

OSTEOARTHRITIS and CARTILAGE

Association of pain with radiological changes in different compartments and views of the knee joint

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Summary

The aim of this study was to examine the association between radiological patellofemoral and tibiofemoral osteoarthritis and knee symptoms in a population-based survey. Two hundred and fifty unrelated, normal individuals (500 knees) were included in the study. Anteroposterior (AP), lateral and skyline radiographs on each individual were graded for joint space narrowing and osteophytes using a standard atlas. Radiographic features were assessed on their ability to predict knee pain for 15 or more days in the last month, the last year or pain 'ever'. The presence of osteophytes had the strongest association with knee pain 'ever' with an odds ratio (95% CI) for skyline osteophytes of 7.56 (3.84-14.81) and anteroposterior osteophytes of 5.00 (2.40-10.43). The presence or absence of joint space narrowing in all the radiological views (AP, lateral and skyline) was not significantly associated with knee pain, but there was a trend for an association with severity of narrowing in the lateral and skyline views. The presence of osteophytes in all knee views (AP, lateral or skyline) was best at predicting knee pain in the last year. Osteophytes predict pain more accurately than narrowing on all knee radiographic views (AP, lateral or skyline). Pain in the last year (defined as two or more episodes of pain, each lasting for at least 15 days and not related to recent trauma) is predicted more accurately than pain in the last month or ever having had an episode of knee pain and is a useful symptom for inclusion in population studies.

Key words: Osteoarthritis, Radiology, Knee, Pain.

Introduction

OSTEOARTHRITIS (OA) is a major health problem in developed countries. For subjects over the age of 45 years most population survey show that the presence of radiographically determined OA of the knee varies between 14 and 30% and increases steadily with age [1]. Most studies suggest that the proportion of radiological disease that is symptomatic is between 40 and 80% [2]. This phenomenon could be explained if clinical and radiological OA are different entities or, alternatively, if the techniques used routinely to quantify radiographic changes are not sufficiently sensitive or specific.

It has been suggested that symptomatic knee OA may often be caused by patellofemoral disease, which is not revealed by conventional anteroposterior (AP) radiographs, and is difficult to grade reproducibly [3-5]. We have recently confirmed that skyline views are the optimal method for assessing

patellofemoral joint (PFJ) OA [6]. It may be that there are different sub-groups of OA resulting in symptomatic disease, and that disease in different knee joint compartments accounts for different proportions of the knee pain observed in the population. The aim of this study was to examine data from a population-based survey to determine how well radiological changes of OA at the PFJ and tibiofemoral joints (TFJ) predict knee pain in the last month, in the last year and pain 'ever'.

Methods

SELECTION OF CASES

This was a population-based study of 250 unrelated, middle-aged women who were randomly selected from a group of 500 as part of a twin study of osteoarthritis. The participation rate in the twin study was 83%. Only one twin of each pair was randomly included. The analyses performed in this report refer to the knee joints (500) examined as separate units.

Each participant was interviewed with a standard questionnaire, and the joints were examined in a systematic way using previously validated and

Submitted 30 August 1995; accepted 5 January 1996.
This study was funded by a Project Grant from the Arthritis and Rheumatism Council; F. Cicuttini was funded by NH and MRC (Australia).
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reproducible techniques [7]. Information about knee pain and duration was collected for each knee separately. Details were collected as to whether the individual had ever had pain in the knee, the onset duration, whether they had pain in the knee in the month before the visit to the clinic, the duration of that pain, whether they had knee pain the last year, and the number of episodes of knee pain in the last year.

The following radiographic views of the knees were obtained (i) a weight bearing (AP) view in full extension, (ii) a standing lateral view in 30° flexion and (iii) a skyline view in 45° flexion using a perspex positioning wedge. A complete set of all radiographs was available on all participants.

PROCEDURE

All radiographs were independently assessed by two trained observers blind to the clinical findings. Using a published atlas of individual features [8], the presence of definite osteophytes or narrowing was used to classify disease. The radiological features of knee OA in both the TFJ and PFJ were graded on a four point scale (0–3) for individual features, which included osteophytes and joint space.

The individual joint components assessed were the medial and lateral TFJ, the lateral PFJ and the skyline views of the PFJ. The initial scoring results of the two observers were compared and (in the case of disagreement) the radiographs were reviewed by the two observers together with a third independent observer. The intraobserver and interobserver variability was assessed in a sample of 50 sets of knee films selected to include the full range of radiological features encountered in the study.

Different categories of pain were examined: pain the last month (defined as an episode of pain in that knee lasting 15 or more days in the month before examination); pain in the last year [defined as at least two episodes of pain (>15 days) in that knee in the last year]; and pain 'ever' (defined as ever having had an episode of pain in that knee lasting 15 or more days). Only knee pain not associated with trauma was defined as knee pain for the purposes of this study.

STATISTICAL ANALYSIS

The prevalence of joint disease of the subjects was compared using CH² test. Unweighed kappa (κ) coefficients were calculated to assess reproducibility. Each knee joint was treated as a separate unit in the analyses as clinical and

radiological information was available for each joint separately. Odds ratios and 95% confidence intervals were calculated for those with pain and radiological features of OA vs those with pain and no radiological features. Logistic regression software (SPSS for Windows) was used to adjust for confounders (age and body weight). A CH² test for trend was performed to examine the association between knee pain and increasing grade of osteophytes and narrowing in each radiological view.

