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THE AMERICAN COLLEGE OF RHEUMATOLOGY CRITERIA FOR THE CLASSIFICATION AND REPORTING OF OSTEOARTHRITIS OF THE HIP

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Clinical criteria for the classification of patients with hip pain associated with osteoarthritis (OA) were developed through a multicenter study. Data from 201 patients who had experienced hip pain for most days of the prior month were analyzed. The comparison group of patients had other causes of hip pain, such as rheumatoid arthritis or spondylarthropathy. Variables from the medical history, physical examination, laboratory tests, and radiographs were used to develop different sets of criteria to serve different investigative purposes. Multivariate methods included the traditional "number of criteria present" format and "classification tree" techniques.

Clinical criteria: A classification tree was developed, without radiographs, for clinical and laboratory criteria or for clinical criteria alone. A patient was classified as having hip OA if pain was present in combination with either 1) hip internal rotation ≥15°, pain present on internal rotation of the hip, morning stiffness of the hip for ≤60 minutes, and age >50 years, or 2) hip internal rotation <15° and an erythrocyte sedimentation rate (ESR) ≤45 mm/hour; if no ESR was obtained, hip flexion ≤115° was substituted (sensitivity 86%; specificity 75%).

Clinical plus radiographic criteria: The traditional format combined pain with at least 2 of the following 3 criteria: osteophytes (femoral or acetabular), joint space narrowing (superior, axial, and/or medial), and ESR <20 mm/hour (sensitivity 89%; specificity 91%). The radiographic presence of osteophytes best separated OA patients and controls by the classification tree method (sensitivity 89%; specificity 91%).

The "number of criteria present" format yielded criteria and levels of sensitivity and specificity similar to

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those of the classification tree for the combined clinical and radiographic criteria set. For the clinical criteria set, the classification tree provided much greater specificity. The value of the radiographic presence of an osteophyte in separating patients with OA of the hip from those with hip pain of other causes is emphasized.

The hip is described as an enarthrosis, a ball-and-socket joint. The applied stress to the hip joint during motion and weight bearing is both dynamic and static. These mechanical stresses, combined with biochemical alterations of cartilage and inadequate chondrocyte repair mechanisms, may result in cartilage disruption (1). Disruption in articular cartilage alone is often asymptomatic (2). As changes progress, symptoms often ensue (3) and are likely to be related to associated changes in subchondral bone, synovium, joint margins, and paraarticular structures (2). We call this disease symptomatic osteoarthritis (OA) of the hip.

The Diagnostic and Therapeutic Criteria Committee of the American College of Rheumatology (ACR) established an Osteoarthritis Subcommittee to develop classification criteria in order to promote uniformity in reporting OA. Such classification criteria are intended to select a group of clinical, laboratory, and/or radiographic features which identify patients with OA and which separate patients with OA from patients with other diseases. Criteria derived from such studies would contain major characteristics of OA, but would not necessarily include the entire spectrum of disease manifestations; hence, they would not be appropriate, and are not intended, for use in the diagnosis of an individual patient. Rather, OA criteria would be designed to separate symptomatic OA from other diseases associated with joint symptoms. In addition, though not specifically studied, the criteria are intended to separate symptomatic OA from asymptomatic OA evidenced by histopathologic changes identified postmortem or asymptomatic OA evidenced by changes identified radiographically.

Since OA has different clinical manifestations in different joint groups, it was thought that the task of criteria development should focus on one joint group at a time. Criteria were developed for the classification of OA of the knee, using combinations of 1) clinical, 2) clinical and laboratory, and 3) clinical, laboratory, and radiographic criteria (4). Classification criteria for OA of the hand were then developed using 1) clinical and 2) clinical with radiographic criteria (5).

We report here our efforts toward developing classification criteria for OA of the hip, using combinations of 1) clinical with and without laboratory criteria and 2) combined clinical, laboratory, and radiographic criteria.

Table 1. Classification of the 201 patients in the study group

Condition	No. of patients
Osteoarthritis (OA) patients	114
Idiopathic OA of the hip	63
Idiopathic generalized OA, including hip	38
Secondary OA of the hip	13
Rheumatoid arthritis or spondylarthropathy	6
Congenital/developmental deformity	4
Avascular necrosis	3
Control patients	87
Rheumatoid arthritis	37
Sciatic radiculopathy	11
Spondylarthropathy	9
Trochanteric bursitis	9
Nonarticular rheumatism, including fibromyalgia	9
Avascular necrosis	4
Fracture	3
Other*	5

* One patient had traumatic synovitis, 1 had piriformis syndrome, 1 had congenital hip dysplasia without OA, 1 had myositis, and 1 had disc disease.

