an increase in size of an osteophyte during a period of follow-up undoubtedly indicates progressive disease. However, the magnitude of this increase does not necessarily imply more than the simple observation of an increase alone. In order to minimize the discrepancies due to subjective evaluations, the observation of a change alone, and not the magnitude of the change, was thus taken into account. A system where the change in the anatomy is recorded 'as such' is sensitive to change *per se*.

The proposed anatomical lesion progression system showed large increases in progression scores during three years of follow-up, especially in the IP joints. The median anatomical lesion progression score for the IP joints was 5.000 (25 and 75 percentile values: 2.000 and 8.500, respectively).

A major drawback of the OA-associated feature-based anatomical lesion scoring system is that it is essentially designed to score non-erosive OA joints or erosive OA joints up to the 'J' phase. However, approximately 40% of our patient population who had attended the clinics because their OA became symptomatic showed the erosive type of OA. Here, especially in the affected IP joints, the occurrence of erosive changes hamper the interpretation of changes in interbone distance or in subchondral bone architecture. These considerations have led to the development of a scoring system based on the consecutive anatomical phases recognized in the course of the disease. The median anatomical phase progression score per patient for the IP joints was 1.159, which corresponds with the development of non-erosive OA in one single previously non affected joint. The other patients who developed erosive OA in one or more of their IP joints during follow-up showed higher progression scores. As previously reported[8] both systems showed a good correlation when the progression of OA was estimated. Since changes in both non-erosive and erosive joints are recorded by the anatomical lesion progression system, it is more sensitive to change than the anatomical phases progression system which principally records progression through erosive phases in erosive OA. However, the latter evaluates anatomopathological sequences which are clinically relevant. Finger joint OA becomes symptomatic during inflammatory episodes associated with the onset of erosive OA. Sequential radiographs showed that remodeling occurred only in IP joints that had progressed through destructive phases.[8] Remodeled distal and proximal IP finger joints present the typical nodal appearance of Heberden's and Bouchard's noduli and limit the daily activities of the hands. The assessment of the anatomical phases enabled the individual patient's risk of developing or experiencing progressive erosive OA to be assessed.

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