Supplementary Online Content

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This supplementary material has been provided by the authors to give readers additional information about their work.

eTable 1. Literature Search

Ovid MEDLINE(R) Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid MEDLINE(R) Daily and Ovid MEDLINE(R) 1946 to 2019 November 1st
1   exp physical examination/
2   exp medical history taking/
3   clinical sign$.tw
4   clinical exam$.tw
5   physical exam$.tw
6   provoca$.tw
7   or/1-6
8   exp "sensitivity and specificity"/
9   sensitivity.tw
10   specificity.tw
11   predictive value$.tw
12   likelihood ratio$.tw
13   post-test probability.tw or posttest probability.tw
14   ((pre-test or pretest) adj probability).tw
15   or/8-14
16   exp hip/ or hip.tw
17   7 and 15 and 16
18   limit 17 to (english language and humans)

Embase 1974 to 2019 November
1   exp physical examination/ (203495)
2   clinical sign$.tw. (144450)
3   clinical exam$.tw. (63022)
4   physical exam$.tw. (93204)
5   provoca$.tw. (25140)
6   exp anamnesis/ (200144)
7   1 or 2 or 3 or 4 or 5 or 6 (631991)
8   sensitiv$.tw. (1472852)
9   specificit$.tw. (529820)
10   post-test probabilit$.tw. (833)
11   posttest probabilit$.tw. (398)
12   ((pre-test$ or pretest$) and probabilit$).tw. (3815)
13   predictive value$.tw. (130600)
14   likelihood ratio$.tw. (16752)
15   8 or 9 or 10 or 11 or 12 or 13 or 14 (1796014)
16   exp hip/ (50626)
17   (hip or hips).tw. (157181)
18   16 or 17 (167646)
19   7 and 15 and 18 (575)
20   19 (575)
21   limit 20 to (abstracts and english language) (500)

PubMed
1   physical examination [MeSH]
2   medical history taking [MeSH]
3   clinical sign* [tiab]
4   clinical exam* [tiab]
5   physical exam* [tiab]
6   provoca* [tiab]
7   #1 OR #2 OR #3 OR #4 OR #5 OR #6

8   "sensitivity and specificity"
9   Sensitivity [tiab]
10   Specificity [tiab]
11   predictive value* [tiab]
12   likelihood ratio* [tiab]
13   post-test probabilit* [tiab] OR posttest probabilit* [tiab]
14   (pre-test OR pretest) AND probability* [tiab]
15   #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14
16   Hip [Mesh] OR hip [tiab] OR hips [tiab]
17   #7 AND #15 AND #16
18   limit #17 to (animal studies only)
19   #17 NOT #18
20   limit #19 to (english language)

EBSCO CINAHL 1961 – 2019 November
1.   (MH "Physical Examination+")
2.   (MH "Patient History Taking+") OR (MH "Medication History")
3.   TX "clinical sign*"
4.   TX "clinical* exam**"
5.   TX "physical exam*"
6.   TX provocat*
7.   1 OR 2 OR 3 OR 4 OR 5 OR 6
8.   (MH "Sensitivity and Specificity")
9.   TX Sensitivity
10.   TX Specificity
11.   TX "predictive value*"
12.   TX "likelihood ratio*"
13.   TX "post-test probabilit*" OR TX "posttest probabilit*"
14.   TX "pretest probabilit*" OR TX "pre-test probabilit*"
15.   8 OR 9 OR 10 OR 11 OR 12 OR 13 OR 14
16.   MW hip* OR TX hip OR hips
17.   7 AND 15 AND 16

eTable 2. Characteristics of Included Studies (see eTable 3 for JAMA Rational Clinical Examination Quality Levels and Risk of Bias)