METHODS

Classification. Disease classification was defined as previously described for idiopathic (primary) and secondary OA because of the frequent difficulty in identifying secondary OA in the hip (4). Patients with symptomatic idiopathic and secondary OA of the hip were included in the study. The comparison, or control, group was composed of patients with hip pain or pain in the hip region but of other causes.

Delphi procedure. A list of 21 historical, physical, and laboratory features relevant to OA of the hip was defined (6) and mailed to the committee members. These features were rated by each committee member for the following: 1) percentage of patients with OA in whom the feature would be expected (sensitivity), 2) percentage of normal adults in whom the feature would not be expected (specificity), and 3) percentage of patients with other hip conditions (e.g., rheumatoid arthritis, psoriatic arthritis) in whom the feature would be expected (inverse of specificity). The results were collated and tabulated, and the means, standard deviations from the means, and medians were listed. As per the Delphi technique (7), this list was recirculated to the subcommittee members, who had the opportunity to revise their initial responses on 2 subsequent occasions.

Prospective study protocol. The results of the Delphi procedure yielded a list of features that was expanded to 76 items concerning historical, physical, laboratory, and radiographic findings, and a data collection protocol was designed. Variables were included if published studies had found them to be important and/or if identified by the Delphi exercise. Consecutive patients with symptomatic OA of the

hip and a comparison group with symptoms in the hip region of other cause were entered prospectively into the study. Fifteen centers submitted 5–23 protocols each for patients with hip symptoms, 57% of whom had symptomatic OA of the hip (Table 1).

The clinical diagnosis by the contributing center became the so-called "gold standard" for separating patients into OA and control groups. For this reason, all data forms were reviewed independently by 3 members of the subcommittee (RA, RG, and DK) for verification of the clinical diagnosis. If the reviewers disagreed with the submitted clinical diagnosis, a final diagnosis was negotiated with the center coordinator.

Demographic and historical features included age, sex, race, occupation, symptoms such as pain and hip stiffness, ambulation assistance devices, impaired activities, history of trauma, benefit from nonsteroidal antiinflammatory drugs (NSAIDs), and symptoms or history of OA at other sites. A 4-point scale was used to grade severity of pain, pain while at rest, night pain, pain while seated for 30 minutes or more, pain while rising from a seated position, and pain on initial, mid-, or prolonged ambulation. Pain frequency was recorded as the number of days pain was present over the preceding month. Pain location was recorded as lateral hip, posterior hip, groin (medial), or anterior hip. Pain was recorded as "not radicular" or as radiation to the sacral notch, sacroiliac region, lumbar spine, knee, medial leg, lateral leg, or ankle/foot. Changes in pain at mid-ambulation (better, no change, or worse) were also recorded.

Physical examination of the hip noted the presence of a limp (antalgic gait), the range of motion (6 directions), pain on hip motion (6 directions), Trendelenburg sign (8), Achilles and patellar reflexes, degrees of active and passive straight leg raising from a reclined position, leg length (medial malleolus to anterior superior iliac crest), signs of OA of the knee, and related hip area problems (e.g., scoliosis, trochanteric tenderness, sacroiliac tenderness, tenderness of the symphysis pubis, etc.).

Laboratory tests included the Westergren erythrocyte sedimentation rate (ESR) and rheumatoid factor (RF) titer by latex agglutination test.

Radiographs. Findings on radiographs of the hip were recorded by the center coordinator and independently by one of the subcommittee members (WAM), a musculoskeletal radiologist, utilizing a previously described format (9). Single-view anteroposterior radiographs were read blindly by the radiologist, without knowledge of the clinical data. Radiographs were examined for 9 items (8), as follows: joint space narrowing (superior, axial, and medial), femoral and acetabular osteophytes, femoral and acetabular sclerosis, femoral and acetabular cyst formation, femoral head remodeling, protrusio acetabuli, femoral buttressing (thickening of the medial femoral calcar), avascular necrosis of the femoral head (AVN), and congenital or developmental hip abnormality. Joint space narrowing was assessed as defined by Resnick and Niwayama (10). Femoral head migration in relation to the acetabulum was defined as superior (femoral head moves upward), medial (femoral head moves toward the inner third of the joint), and axial (femoral head moves toward the center third of the joint). The 9 items were graded 0–3 (0 = absent, 1 = mild, 2 = moderate, and 3 = severe). For analysis, the radiographic interpretations by the center coordinator and the radiologist were averaged. For each item, if the average was 1 or more, then the finding was recorded as present; if the average was less than 1, then the finding was recorded as absent.

