

## SCIENTIFIC PAPERS

# Radiological progression of osteoarthritis: an 11 year follow up study of the knee

Tim D Spector, Jane E Dacre, Pat A Harris, Edward C Huskisson

## Abstract

A follow up study was carried out in 1990 on 169 well documented patients initially presenting with osteoarthritis of the hands or knees between 1975 and 1977. Radiographic change in the knee was used as the outcome measure. Sixty three subjects had paired knee radiographs a mean of 11 years apart and were 69 (range 52-87) years old at follow up. Thirty subjects were known to have died, 28 were untraceable, and 48 were traced but did not have paired films available. The films were read independently and blind to time sequence by two observers using five different radiological scoring methods. Most of the knees did not increase in Kellgren and Lawrence grade, with only 33% deteriorating over the time period. The results were similar when a subject was categorised by their worst knee. When a more sensitive global score on paired films was used 50% of knees showed a slight deterioration and 10% improved. Visual analogue pain scores remained unchanged. Those with knee pain at baseline had a greater chance of progressing, as did those with existing osteoarthritis in the contralateral knee. These results suggest that most patients with osteoarthritis attending rheumatology clinics do not deteriorate radiographically or symptomatically over an 11 year period. More work is needed in the selection and early detection of subjects with a poor prognosis and in focusing early intervention on this high risk group.

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The natural history and prognosis of osteoarthritis is poorly understood despite it being one of the most common musculoskeletal diseases and causes of disability in developed countries.<sup>1</sup> As we know little about the long term outcome of patients presenting to a rheumatology outpatient department, doctors are unable to give much advice on prognosis in individual subjects. To date only two clinical studies have been performed looking at the outcome of osteoarthritis of the knee joint.<sup>2,3</sup> These studies suggested that progression occurs in most patients, but the relation between the clinical features such as pain and radiographic change is unclear. We examined the natural history and long term outcome of a large group of patients with osteoarthritis seen initially between 1976 and 1978 using a follow up study with radiological progression on paired films as the principal outcome measure.

## Subjects and methods

### SUBJECTS

The cohort studied came from two groups of patients. The first consisted of 100 consecutive patients attending a rheumatology clinic with osteoarthritis of the hand and knee seen originally in 1976 at a mean age of 60 years. The second was a group of 69 symptomatic patients with osteoarthritis of the hand or knee who were enrolled in a short term drug study between 1977 and 1978 (mean age of 61 years). Overall there were 47 men and 122 women. Details of the two groups of subjects were well documented at baseline and the first group of 100 consecutive patients was analysed as part of a descriptive study of clinical osteoarthritis.<sup>4</sup> In addition to radiographs baseline details included height, weight, visual analogue pain scores, latex serology, erythrocyte sedimentation rate, details of early morning stiffness, and pattern of joint disease.

### METHODS

To obtain current addresses and health status we used a variety of different sources of information. Data were obtained progressively starting with original hospital records, drug study entry forms, and past or present general practitioners. The Family Health Services Authority was then contacted to obtain information about new general practitioners. All untraced patients were flagged centrally with the Office of Population Census and Surveys to find out if they had died. Notification of cause of death or cancer registration was also obtained simultaneously. Finally, local electoral registers were consulted and directory enquiry services used to search for telephone numbers.

Patients were contacted and asked to attend the hospital outpatients department. At the follow up visit a questionnaire was administered containing questions on distribution of joint and knee pain, operations, treatments, and visual analogue pain scores. The hand, hip, and knee joints of all patients were examined systematically by the main observer from the original study (ECH), and joints affected with osteoarthritis were recorded. The five patients who were traced but were unwilling or unable to attend provided the questionnaire data by telephone and were asked to visit their local general practitioner. The general practitioner completed the clinical findings and requested the relevant radiographs, which were forwarded by post.

Department of  
Rheumatology,  
St Bartholomew's  
Hospital Medical  
College,  
Charterhouse Square,  
London EC1M 6BQ,  
United Kingdom  
T D Spector  
J E Dacre  
P A Harris  
E C Huskisson

Department of  
Preventive Medicine,  
St Bartholomew's  
Hospital Medical  
College,  
Charterhouse Square,  
London EC1M 6BQ,  
United Kingdom  
T D Spector  
P A Harris

Correspondence to:  
Dr T D Spector,  
Department of  
Rheumatology,  
St Bartholomew's  
Hospital Medical  
College,  
Charterhouse Square,  
London EC1M 6BQ,  
United Kingdom.