Study	Design	Hips[a]	Setting	Population	Demographics	Clinical features
Altman 1991[1]	Cohort	201 (114 cases, 87 controls)	Hospitals throughout the USA.	Consecutive patients with symptomatic hip osteoarthritis and a control group with other causes for hip pain.	Mean age 61; 36% female.	History (pain distribution, pain on mobilising, reduced function, morning stiffness <60 minutes), family history, benefit of NSAIDs, OA elsewhere), physical examination (limp, range of movement, pain on movement, Trendelenburg positive, reflexes, leg shortening, Heberden's nodes), laboratory findings (Erythrocyte sedimentation rate <20mm/h, ESR <45mm/h, Rheumatoid factor <1:80 titer).
Bierma-Zeinstra 2002[2]	Cohort	220 (78 OA, 142 non-OA; 25 severe OA, 195 not severe OA)	Two hospitals in Rotterdam, The Netherlands.	Consecutive patients aged >50 referred with hip pain.	Mean age 66; 73% female.	History (aggravating features, pain distribution), physical examination (tenderness, range of motion, weakness, pain on movement).
Birrell 2001[3]	Cohort	250 (84 OA, 166 non-OA; 26 severe OA, 164 not severe - OA)	Primary care, UK.	Consecutive patients with hip pain presenting to 36 general practitioners with an interest in musculoskeletal pain.	Median age 63; 68% female.	Restricted hip range of movement (flexion, internal rotation, external rotation)
Holla 2012[4]	Cohort	344 (86 OA, 258 non-OA)	Ten hospitals in The Netherlands.	Patients with hip symptoms from the Cohort Hip & Cohort Knee (CHECK) study.	Mean age 56; 78% female.	Restricted hip range of movement.
Morvan 2009[5]	Case control	237 (126 OA, 111 non-OA)	Multiple hospitals in France.	Patients referred to rheumatology clinics with hip pain.	Mean age 58; 73% female.	Four question screening questionnaire (pain in last 4w [hip, groin, upper thigh], pain when climbing stairs or walking down slopes, limited range of motion hip, do you have OA diagnosis)
Sutlive 2008[6]	Cohort	72 (21 OA, 52 non-OA)	Military healthcare beneficiary system, Texas, USA.	Patients aged >40 with unilateral pain in the buttock, groin, or anterior thigh.	Mean age 59; 56% female.	Gender, constant lumbar/buttock pain, groin pain same side, self-reported squatting aggravating factor, squat causing posterior pain, active hip flexion causing lateral pain, scour test (hip flexed to 90° then knee moved toward the opposite shoulder with axial load applied along the axis of the femur), passive IR <25°,

						Patrick's test <60° (reduced flexion, abduction, external rotation [FABER] range of movement to <60° as measured with an inclinometer), active hip extension causing hip pain, abduction or adduction causing groin pain, compound score

Abbreviations: NSAID, nonsteroidal anti-inflammatory agents; OA, osteoarthritis, IR, internal rotation

[a]All studies adopted individual hips (either the hip referred, self-reported, or most symptomatic) as the unit of analysis but two studies[3,4] included data from symptomatic contralateral hips.

eTable 3. Quality Assessment of Included Studies Using Rational Clinical Examination Levels of Evidence and QUADAS-2

Study	Level[a]	Patient selection		Index tests		Reference standard		Flow and timing	
		Risk of bias	Applicability	Risk of bias	Applicability	Risk of bias	Applicability	Risk of bias	Applicability
Altman 1991[1]	1	Low	Low	Low	Low	Low	Low	Low	Low
Bierma-Zeinstra 2002[2]	1	Low	Low	Low	Low	Low	Low	Low	Low
Birrell 2001[3]	1	Low	Low	Low	Low	Low	Low	Low	Low
Holla 2012[4]	1	Low	Low	Low	Low	Low	Low	Low	Low
Morvan 2009[5]	1	Low	Low	Low	Low	Low	Low	Low	Low
Sutlive 2008[6]	3	Low	Low	Low	Low	Low	Low	Low	Low

[a]**JAMA Rational Clinical Examination Levels of Evidence**

1. Independent, blind comparison of symptoms or signs with a reference standard for hip osteoarthritis (plain radiographs) among a large cohort (>200) of consecutive patients with hip or groin pain.
2. Independent, blind comparison of symptoms or signs with a reference standard for hip osteoarthritis among a small number (<200) of consecutive patients with hip or groin pain.
3. Independent, blind comparison of symptoms or signs with a reference standard in non-consecutive patients with hip or groin pain.
4. Non-independent comparison of symptoms or signs with a reference standard among samples of patients who are known to have hip osteoarthritis.
5. Non-independent comparison of symptoms or signs with a reference standard of uncertain validity among samples of patients.