Results

This population of middle-aged women did not differ in prevalence of OA or risk factors of OA (i.e., age, weight, smoking, physical activity) from another population-based sample of middle-aged women previously described [7]. The demographic features of the population were as follows: mean age 56.4 ± 6.8 years, mean weight 63.7 ± 10.9 kg; 47.2% past or current smokers; 89% post-menopausal; and mean age of menopause 48.9 ± 6.3 years.

INTRAOBSERVER AND INTEROBSERVER REPRODUCIBILITY

Intraobserver and interobserver agreement is shown for κ coefficients (Table I). The intraobserver and interobserver assessment of osteophytes in all knee compartments (lateral TFJ, medial TFJ and PFJ on lateral view and skyline view) was high ($\kappa > 0.8$). In the assessment of joint space narrowing, the intraobserver reproducibility for lateral and medial TFJ score was high ($\kappa > 0.88$) with lower interobserver reproducibility (lateral TFJ $\kappa = 0.6$, medial TFJ $\kappa = 0.72$). The skyline view performed more reproducibly than assessment of the lateral PFJ view for joint space narrowing ($\kappa = 0.8$ vs $\kappa = 0.6$). However, for both views there was a similar good reproducibility in the assessment of osteophytes.

ASSOCIATION BETWEEN KNEE PAIN AND RADIOLOGICAL ABNORMALITIES

The association between knee pain and the presence of radiological abnormalities for each of the different knee views was examined. The odds ratio for having pain if radiological changes were present compared with absent radiological changes was estimated (Table II). As the crude odds ratios were not significantly different to those adjusted ones for age and body mass index, the unadjusted odds ratios are presented. There was an association between the presence of knee pain

Table I.
Intraobserver and interobserver kappa coefficients dichotomized for each radiological feature of osteoarthritis into disease present or absent in the knee joint compartments

Radiographic feature of osteoarthritis	View/compartment			
	Anteroposterior/ lateral tibiofemoral	Anteroposterior/ medial tibiofemoral	Lateral/ patellofemoral joint	Skyline/ patellofemoral joint
Intraobserver				
Joint space narrowing	0.92	0.88	0.60	0.80
Osteophytes	0.96	0.94	0.84	0.90
Interobserver				
Joint space narrowing	0.60	0.72	0.60	0.80
Osteophytes	0.90	0.88	0.80	0.90

when radiological disease was defined as osteophytes alone or as all radiological disease (osteophytes or narrowing or osteophytes and narrowing) on all three radiological knee views (AP, lateral and skyline). The strongest relationship was observed for osteophytes on the skyline view 7.56 (3.85–14.81). The odds of having knee pain if osteophytes were present on the skyline view was not significantly changed by adjusting for the presence of osteophytes at the TFJ (data not shown). Joint space narrowing

on all views was not significantly associated with pain.

Although the numbers were too small to examine the association of each radiological grade (0–3) of osteophyte and narrowing with pain individually, we examined to see whether there was a trend in the association between increasing radiological grade and knee pain. Very significant associations were found between knee pain and increasing grade of osteophyte in each of AP view, lateral view and skyline ($P < 0.001$). A significant association

Table II.
Odds ratios for ever having had knee pain (episode lasting 15 or more days) in those with radiological abnormalities vs no radiological abnormality

	Number (%) with radiological features among those with pain ($N=41$) and no pain ($N=459$)	Odds ratio (95% CI)
All radiological disease*:		
Anteroposterior	15 (36.6) 58 (12.6)	3.99 (2.00–7.97)
Lateral	15 (36.6) 82 (17.9)	2.69 (1.36–5.30)
Skyline	21 (51.2) 70 (15.3)	5.84 (3.01–11.33)
Osteophytes:		
Anteroposterior	13 (31.7) 39 (8.5)	5.00 (2.40–10.43)
Lateral	13 (31.7) 64 (15.9)	2.87 (1.41–5.82)
Skyline	21 (51.2) 56 (12.2)	7.56 (3.85–14.81)
Joint space narrowing:		
Anteroposterior	5 (12.2) 28 (6.1)	2.13 (0.78–5.87)
Lateral	5 (12.2) 39 (8.5)	1.54 (0.57–4.14)
Skyline	5 (12.2) 41 (8.9)	1.42 (0.53–3.82)

*Osteophytes or joint space narrowing or both osteophytes and joint space narrowing.

was found between knee pain and increasing grade of narrowing in the lateral view ($P=0.002$) and skyline view ($P < 0.001$). No such association was found for narrowing in the AP view ($P=0.36$).

SENSITIVITY, SPECIFICITY AND POSITIVE PREDICTIVE VALUE OF RADIOLOGICAL KNEE OA FOR PREDICTING KNEE PAIN

We examined the sensitivity, specificity and predictive value of radiological abnormalities in the different knee compartments for predicting pain in that knee in the last month, the last year or pain 'ever' (Table III). As the association between pain and radiological abnormalities was strongest for osteophytes (Table II), the presence of osteophytes was used as the definition of radiological abnormality to compare with symptom duration.

