

Role of radiography in predicting progression of osteoarthritis of the hip: prospective cohort study

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Abstract

Objectives To investigate which variables identify people at high risk of progression of osteoarthritis of the hip.

Design Population based cohort study.

Setting Ommoord district in Rotterdam, Netherlands.

Participants 1904 men and women aged 55 years and older from the Rotterdam study were selected on the basis of the presence of osteoarthritic signs on radiography at baseline, as defined by a Kellgren and Lawrence score \geq grade 1.

Main outcome measures Radiological progression of osteoarthritis of the hip, defined as a decrease of joint space width (≥ 1.0 mm) at follow-up or the presence of a total hip replacement.

Methods Potential determinants of progression of hip osteoarthritis were collected at baseline. x Ray films of the hip at baseline and follow-up (mean follow-up time 6.6 years) were evaluated. Multivariate logistic regression models were used to assess the association between potential risk factors and progression of hip osteoarthritis.

Results In 13.1% (1904 subjects) of the study population (mean age 66.2 years), progression of hip osteoarthritis was evident on the radiograph. Starting with a simple model of only directly obtainable variables, the Kellgren and Lawrence score at baseline, when added to the model, was a strong predictor (odds ratio 5.8, 95% confidence interval 4.0 to 8.4), increasing to 24.3 (11.3 to 52.1) in subjects with hip pain at baseline.

Conclusions The Kellgren and Lawrence score at baseline was by far the strongest predictor for progression of hip osteoarthritis, especially in patients with existing hip pain at baseline. In patients with hip pain, a radiograph has strong additional value in identifying those at high risk of progression of hip osteoarthritis.

Introduction

Identifying people at high risk of rapid progression of osteoarthritis is important, firstly because well characterised "high risk" groups may be useful in clinical trials, and secondly to identify those in need of disease modifying drugs (assuming such drugs become available). Additionally, people whose osteoarthritis has not progressed can be reassured.

No consensus has been reached on how to define progression of hip osteoarthritis.¹ International committees have suggested evaluating structural as well as symptomatic variables in clinical studies.^{2,3} A potential composite outcome measure is the need for total hip replacement, based on the assumption that operations are performed only in patients who have severe symptomatic osteoarthritis and structural damage.^{4,5}

Potential factors that may identify people at risk of progression of hip osteoarthritis include systemic factors (metabolic, hormonal, genetic, and related to

age or sex), local biomechanical factors (such as mechanical workload), body mass index and acetabular dysplasia, and already existing osteoarthritic changes visible on radiograph, clinical symptoms, and signs of cartilage degradation. A recent review reported that radiological features were the main mediators of progression of hip osteoarthritis⁶; however, all the included studies were small, hospital based, and had a short follow-up.

We investigated in a large open population, with a long term follow-up period, which easily measurable clinically relevant risk factors will best identify patients at high risk of progression of osteoarthritis of the hip.

Methods

The study population consisted of participants of the Rotterdam study, a prospective cohort of men and women aged 55 years and older. The objective of the Rotterdam study is to investigate the incidence of, and risk factors for, chronic disabling diseases.⁷

All 10 275 inhabitants of the Rotterdam district of Ommoord received an invitation to participate. Of these who revisited the centre after six years, 1920 had signs of osteoarthritis visible on a radiograph at baseline, as defined by a Kellgren and Lawrence score of 1 or greater. After exclusions, 1904 participants were included in the study population. We conducted baseline measurements between 1990 and 1993. The mean follow-up time was 6.6 years.

Our study group was younger than the total population of Rotterdam and had a lower prevalence of disability of the lower limb and of hip pain.

Radiographical assessment

Weight bearing anteroposterior radiographs of the hip and knee were obtained. Radiographs of the pelvis were obtained with both feet in 10° internal rotation and the x ray beam centred on the umbilicus, and of the knee with the patellae in central position. For the hand, we obtained standard anteroposterior radiographs. One blinded reader evaluated the radiographs of the hip obtained at baseline and at follow-up. Three blinded readers independently evaluated the baseline radiographs of the knee and the hand. All radiographs of the hip were grouped by patient and read by pairs in chronological order, which was known to the reader (chronologically ordered reading procedure).⁸

Outcome measure

We defined progression of osteoarthritis of the hip as a joint space narrowing of 1.0 mm or more or a total hip replacement at follow-up. We measured the lateral,

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The Kellgren and Lawrence score is on bmj.com



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superior, and axial compartments of the hip. We defined joint space narrowing as the joint space width of baseline minus follow-up.