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## RADIOLOGICAL METHODS

Anteroposterior radiographs were performed in the department of diagnostic radiology at St Bartholomew's Hospital using a standardised protocol for knee radiography which had not altered over the 11 year period. Two trained observers read all the paired knee films, blinded to time sequence, date, and patient details, using five different scoring methods. Films were read independently for the following: Kellgren and Lawrence grade (0-4);<sup>5</sup> overall joint space score (0-5);<sup>6</sup> and individual features medially and laterally (0-3) (osteophytes, narrowing, and sclerosis) using a radiographic atlas.<sup>7</sup> In addition, digitised image analysis of joint space was performed using previously published methods which have good reproducibility.<sup>8</sup> This gives a measure of mean joint space height in the medial and lateral compartments. A change of >10% was assumed to be significant. The patellofemoral compartment was not assessed as lateral views were not available.

For all the grading systems individual knees were categorised into those in which there was no change and those that had improved or deteriorated. Progression was defined as a change of one grade or more or, for digitised image analysis, greater than 10% reduction in joint space. When knee joints had been replaced this was taken to indicate progression of osteoarthritis. These joints were included as such in the analysis. Progression was also categorised for subjects rather than knees and the worst grade for either knee was recorded as the score for that subject.

Interobserver and intraobserver reproducibility of all five scoring systems were compared by each observer reading 40 randomly selected films twice, two weeks apart (table 1). The within observer agreements were good with  $\kappa$  values above 0.6 for most of the methods. The between observer agreement for the detection of sclerosis was less. It was highest for the detection of osteophytes and lowest for grading joint space. For the analysis the results for each scoring system obtained by the observer with the best intraobserver reproducibility was used. In addition a global assessment of change on a nine point score from -4 to +4 was used, examining the overall change in osteophytes, sclerosis, and joint space loss. For this global measurement the films were read paired, unblinded, and in time sequence. Two observers read these films jointly and a consensus reading was established. Mild progression was defined as an increase in one point and moderate or severe progression defined by an increase of two or more points.

Table 1 Reproducibility of radiographic scoring methods using weighted  $\kappa$  statistics

Method (scale)	Interobserver agreement ( $\kappa$ ): 126 films read by two observers	Intraobserver agreement ( $\kappa$ ): 40 films read twice	
		Observer A	Observer B
Kellgren and Lawrence (0-4)	0.57	0.79	0.74
Joint space score (0-5)	0.34	0.69	0.61
Osteophytes (0-3)	0.74	0.74	0.75
medial and lateral			
Medial narrowing (0-3)	0.29	0.83	0.59
Sclerosis (0-1)	0.58	0.47	0.64

## Results

## PATIENT DETAILS

In 63 subjects paired radiographs were obtained for further analysis. With the exception of eight films all radiographs were paired non-weight-bearing anteroposterior radiographs eight to 15 years apart with a mean of 11 years. Of the original cohort, 30 subjects were known to have died, and 28 were untraceable without any record of death. Thirty four subjects were traced but their original radiographs were missing and for a further 14 some earlier radiographs were available, but did not include the baseline films. The mean age at follow up was 69 (range 52-87) years and there were 48 women and 15 men.

## RADIOGRAPHIC CHANGE

The figure shows the distribution of radiographic change at baseline and at follow up as assessed by the standard Kellgren and Lawrence score. At baseline 36.5% of knees were radiologically normal, 17.5% had grade 1, 25.4% had grade 2, 19% had grade 3, and 1.6% had grade 4 osteoarthritis. At follow up 9.5% had grade 4 osteoarthritis and 20.6% grade 0. Five subjects had had a knee replacement (one bilateral). Of the 13 patients with unilateral grade 2 or more at baseline, 12 (92.3%) developed bilateral disease by follow up, four of these having increased two grades in the contralateral knee. Table 2 shows the percentage of knees and subjects showing radiographic progression by the different scoring methods used. Sclerosis was a poor indicator of change. Overall 19.42% of knees showed progression depending on the method used. Using the more sensitive global score 50% of knees had deteriorated to a mild degree (an increase of one in four grades), though only 24.6% had progressed by more than one grade. Although there was wide individual variation the mean percentage joint space loss determined by computer was 9%, roughly equivalent to 0.4 mm<sup>2</sup>/year. A small percentage of knees appeared to improve with all methods except sclerosis (range 4-12.7%), and this was also seen using the global score (9.5%). No differences were noted between the right and left knees. Results were similar when the worst knee of a subject was used for analysis. The range for subjects who deteriorated in one knee was between 23.8% and 41.2%.