The presence of osteophytes on any knee view (AP, lateral or skyline) was good at predicting pain in that knee in the last year but poor at predicting pain in the last month or pain 'ever'. The highest positive predictive value for pain in that knee in the last year was seen for AP osteophytes (61.5%) although the values for lateral and skyline osteophytes were very similar (57.9% and 59.7% respectively). Osteophytes were generally poorer at predicting pain in the last month or pain 'ever', with AP osteophytes having the highest predictive value for pain in the last month (19.2%) whereas skyline osteophytes had the highest value for pain 'ever' (27.3%). When radiological abnormality was

defined as osteophytes in any view (AP, lateral or skyline), the predictive value was lower than for osteophytes on either the skyline or AP views alone at all three time points.

When only one radiological view was examined, only skyline osteophytes had a sensitivity of greater than 50% for detecting pain 'ever' in that knee (51.2%) or pain in the last month (52.2%). A sensitivity of greater than 50% was observed for knee pain in the last month or the last year when osteophytes in all views (AP and/or lateral and/or skyline) were included. However, this was at the cost of a lower specificity.

Discussion

In this study, osteophytes on the skyline view had a stronger association with knee pain [odds ratio (95% CI) of 7.56 (3.85–14.85)] than osteophytes on the lateral or anteroposterior views. The presence or absence of joint space narrowing in all the radiological views (AP, lateral and skyline) was not significantly associated with knee pain, although there was a trend for an association with severity of narrowing in the lateral and skyline views. When pain at different times was examined, the presence of osteophytes in all knee views (AP, lateral or skyline) predicted knee pain in the last year better than pain in the last month or ever having had an episode of pain.

The finding that osteophytes are better predictors of knee pain than joint space narrowing is consistent with the findings of a previous

Table III.
Sensitivity, specificity and positive predictive value of knee osteophytes for the presence of knee pain at different times (N=500)

	Sensitivity %	Specificity %	Positive predictive value %
Episode of knee pain lasting ≥ 15 days in the last month:			
Anteroposterior osteophytes	40.0	89.2	19.2
Lateral osteophytes	40.0	85.8	13.0
Skyline osteophytes	52.2	86.4	16.9
Anteroposterior or Lateral or Skyline osteophytes	64.1	76.2	12.5
Two or more episodes of knee pain in the last year			
Anteroposterior osteophytes	20.3	94.0	61.5
Lateral osteophytes	27.8	90.5	57.9
Skyline osteophytes	29.1	90.8	59.7
Anteroposterior or Lateral or Skyline osteophytes	41.1	81.5	51.2
A past episode of knee pain lasting ≥ 15 days;			
Anteroposterior osteophytes	31.7	91.5	20.5
Lateral osteophytes	31.7	86.1	16.9
Skyline osteophytes	51.2	87.7	27.3
Anteroposterior or Lateral or Skyline osteophytes	61.0	77.6	19.5

population-based study [19]. In contrast, however some authors have suggested that osteophytes may be a feature of aging rather than OA [10–12]. However, a study that correlated radiological grading of the severity of OA and arthroscopic evidence of cartilage degeneration, showed that patients whose radiographs showed osteophytosis as the only abnormality, and who had normal articular cartilage at arthroscopy, were younger than the patient group as a whole [13]. Furthermore, in that study it was found that TFJ space narrowing was found in 30% of patients whose articular cartilage was normal on arthroscopic examination [13]. In a study that questioned the role of osteophytes in defining OA, Danielsson and Hernborg reported that only approximately 30% of patients with osteophytes, but no other radiological changes in the knee, had developed structural changes of OA on follow-up 14–18 years later [14]. However, in that investigation, TFJ space narrowing was not included as an outcome.

In this study, the predictive value of skyline osteophytes was similar to that of tibiofemoral osteophytes (seen on the AP view), but generally higher than for osteophytes on the lateral view, which is an alternative way to image the patellofemoral compartment. As yet, we have no explanation for the differences observed between the skyline view and the lateral view osteophytes in assessing pain. It may be that the two patellofemoral views are detecting different osteophytes that may be markers for different sub-group of patients with OA. Knee pain in the last year was predicted more accurately than pain in the previous month or pain ever in that knee. This probably, in part, reflects the variable quality of current pain, which may lead to misclassification. Furthermore, the problems of recall for pain 'ever' in contrast to pain in the last year, may lead to the discrepancy between the pain reported at these times.

In summary, this study has confirmed that osteophytes are the best radiological predictors of pain, with osteophytes in the skyline view, in general better than the lateral or AP views. These data provide further evidence that information on the knee joint should be reported by the different compartments and suggest that knee pain in the last year (defined as two or more episodes of pain, each lasting for at least 15 days and not related to recent trauma) is a useful symptom for inclusion in population studies.

Acknowledgments

We are grateful to Christel Manzi and Mary Leedham-Green for their help, the Radiology Department at St Thomas' Hospital, and the study participants themselves.

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