Data analysis. After verification of the diagnosis and interpretation of the radiographs, data were entered into MEDLOG, a data processing program (Information Analysis Corporation, Mountain View, CA). Data management and analysis were performed in collaboration with the Arthritis, Rheumatism, and Aging Medical Information System (ARAMIS) staff, based at Stanford University (Stanford, CA).

The accuracy of data entry was verified by 2 methods. Twenty percent of the variables entered were randomly selected and reviewed in all records (e.g., diagnosis, age, pain measures, radiologist's diagnosis, and hip range of motion). In addition, 20% of the records themselves were reentered, and the two printed charts were compared for entry errors. Errors were found in 1.8% of the entries.

The data were analyzed by univariate techniques using t-tests for continuous variables and chi-square tests for dichotomous variables. A variable was included in subsequent analyses if it discriminated between OA and control patients at a level of $P < 0.05$.

Classification criteria were developed using the variables identified by the above method, employing two multivariate methods. A brief overview of the methods has been described previously (11).

The first multivariate method was the traditional "number of criteria present" format for criteria development, which has been utilized in prior ACR classification studies (4,5,12,13). This method classifies a subject as having OA of the hip if a minimum number of criteria is found to be present in that patient. The aim was to derive a rule with both high sensitivity and high specificity in separating OA patients from the control patients.

The second multivariate method for criteria development was based on the creation of a classification tree by recursive partitioning (14). In this method, all patients in the sample (includes both OA and control patients) are divided into 2 subgroups according to a value of the criterion which "best" or "most definitely" separates OA and non-OA. Then, each of the 2 subgroups is split again by the same procedure, producing a tree (Figure 1). The "best" variable is determined by a "goodness-of-split" index (14) that can be evaluated for any split of any group of the tree. Two subgroups result from every split. The size of the tree is determined by an algorithm (14), which balances tree size with overall classification error. The most descendent subgroups of the tree are the classifying groups (square boxes in Figures 1 and 2).

The sensitivity and specificity rates for the classification rules, obtained by either the traditional "number of criteria present" format or the classification tree format, are suspected to be optimistic (too high) because they apply to the data used in making the rules. Less biased estimates, known as "cross-validated" estimates, were provided for the classification tree (15). In the cross-validation technique, the sample was randomly divided into 10 groups of almost

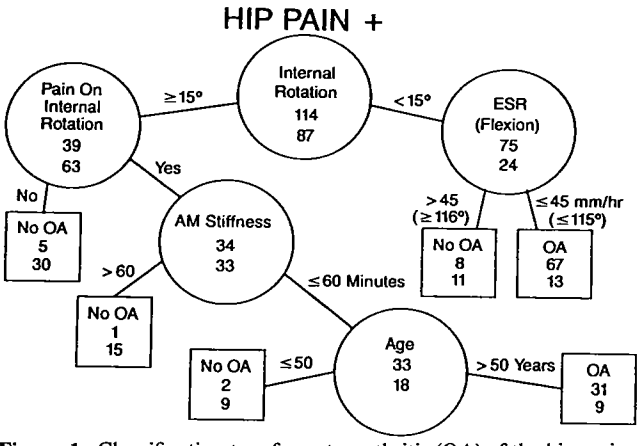

Figure 1. Classification tree for osteoarthritis (OA) of the hip, using clinical criteria. The tree is derived by recursive partitioning (see Methods), beginning with the feature of hip pain, present in all study subjects. The circles show the variables by which the groups are split. The upper number within the circles is the number of patients with OA, and the lower number is the number of patients without OA (from the control patient group). The arms radiating from the circle show the cut-point values on which the variables are split. The boxes show the classifying groups, and specify whether subjects are classified as having OA or not having OA (No OA). The upper number within the boxes is the number of patients with OA, and the lower number is the number without OA; these numbers identify the number of subjects who were properly classified by the criterion as well as the number who were misclassified. Parentheses indicate the surrogate variable "flexion" to be used when the erythrocyte sedimentation rate (ESR) is not available; the appropriate cut-point values for the surrogate are also shown in parentheses. This classification tree yields an overall sensitivity of 86% and a specificity of 75%.