## PREDICTION OF PROGRESSION

To assess possible predictive factors for radiological progression we examined whether the baseline Kellgren and Lawrence score related to the numbers that subsequently progressed (table 3). Although numbers were small, no obvious differences in rates of progression were seen between those knees initially graded 0, 1, or 2—that is, those with no disease, mild, or moderate osteoarthritis at entry. Table 4 shows that in all but one of the different scoring methods there were more progressors in the group of patients with knee pain on entry to the study than in the asymptomatic group. The findings were similar when analysis was restricted to those with grade 0 or 1 at baseline;

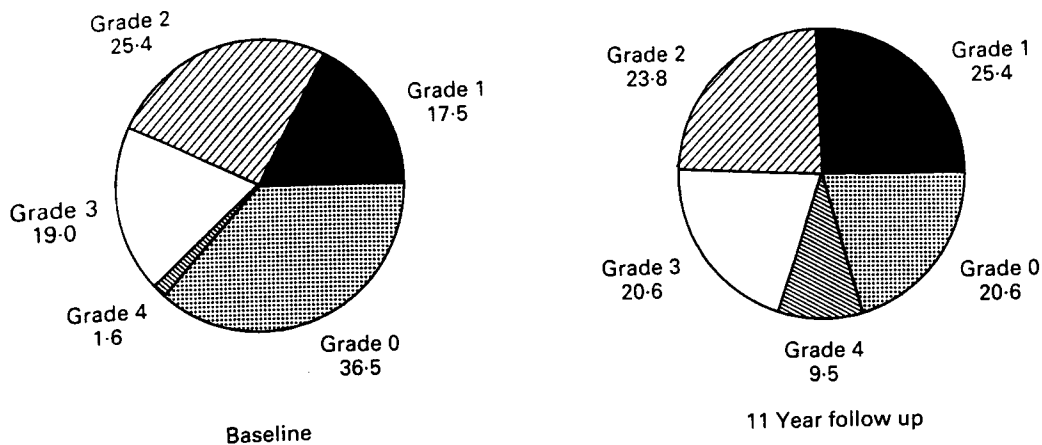


Table 2 Number (%) of knees ( $n=126$ ) and subjects ( $n=63$ ) changing grade compared with baseline

Scoring system (scale)	No change (No (%))		Improved (No (%))		Deteriorated (No (%))	
	Knees	Subjects	Knees	Subjects	Knees	Subjects
Kellgren and Lawrence (0-4)	75 (60)	34 (54)	10 (8)	5 (8)	41 (33)	24 (38)
Joint space (0-5)	59 (47)	30 (48)	14 (11)	10 (16)	53 (42)	23 (37)
Osteophytes (0-3)*	176* (70)	35 (56)	11 (4)	2 (13)	65 (26)	26 (41)
Medial narrowing (0-3)	87 (69)	39 (62)	15 (12)	9 (14)	24 (19)	15 (24)
Sclerosis (0-1)*	222* (88)	41 (65)	1 (0)	6 (10)	29 (12)	16 (25)
Medial joint space (> 10% loss)†	16 (16)		41 (42)		41 (42)	
Global score (-4 to +4)			12 (10)	3 (5)	63 (50)	41 (65)
Mild: 1 grade change	51 (40)	19 (30)	0 (0)	0 (0)	31 (25)	19 (30)
Moderate: 2 grade change	95 (75)	44 (70)				

\*Medial and lateral combined.

†Readings only available on 98 knees.

Table 3 Proportion of knees deteriorating by initial Kellgren and Lawrence grade

Baseline Kellgren and Lawrence grade	Progression of $\geq 1$ grade (No (%))
0	11 (48)
1	5 (45)
2	6 (38)
3	2 (16)

Table 4 Comparison of poor outcome in subjects with knee pain at study entry. Number (%) of knees is shown

Scoring method (scale)	Deteriorated (%)	
	No knee pain ( $n=18$ )	Knee pain ( $n=41$ )
Kellgren and Lawrence (0-4)	9 (25)	29 (35)
Joint space score (0-5)	16 (45)	34 (42)
Osteophytes (0-3)*	7 (10)	57 (35)
Medial narrowing (0-3)	3 (8)	23 (28)
Sclerosis (0-1)*	2 (3)	25 (15)
Medial joint space digitised image analysis (> 10% loss)	13 (14.2)	25 (27.4)
Global score (-4 to +4)		
Mild: 1 grade	8 (22.2)	54 (65.8)
Moderate: 2 grades	1 (2.7)	29 (35.3)

Medial and lateral combined.

nine of 15 with knee pain progressed compared with six of 16 without knee pain at baseline ( $p=0.2$ ). No major differences in weight change were found between the groups; progressors lost 1.4 kg on average compared with 1 kg in non-progressors. Although numbers were small men were less likely to progress; only four of 24 compared with 11 of 39 in the good prognosis group ( $p=0.3$ ).