eTable 4. History Findings and Likelihood of Hip Osteoarthritis

Feature	Threshold	Sensitivity (95% CI)	Specificity (95% CI)	LR+ (95% CI)	LR-(95% CI)
		GENERAL FEATURES			
Family history of osteoarthritis[1,a]	Self-reported	34 (25-44)	84 (74-91)	2.1 (1.2-3.6)	0.79 (0.67-0.93)
History of knee osteoarthritis[1,a]	Self-reported	33 (24-43)	84 (73-92)	2.1 (1.1-3.8)	0.80 (0.68-0.95)
History of hand osteoarthritis[1]	Self-reported	47 (37-57)	72 (60-82)	1.7 (1.1-2.6)	0.74 (0.58-0.92)
Age[1,2,b]	>60	96 (80-99.9)	25 (29-42)	1.5 (1.3-1.7)	0.11 (0.02-0.78)
	>50	91 (84-96)	28 (19-39)	1.3 (1.1-1.5)	0.32 (0.16-0.62)
Morning stiffness <60 minutes[1,2,b]	Self-reported	56-91	41-67	1.5-1.7	0.22-0.65
Female sex[1,2,6]	Female	59 (39-80)	54 (22-86)	1.4 (0.81-1.9)	0.74 (0.53-0.94)
Benefit from NSAIDs[1]	Self-reported	71 (62-79)	51 (40-62)	1.4 (1.1-1.8)	0.57 (0.40-0.82)
Pain duration >3 months[2]	Self-reported	80 (59-93)	38 (32-46)	1.3 (1.0-1.6)[2]	0.52 (0.23-1.2)
Contralateral hip symptomatic[1,2]	Self-reported	20-42	54-88	0.91-1.6	0.91-1.1
Nocturnal pain[2]	Self-reported	12 (2.5-31)	85 (79-90)	0.81 (0.27-2.5)	1.0 (0.88-1.2)
		LOCATION OF PAIN			
Worst pain in medial thigh[2,a]	Self-reported	12 (2.5-31)	98 (96-99.7)	7.8 (1.7-37)	0.89 (0.77-1.0)
Groin pain[1,2,6]	Self-reported	39 (31-47)	74 (52-96)	1.7 (0.01-3.4)	0.89 (0.54-1.23)
Foot pain[6]	Self-reported	43 (22-66)	71 (56-82)	1.5 (0.81-2.8)	0.8 (0.5-1.2)
Worst pain in anterior thigh[2,6]	Self-reported	12-33	74-77	1.4-1.5	0.87-1.0
Radiation to knee[1,2]	Self-reported	32-64	16-71	0.76-1.1	0.96-2.2
Posterior thigh pain[6]	Self-reported	24 (8.2-47)	74 (60-86)	0.93 (0.38-2.3)	1.0 (0.77-1.4)
Worst pain over trochanter[2]	Self-reported	24 (9.4-45)	69 (62-75)	0.77 (0.37-1.6)	1.1 (0.87-1.4)
Lateral thigh pain[1,2]	Self-reported	4.0-57	44-92	0.52-1.0	0.98–1.0
Worst pain in buttock[2,6]	Self-reported	12-67	57-69	0.38-1.6	0.59–1.3
		ACTIVITIES WORSENING PAIN			
Pain on climbing upstairs or walking down slopes[5,ab]	Self-reported	68 (59-76)	68 (58-76)	2.1 (1.6-2.8)	0.47 (0.35-0.63)
Pain on initial steps after rest[2]	Self-reported	92 (74-99)	26 (20-32)	1.2 (1.1-1.4)	0.31 (0.08-1.2)
Pain on walking[1,2, b]	Self-reported	80-97	12 -34	1.1-1.2	0.25-0.58
Pain aggravated by lying on side[2]	Self-reported	60 (39-79)	37 (31-45)	0.96 (0.68-1.3)	1.1 (0.64-1.8)
Pain relieved by sitting[2]	Self-reported	92 (1.0-26)	33 (60-73)	1.4 (0.2-1.6)	0.24 (0.06-0.9)

[a]Positive likelihood ratio ≥2.0;

[b]Negative likelihood ratio ≤0.5.