equal size (i.e., each group contained approximately 10% of the patients with hip OA and 10% of the control patients). A rule was obtained using 90% of the sample and was tested against the remaining 10%. Sequentially leaving out 10% of the patients' data allowed 10 rules and 10 tests. The averages of the 10 sensitivity rates and 10 specificity rates are the cross-validated estimates. No computer program is available for cross-validation of the traditional rule format.

RESULTS

The study included 227 patients. Review of charts resulted in a change in the major diagnostic category of 9 patients (4%). Two entered as OA were changed to sciatic radiculopathy, 6 entered as rheumatoid arthritis or spondylarthropathy were changed to OA secondary to the rheumatic disease, and 1 entered as polio was changed to OA. There were minor diagnostic category changes for 12 patients (e.g., gout was changed to sciatic radiculopathy, generalized OA was changed to OA of the hip, etc.). In addition, 26 (11%) of the charts were omitted because they contained insufficient data. Data for the remaining 201 patients were analyzed. There were 114 patients with OA of the hip and 87 control patients, 43% of whom had rheumatoid arthritis (Table 1).

Univariate analysis. Summary statistics of selected historical features are listed in Table 2 (selected by statistical significance or clinical importance; not all data are listed). Overall, the patients with OA were older than the controls. Hip pain was present in all patients but was not always a primary complaint. As a primary complaint, hip pain was slightly less common in the OA patients (72%) than in the controls (78%). Two additional primary complaints were aching and stiffness in 10–15% of both the OA and control groups. Both hips were symptomatic in 42% of the OA patients and 46% of the control patients. Pain while at rest, pain at night, and pain with prolonged sitting were present in approximately two-thirds of all patients. Pain on activity, such as increased pain upon rising from a seated position and increased pain with initial or mid-ambulation, was present in approximately 90% of all patients. Pain with prolonged ambulation was more common in the OA group.

Among patients in whom pain was present, neither the location of the pain (e.g., groin) nor pain radiation separated hip pain of OA from hip pain of other conditions, such as spinal radiculopathy. Not unexpectedly, the presence of either a family history

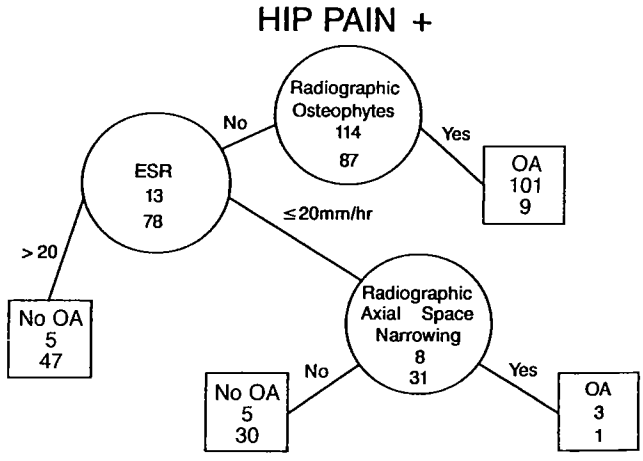

Figure 2. Classification tree for osteoarthritis (OA) of the hip, using combined clinical (history, physical examination, and laboratory) and radiographic criteria. See Figure 1 and Methods for details. This classification tree yields an overall sensitivity of 91% and a specificity of 89%.