Potential predictors of progression

Radiographical predictors—At baseline, we used measurements of the Kellgren and Lawrence score to quantify osteoarthritis of the hip, knee, and hand on radiograph (in five grades; see bmj.com). We considered a patient to have osteoarthritis on radiograph of the hip or knee, if his or her score was 2 or higher. We defined osteoarthritis of the hand on radiograph as a score of 2 or higher in at least one of two joints out of the three groups of hand joints. See bmj.com for inter-rater reliability and intraclass correlation coefficients for joint assessments.

Predictors collected by questionnaire—At baseline, interviewers conducted a home interview, dealing with demographic characteristics, medical history, risk factors for chronic diseases, and use of medication. We used a modified version of the Stanford health assessment questionnaire to obtain a lower limb disability index by calculating the mean score of the answers to six questions. We asked for the presence of hip pain and morning stiffness. We collected data on age at and type of menopause (spontaneous or artificial); we asked for family history of osteoarthritis and for current or last occupation, including the duration of this occupation.

Predictors collected by physical examination—At the research centre we measured height and weight, and calculated body mass index (kg/m^2); obesity was a body mass index of $30 \text{ kg}/\text{m}^2$ or more. We measured blood pressure and serum glucose concentration for diabetes mellitus. In a subset of 525 subjects, we tested internal and external rotation, flexion, and extension of the hips (see bmj.com).

Statistical analysis

We first performed univariate logistic regression analyses and used factors with $P < 0.1$ for the multivariate analyses. For these we chose a practical approach, and in two different models we assessed which predictors best identified people with progression of hip osteoarthritis.

Model 1—We included those factors that are easily and directly obtainable by the doctor, such as age, sex, family history of osteoarthritis, age at menopause, hypertension, diabetes, body mass index, mechanical

workload, disability of the lower limb, presence of hip pain, and morning stiffness.

Model 2—We added the information obtained from additional radiographical testing to assess whether radiographical factors offered additional value to model 1.

Additionally, we used classification tables of observed cases compared with predicted cases to assess the proportion correctly predicted by each model.

To investigate which factors will identify the progressors of hip osteoarthritis in a clinical situation we repeated the same procedure for those subjects with existing hip pain at baseline. We considered pain as a potential marker for symptomatic osteoarthritis of the hip.

Of the 1904 participants, we used only the hips with a Kellgren and Lawrence score of 1 or higher for analyses (2918 hips). We estimated the associations between the potential predictors and progression of the hip. See bmj.com for details of multivariable model.

Results

The study population had a mean age of 66.2 years; 13.1% had progression of osteoarthritis of the hip on radiograph after a mean follow-up time of 6.6 years. Of these patients, 35.8% had an incident total hip replacement during the follow-up period. See bmj.com for baseline characteristics of the study population, and the univariate associations with progression of hip osteoarthritis.

The table shows the associations between predictors and progression of osteoarthritis of the hip on radiograph in the total study population for the two models used.

We repeated the same procedure for those subjects with prevalent hip pain at baseline ($n = 411$). We found a much stronger association of a baseline Kellgren and Lawrence score of 2 or higher with progression of osteoarthritis of the hip as seen on radiograph with an odds ratio of 24.3 (additional to model 1, $P < 0.0001$). Surprisingly, age lost its relevance in the second model. The probability of a Kellgren and Lawrence score of 2 or higher after the test was 74.6% (probability before test 27.4%; (see bmj.com)).