#### SYMPTOMS OF OSTEOARTHRITIS

Prospective and retrospective data on symptoms were available. At the end of the study we asked

all the subjects whether they thought their pain had got worse, stayed the same, or improved. Fifty six per cent thought their symptoms had got worse. However, we examined the visual analogue scale pain scores recorded at baseline and compared them with those at follow up. There was little change detected; for the group overall a mean visual analogue scale pain score of 53 mm at baseline and 48 mm at follow up was found. The mean (SD) change for each subject was a non-significant reduction of 5.3 (32.3) mm. Furthermore reported knee pain was present in 69% of subjects at onset and only 52% reported to currently have knee pain.

We were able to obtain radiographs for four subjects (all men) who have subsequently died. These paired films did not show any marked difference from those still living in terms of progression. One of the four men who died had progressed, and one improved using the Kellgren and Lawrence grading scale.

#### Discussion

In follow up studies such as this the major potential problem is of selection bias which occurs owing to the exclusion of those who have died or not responded. Our results are only likely to have been significantly altered if the untraceable or dead subjects were those who had progressed the fastest and had the most severe disease. This group would include patients most likely to seek further medical attention and thus it is unlikely that they were those preferentially lost to follow up. The analysis of the four dead patients did not show any major differences from the other group. In addition, the National Health and Nutrition

Examination Epidemiologic Follow-up Study (NHEFS I) was unable to detect any age specific differences in rates of knee osteoarthritis between those not followed up owing to subsequent death and survivors.<sup>9</sup>

There is no universally agreed method of scoring radiographs and it could be that the methods used were too insensitive or prone to error to detect any change.<sup>10</sup> Nevertheless we used a variety of current methods which have been previously validated and found to be reproducible. These various methods reached similar conclusions and they correlated well with each other. In addition we used a highly sensitive global method of assessment. This technique was likely to be biased in favour of detecting change as the films were read unblinded to time sequence and change was graded rather than absolute scores. Even using this highly sensitive method 50% of knees remained unchanged or improved over the study period and only one in four had moderate progression.

Of the two other studies performed the first by Hernborg and Nilsson looked at 71 subjects after 13 years of follow up.<sup>2</sup> The subjects were selected, however, from a database of over 2000 knee radiographs and the criteria of selecting them were based mainly on the presence of sclerosis which would have produced a highly selected group of subjects. Our study suggests that sclerosis is difficult to score consistently and is a poor indicator of radiographic progression. In addition this study lacked any good baseline data and excluded knees with osteophytes. Overall these workers found that 55% of the radiographs had deteriorated and 56% of subjects reported retrospectively that their symptoms had got worse. The second study, by Massardo *et al*, was an eight year follow up of clinical and radiological features of 31 patients with osteoarthritis of the knee joint in whom paired radiographs were obtained for 26.<sup>3</sup> Although the numbers in this study restricted the interpretation or subgroup analysis, these workers concluded that 61% of subjects had deteriorated radiographically and 65% symptomatically, again based on retrospective recall. There was a poor correlation between those who progressed radiologically and those with increased symptoms, however.

It appears that the long term prognosis in a large proportion of patients with osteoarthritis is good. Only a minority are likely to progress rapidly and have a deterioration in their knee symptoms. Knee pain has been shown in a number of population studies to have prog-

nostic significance,<sup>11</sup> and our data suggest that patients with knee pain may progress more rapidly. A small percentage of patients did appear to improve over the 11 year study period. Most of the improvement was due to joint space enlargement. Some of this may be due to errors in measurement or radiographic technique. Slight flexion or rotation of the knees can produce marked alterations in joint space.<sup>12</sup> The possibility remains that, as in the hip, there is a small subgroup of patients with osteoarthritis of the knee joint who might actually improve their radiographic features.<sup>13 14</sup>

The slow progression of disease in most subjects may explain the lack of efficacy shown by most treatment options for osteoarthritis. Further work is needed to improve methods of detecting those who do progress early so that more invasive treatment can be directed against them, and those with a good prognosis reassured.

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