Table 2. Selected clinical and laboratory features of the study population*

Feature	OA patients (n)	Control patients (n)	Sensitivity (%)	Specificity (%)	*P*
History					
Age	64 ± 13 (114)	57 ± 15 (85)	–	–	<0.001
Age >50 years, %†	91	72	91	28	<0.001
Women, %	43 (114)	28 (87)	–	–	0.025
Right hip symptomatic, %	60 (114)	66 (87)	60	34	0.40
Contralateral hip symptomatic, %	42 (112)	46 (85)	42	54	0.58
Pain, days/month	25 ± 8 (105)	24 ± 10 (82)	–	–	0.23
Pain distribution					
Lateral thigh, %	57 (112)	56 (86)	57	44	0.85
Groin, %	39 (113)	54 (84)	39	46	0.041
Radiates to the knee, %	64 (109)	84 (83)	64	16	0.002
Pain on prolonged ambulation, %	97 (112)	88 (83)	97	12	0.021
History of reduced lower-extremity function, %	93 (114)	78 (86)	93	22	0.004
AM stiffness, hip, minutes	26 ± 54 (109)	68 ± 90 (86)	–	–	<0.001
AM stiffness, hip, ≤60 minutes, %†	91	59	91	41	<0.001
Impaired ADL, %	93 (114)	81 (86)	93	19	0.023
Family history of OA, %	34 (106)	16 (85)	34	84	0.006
Benefit from NSAIDs, %	71 (113)	49 (85)	71	51	0.022
History of OA of knees, %	33 (104)	16 (69)	33	84	0.014
History of OA of hands, %	47 (104)	28 (69)	47	72	0.010
Physical					
Antalgia, %	85 (93)	57 (72)	85	43	<0.001
Hip range of motion					
Flexion, degrees	81 ± 23 (113)	92 ± 27 (87)	–	–	0.002
Flexion ≤115°, %	96	82	96	18	0.003
Extension, degrees	5 ± 11 (107)	12 ± 13 (83)	–	–	<0.001
Abduction, degrees	29 ± 16 (112)	35 ± 17 (86)	–	–	0.011
Adduction, degrees	15 ± 9 (112)	20 ± 9 (86)	–	–	0.001
Internal rotation, degrees	11 ± 13 (110)	20 ± 12 (87)	–	–	<0.001
Internal rotation <15°, %†	66	28	66	72	<0.001
External rotation, degrees	19 ± 15 (110)	29 ± 17 (87)	–	–	<0.001
Hip pain					
Flexion, %	80 (109)	60 (85)	80	40	0.003
Extension, %	64 (106)	50 (80)	64	50	0.053
Abduction, %	76 (108)	56 (84)	76	44	0.003
Adduction, %	68 (107)	46 (83)	68	54	0.002
Internal rotation, %†	82 (108)	61 (84)	82	39	0.001
External rotation, %	79 (107)	63 (84)	79	37	0.012
Trendelenburg sign, %	37 (95)	19 (67)	37	81	0.017
Reflexes, patellar, %	96 (103)	94 (81)	96	6	0.51
Reflexes, Achilles, %	85 (103)	88 (81)	85	12	0.66
Active straight leg raising, degrees	61 ± 30 (105)	68 ± 29 (82)	–	–	0.12
Passive straight leg raising, degrees	74 ± 23 (109)	81 ± 23 (81)	–	–	0.025
Shortened leg length, %	42 (79)	28 (69)	42	72	0.07
Bony enlargement of knee, %	23 (111)	18 (82)	23	82	0.47
Heberden's nodes, %	58 (110)	27 (83)	58	73	<0.001
Increased palpable knee temperature, %	4 (112)	19 (84)	4	81	<0.001
Laboratory					
ESR, mm/hour	23 ± 20 (59)	38 ± 32 (66)	–	–	0.001
ESR <20 mm/hour, %†	58	36	58	64	0.017
ESR <45 mm/hour, %†	85	64	85	36	0.012
RF titer	28 ± 174 (55)	1,006 ± 2,466 (53)	–	–	0.004
RF ≤1:80, %	96	38	96	62	<0.001

* Unless otherwise indicated, values are the mean ± SD; n values are the number of patients with data for that feature. OA = osteoarthritis; ADL = activities of daily living; NSAIDs = nonsteroidal antiinflammatory drugs; ESR = erythrocyte sedimentation rate (Westergren); RF = rheumatoid factor (by latex agglutination).
† Criterion selected in 1 or more of the multivariate rules.