Analysis of the subset for whom data on limited range of motion were available, showed that a restricted flexion of the hip of more than 20% had an independent association in the final model (odds ratio 3.1, 95% confidence interval 2.1 to 4.7) with progression of osteoarthritis of the hip as seen on

Association between predictors and progression of osteoarthritis of the hip of complete study population in two models ($n=2918$ hips). Values are odds ratios (adjusted for follow-up time) with 95% confidence intervals

Predictor variable	Model 1 (clinical variables)	Model 2 (including radiological variables)
Age in years	1.07 (1.05 to 1.09)	1.06 (1.04 to 1.08)
Sex	1.7 (1.3 to 2.2)	1.8 (1.4 to 2.4)
Disability index score ≥ 0.5	1.9 (1.4 to 2.6)	—
Presence of hip pain	2.6 (1.9 to 3.7)	2.4 (1.7 to 3.5)
Baseline joint width space (≤ 2.5 mm)	—*	1.9 (1.2 to 2.9)
Baseline Kellgren and Lawrence grade ≥ 2	—*	5.8 (4.0 to 8.4)
Correctly predicted by model	0.875	0.897

Predictors were included in a model with $P < 0.05$.

Progression of osteoarthritis of the hip was defined as a joint space narrowing ≥ 1.0 mm or a total hip replacement at follow-up.

*Not tested in this model.

radiograph. However, the strong additional value of radiographical findings still holds.

All subjects with a Kellgren and Lawrence score of 4 at baseline had had total hip replacement operation at follow-up (figure). Of the subjects with hip pain and a Kellgren and Lawrence grade of 2 at baseline, 73% developed progression during follow-up, compared with 36% in the total study population.

Discussion

In this prospective cohort study we found that a Kellgren and Lawrence score of 2 or higher at baseline was the strongest identifier of people at high risk of progression of hip osteoarthritis. This holds particularly true for patients with hip pain at baseline. In addition, a lower limb disability index of 0.5 or higher was also an independent identifier of these high risk patients.

Predictors for progression of osteoarthritis of the hip

In the total study population, the independent predictors for progression of osteoarthritis of the hip were age, female sex, the presence of hip pain, joint space width at baseline ≤ 2.5 mm, and a Kellgren and Lawrence score of 2 or higher at baseline. These findings are in agreement with those reported by Lieveense et al.⁶ In subjects who consulted a general practitioner for hip pain, Birrell et al showed that a simple scoring system based on the severity of symptoms as seen on radiograph and clinical measures could clearly identify groups at high likelihood of being put on a waiting list for a total hip replacement procedure.⁹ These two studies support our findings.

Were important predictors missed?

We expected that local biomechanical factors (such as mechanical workload and sports activity) would have independent associations with the progression of osteoarthritis of the hip. A possible explanation for the lack of association may be that we used information about historical workload and not of workload during the follow-up period.

Limitations of the study

Overall, participants were generally healthier than non-participants; participants had to be mobile enough to visit the research centre at baseline and at follow up, and survive the follow-up period, which implies a healthy cohort effect. Therefore, the general-

What is already known on this topic

Osteoarthritis of the hip is one of the main causes of disability among elderly people, and the prevalence of hip osteoarthritis will increase

The main mediators of progression of hip osteoarthritis are, based on small hospital based studies with a short follow-up time, radiological features

What this study adds

In a clinical situation and for clinical trials, an x ray film has strong additional value to identify people who are at high risk of progression of hip osteoarthritis

isability of the findings is likely to hold, particularly for those subjects who are mobile enough to visit a doctor. Also the model was tested only in the chosen population. Because we used an open study population, our model should be validated in a clinical setting and predictive values assessed subsequently.

Conclusions

A Kellgren and Lawrence score of 2 or higher at baseline is the strongest predictor of progression of hip osteoarthritis, especially in people with hip pain at baseline. In a clinical situation and for clinical trials, an x ray film has strong additional value in identifying people at high risk of progression of hip osteoarthritis.

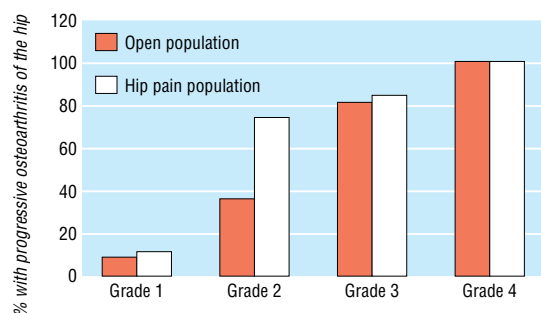
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Proportion of subjects with a joint space narrowing of 1 mm or more or a total hip replacement by Kellgren and Lawrence grade at baseline

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