Table 3. Frequency of radiographic findings in the hips*

Finding, area	OA patients (n = 114)	Control patients (n = 87)	Sensitivity (%)	Specificity (%)	P
Narrowed joint space					
Superior	85	34	85	64	<0.001
Axial†	78	32	78	68	<0.001
Medial	64	24	64	76	<0.001
At least 1 of the above†	91	40	91	60	<0.001
Osteophytes					
Femoral	75	5	75	95	<0.001
Acetabular	77	8	77	92	<0.001
Either femoral or acetabular†	89	10	89	90	<0.001
Sclerosis					
Femoral	73	20	73	80	<0.001
Acetabular	67	21	67	79	<0.001
Either femoral or acetabular	80	26	80	74	<0.001
Cysts					
Femoral	48	15	48	85	<0.001
Acetabular	55	18	55	82	<0.001
Either femoral or acetabular	61	26	61	74	<0.001
Femoral head remodeling	58	15	58	85	<0.001
Femoral buttressing†	57	8	57	92	<0.001

* Values are percentages. OA = osteoarthritis.
† Criterion selected in 1 or more of the multivariate rules.

of OA or a history of OA in other joints was more common in patients with OA. Nearly half (47%) of the OA patients had a history of concomitant OA of the hands. The use of devices as aids to ambulation, such as a cane or a crutch, was comparable in the 2 groups. Increased hip stiffness in the control group was primarily in patients who had rheumatoid arthritis. A history of trauma to the hip was uncommon in both groups. NSAIDs were of benefit in 71% of the OA patients but only 49% of the control group. Since 42% of OA patients and 46% of controls had symptomatic contralateral hips, the contralateral side was not used as a comparison or control.

On physical examination (Table 2), those with OA had more severely reduced range of motion and more often had pain on passive motion than did the control group. The involved lower extremity was more likely to have become shortened in the OA patient group (42%) than in the controls (28%); walking with a limp (antalgia) was more common in the OA group (85%, versus 57% in controls). The thigh muscles of OA patients were thinner on the involved side than on the contralateral side (mean ± SD difference in circumference 6.0 ± 22.5 cm versus 5.2 ± 17.4 in controls). The OA patient group more often had signs of OA in the hand (58%, versus 27% in controls). The Trendelenburg test was more often positive in the OA group (37%, versus 19% in controls).

Several parameters failed to separate OA patients from controls. These were signs of neuropathy (reflexes, leg raising, sensory deficit), most signs of OA of the knee (crepitus, bony tenderness, bony enlargement), and features of other areas about the hip (examination of the spine for scoliosis, the symphysis pubis for tenderness, the trochanteric bursa for tenderness, and sacioiliac tenderness).

Range of motion of the hips in the different spheres (i.e., from flexion to extension, from adduction to abduction, and from external rotation to internal rotation) was less able to separate patients with OA of the hip from the controls than was the loss of motion in flexion, extension, adduction, abduction, external rotation, and internal rotation.

The ESR and RF titer were lower in the OA patient group (Table 2). These test results were available for only a portion of the study population: the ESR for 52% of the OA patients and 76% of the controls, and the RF titer for 48% of the OA patients and 61% of the controls.

Radiographic findings are recorded in Table 3. Certain femoral and acetabular changes were present more often in OA patients than in controls: joint space narrowing, osteophyte formation, subchondral sclerosis, subchondral cyst formation, femoral head remodeling, and femoral medial calcar formation (buttressing). Both femoral and acetabular osteophytes were more common in OA patients than in controls. Joint space narrowing was more common in OA than con-

trol patients for the superior, axial, and medial aspects of the joint.

The clinical diagnosis from the contributing center and the radiographic diagnosis from the radiologist were consistent in 159 of the 201 radiographs (79%). Of the 42 cases in which there was disagreement, 22 radiographs were interpreted as normal (6 OA and 16 control patients) and 3 were inadequate for interpretation by the radiologist. The center coordinator and radiologist concurred in the readings of the radiographs of the 22 patients for whom the radiographic diagnosis was interpreted as normal by the radiologist. The radiographic diagnosis and the clinical diagnosis differed in the remaining 17 (8%). The clinical diagnosis and radiographic diagnosis were consistent in the 17 cases of AVN of the femoral head. AVN presented without OA in 4 patients and with secondary OA in 13 patients.

Multivariate analysis: clinical (history, physical examination, and laboratory). Fourteen traditional "number of criteria present" format rules for history, physical, and laboratory findings were examined. The best rule required hip pain with at least 3 of the following 5 criteria: pain on internal rotation of the hip, internal rotation <15°, ESR ≤20 mm/hour, hip stiffness ≤60 minutes, age >50 years. Interestingly, the same 5 criteria were used in the classification tree below. Although reasonably specific (89%), the sensitivity (54%) was much less than desirable.

A classification tree was also developed for the clinical findings. In the presence of hip pain, the classification tree (Figure 1 and Table 4) included 2 groups representing cases classified as OA of the hip: 1) reduced internal rotation of the hip (<15°) and ESR ≤45 mm/hour or 2) if internal rotation of the hip is ≥15°, then internal rotation should be painful, duration of hip stiffness should be <60 minutes, and the patient should be >50 years of age. The classification tree was 86% sensitive and 75% specific. Cross-validation was 83% sensitive and 68% specific.

There was no pattern to misclassified cases. Only half of the misclassified cases of OA were the same by the 2 multivariate methods. Most of the misclassified controls from the classification tree were also misclassified by the traditional statistical format. Patients with trochanteric bursitis were less often misclassified by the classification tree (2 of 9) than by the traditional format (5 of 9).

Multivariate analysis: clinical (history, physical examination, and laboratory) and radiographic. Radiographic criteria were tested alone. The best traditional format after testing 12 combinations required at least 2 of the following 3 criteria: radiographic evidence of osteophytes, joint space narrowing, and/or buttressing. The sensitivity was 89% and the specificity was 90%. The best classification tree for radiographs alone split only on the presence of osteophytes, with the same 89% sensitivity and 90% specificity. The classification tree results cross-validated at 87% sensitivity and 89% specificity. Further splits in the classification tree were statistically unstable, and did not yield additional value.

For the combined clinical and radiographic criteria, the traditional format was tested in 20 combinations for combined historical, physical examination, laboratory, and radiographic criteria. The best rule required hip pain with at least 2 of the following 3 criteria: ESR <20 mm/hour, radiographic evidence of osteophytes, and/or radiographic evidence of joint space narrowing (Table 5). This traditional rule was 89% sensitive and 91% specific.

Table 4. Clinical (history, physical examination, laboratory) classification criteria for osteoarthritis of the hip, classification tree format*

1.	Hip pain
	and
2a.	Hip internal rotation <15°
	and
2b.	ESR ≤45 mm/hour
	(If ESR not available, substitute hip flexion ≤115°)
	or
3a.	Hip internal rotation ≥15°
	and
3b.	Pain on hip internal rotation
	and
3c.	Morning stiffness of the hip ≤60 minutes
	and
3d.	Age >50 years

* This classification method yields a sensitivity of 86% and a specificity of 75%. See Figure 1 for graphic depiction of this classification tree. ESR = erythrocyte sedimentation rate (Westergren).

Table 5. Combined clinical (history, physical examination, laboratory) and radiographic classification criteria for osteoarthritis of the hip, traditional format*

Hip pain
and
At least 2 of the following 3 features
ESR <20 mm/hour
Radiographic femoral or acetabular osteophytes
Radiographic joint space narrowing (superior, axial, and/or medial)

* This classification method yields a sensitivity of 89% and a specificity of 91%. ESR = erythrocyte sedimentation rate (Westergren).

Table 6. Combined clinical (history, physical examination, laboratory) and radiographic classification criteria for osteoarthritis of the hip, classification tree format*

1.	Hip pain
	and
2.	Femoral and/or acetabular osteophytes on radiograph
	or
3a.	ESR ≤20 mm/hour
	and
3b.	Axial joint space narrowing on radiograph

* This classification method yields a sensitivity of 91% and a specificity of 89%. See Figure 2 for graphic depiction of this classification tree. ESR = erythrocyte sedimentation rate (Westergren).

A classification tree combining clinical and radiographic criteria (Figure 2 and Table 6) was similar to the radiographic classification tree, with the classification of OA based first on the presence of osteophytes as compared with the control group. In this classification tree, a second group of cases could be classified as having OA, even in the absence of osteophytes: patients with an ESR ≤20 mm/hour and radiographic evidence of axial joint space narrowing. This classification tree was 91% sensitive and 89% specific. Cross-validation rates were 89% sensitive and 87% specific.

By traditional format rule and classification tree, the majority of misclassified OA cases were patients without radiographic evidence of osteophytes. Most misclassified controls had both osteophytes and joint space narrowing on radiography. There were 5 patients with osteophytes and no joint space narrowing or buttressing: 3 OA patients were misclassified by the traditional format and 2 controls were misclassified by the classification tree. There were 6 patients without osteophytes who had joint space narrowing and buttressing (4 OA and 2 control patients). The traditional format rule selected narrowing of any part of the hip joint (superior, axial, or medial), in contrast to the classification tree, which selected axial joint space narrowing.

DISCUSSION

This study was designed to develop classification criteria for symptomatic OA of the hip. Classification criteria were derived from a group of patients with OA hip pain compared with patients with similar symptoms due to other causes. Pain is probably the major symptom of hip OA (16,17). However, as in other studies (16,17), neither the pattern of distribution of the pain nor the relationship of pain to physical activities was consistent among the patients with hip OA. Hence, the distribution of pain poorly separated OA patients from non-OA control patients.

The importance of the radiograph in the clinical classification of OA of the hip was exemplified by the high sensitivity and specificity of osteophytes in the classification tree, and the combined finding of osteophytes with joint space narrowing or buttressing by the traditional "number of criteria present" format. The importance of the radiograph is further emphasized by the difficulty of classifying OA of the hip by clinical and laboratory criteria alone, mostly because of the lack of adequate specificity. Combining clinical and radiographic findings did little to improve sensitivity or specificity over that provided by radiography; requiring more than osteophytes on the radiograph did not appreciably change the sensitivity or specificity in this study population.

Clinical criteria. As might be expected, clinical criteria without radiographic assessment were reasonably sensitive but not very specific. The classification tree provided more specificity than the traditional format, identifying 2 groups of patients with hip OA, according to the presence of the following combinations of criteria: 1) reduced internal rotation (≤15°) and an ESR ≤45 mm/hour, or 2) internal rotation ≥15°, with pain on internal rotation, hip stiffness in the morning lasting ≤60 minutes, and age >50 years. For clinical population surveys when laboratory tests are not being obtained, hip flexion ≤115° may be substituted for the ESR. The importance of reduced internal rotation and flexion in hip OA is consistent with results reported by Pearson and Riddell (18).

Combined clinical and radiographic criteria. Osteophytes identified radiographically was the criterion which best separated patients with hip OA from the controls. Joint space narrowing was present in 91% of the patients with OA, but the criterion was only 60% specific.

Osteophytes on the lateral edge of the acetabulum are not necessarily a sign of OA (16,19) and are reported in the absence of OA. A patient with osteophytes in the absence of OA would be misclassified with this system if the patient had experienced hip pain for most days of the prior month. However, numerous studies have stressed the importance of osteophytes in hip OA (20–24). These same studies and others (17) have also stressed the importance of joint space narrowing in hip OA. In contrast, hip joint space narrowing alone may not reflect OA (25,26), because joint space narrowing may also occur in other diseases.

The classification tree for combined clinical and radiographic criteria first divides on osteophytes. By adding 2 items in the absence of osteophytes (i.e., ESR <20 mm/hour and radiographic axial joint narrowing), 3 additional cases of OA (1%) can be properly classified. Since the presence of radiographic osteophytes is so typical of OA, the traditional format that combines osteophytes with an ESR <20 mm/hour or with radiographic evidence of joint space narrowing yields almost the same sensitivity and specificity rates as the classification tree.

The Lequesne diagnostic criteria for OA of the hip lists 3 inclusion criteria and 11 exclusions (27). Inclusion criteria are 1) reduced range of motion in at least 3 of 7 spheres (flexion, extension, external rotation, internal rotation, abduction, adduction, and flexion with adduction), 2) radiographic joint space narrowing (specifically, anteroposterior or oblique standing radiograph), and 3) osteophytes, subchondral sclerosis, and/or subchondral cyst formation. The exclusions include several causes of secondary OA, such as rheumatoid arthritis. Although the Lequesne criteria are similar to those developed here, there are differences. Our proposed criteria rely heavily on radiographic osteophytes, depend less on joint space narrowing, emphasize reduced internal rotation over other hip motions, do not require subchondral changes, and do not exclude secondary OA. Also, Lequesne's criteria were proposed for diagnosis; they are, by necessity, more encompassing than criteria for classification.

The classification criteria described above verify the importance of the radiograph in the classification of hip OA. However, the imperfect nature of the criteria reinforces the need for better diagnostic techniques. Any one of the criteria rules presented can be used for classification. It is hoped these criteria will promote more uniform reporting of OA of the hip in future studies.

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