eTable 5. Physical Examination Findings and Likelihood of Hip Osteoarthritis

Feature	Threshold	Sensitivity (95% CI)	Specificity (95% CI)	LR+ (95% CI)	LR- (95% CI)
GENERAL FINDINGS					
Abductor weakness[2,a]	Measured with the patient lying down	44 (24-65)	90 (85-94)	4.5 (2.4-8.4)	0.62 (0.43-0.88)
Limp[1,b]	Present	85 (76-92)	43 (31-55)	1.5 (1.2-1.9)	0.35 (0.20-0.61)
Short leg length[1]	Measured anterior superior iliac crest to the medial malleolus.	42 (31-53)	72 (60-82)	1.5 (1.0-2.4)	0.80 (0.63-1.0)
Trendelenburg sign[1,2]	Inability to keep pelvis parallel to ground while standing on one leg.	37-48	64- 81	1.3-1.9	0.78-0.81
Heberden's nodes[1,2]	Present	36-58	73-74	1.3-2.2	0.58-0.87
Bony enlargement of the knee[1]	Present	23 (16-32)	82 (72-89)	1.3 (0.73-2.3)	0.94 (0.81-1.1)
Patellar reflex[1]	Present	96 (90-99)	6.2 (2.0-14)	1.0 (1.0-1.1)	0.67 (0.18-2.3)
Achilles reflex[1]	Present	85 (77-92)	12 (6.1-22)	0.87 (0.87-1.1)	1.3 (0.56-2.5)
Increased knee temperature[1]	Present	3.6 (1.0-8.9)	81 (71-89)	0.21 (0.07-0.54)	1.2 (1.1-1.3)
PAIN ON PALPATION					
Inguinal ligament tenderness[2,a]	Present	60 (39-79)	75 (68-81)	2.4 (1.6-3.8)	0.53 (0.33-0.87)
Tensor fascia lata tenderness[2]	Present	40 (21-61)	80 (73-85)	2.0 (1.1-3.4)	0.75 (0.54-1.1)
Gluteus medius tenderness[2]	Present	60 (39-79)	62 (55-69)	1.6 (1.1-2.3)	0.64 (0.54-0.71)
Sacroiliac joint tenderness[2]	Present	48 (28-69)	65 (58-72)	1.4 (0.88-2.2)	0.80 (0.54-1.2)
Gluteus maximus tenderness[2]	Present	48 (28-69)	61 (54-68)	1.2 (0.79-1.9)	0.85 (0.58-1.3)
Iliopsoas tenderness[2]	Present	20 (6.8-41)	84 (78-88)	1.2 (0.52-2.8)	0.96 (0.78-1.2)
Superior posterior iliac spine tenderness[2]	Present	36 (18-58)	64 (57-71)	1.0 (0.58-1.8)	1.0 (0.73-1.4)
Ischial nerve tenderness[2]	Present	12 (2.5-31)	83 (77-88)	0.71 (0.24-2.1)	1.1 (0.90-1.2)
PAIN ON MOVEMENT AND PROVOCATION TESTS					
Squat causing posterior pain[6,a]	Test as described by Sutlive et al[6].	24 (8.2-47)	96 (86-99.5)	6.1 (1.3-29)	0.79 (0.62-1.0)
Groin pain on abduction or adduction[6,a]	Present	33 (15-57)	94 (84-99)	5.7 (1.6-20)	0.71 (0.52-0.97)
Scour test[6,a]	Test as described by Sutlive et al.	62 (42-82)	74 (60-86)	2.4 (1.4-4.3)	0.51 (0.29-0.90)
Pain on hip adduction[1,2,b]	Present	68 -80	46 -54	1.5-1.5	0.43-0.59
Pain on hip internal rotation[1,2,b]	Present	82 -88	38 -39	1.4-1.4	0.31-0.45
Pain on hip extension[1,2,6]	Present	62 (54-70)	63 (68-92)	1.4 (1.1-1.7)	0.67 (0.51-0.89)
Pain on hip abduction[1]	Present	92 (74-99)	32 (26-39)	1.4 (1.2-1.6)	0.55 (0.36-0.83)

Pain on hip external rotation[1,2]	Present	64 -79	37-61	1.3-1.6	0.57-0.59
Pain on hip flexion[1,2,6]	Present	64 (48-81)	47 (0.70-93)	1.1 (0.46-1.7)	0.67 (0.26-1.1)

<table>
<tr><td colspan="6" align="center">TESTS OF MOTION</td></tr>
</table>

Restricted movement[3,a]	3 planes	NA[c]	NA[c]	4.5 (2.4-8.4)[c]	NA[c]
	2 planes	NA[c]	NA[c]	1.5 (0.90-2.6)	NA[c]
	1 plane	NA[c]	NA[c]	1.3 (0.85-2.0)	NA[c]
	0 planes	NA[c]	NA[c]	0.91 (0.78-1.1)	NA[c]
Decreased hip adduction[2,ab]	Goniometer compared with published normal values[7,8] and/or comparison to contralateral hip	80 (59-93)	81 (75-86)	4.2 (3.0-6.0)	0.25 (0.11-0.54)
Decreased hip internal rotation[1,2,4,6,ab]	Goniometer compared with published normal values[7,8] and/or comparison to contralateral hip	66 (47-81)	79 (57-92)	3.2 (1.7-6.0)	0.43 (0.31-0.60)
Decreased range of movement[5,ab]	Goniometer compared with published normal values[7,8] and/or comparison to contralateral hip	75 (66-82)	74 (65-82)	2.9 (2.1-4.0)	0.34 (0.25-0.47)
Decreased hip extension[2,ab]	Goniometer compared with published normal values[7,8] and/or comparison to contralateral hip	76 (55-91)	68 (61-75)	2.4 (1.8-3.2)	0.35 (0.17-0.71)
Decreased hip external rotation[2,ab]	Goniometer compared with published normal values[7,8] and/or comparison to contralateral hip	76 (55-91)	64 (57-71)	2.1 (1.6-2.8)	0.37 (0.19-0.76)
Decreased hip abduction[2,b]	Goniometer compared with published normal values[7,8] and/or comparison to contralateral hip	88 (69-98)	46 (38-53)	1.6 (1.3-2.1)	0.26 (0.09-0.77)
Decreased hip flexion[1,2,4]	Goniometer compared with published normal values[7,8] and/or comparison to contralateral hip	68 (24-11)	54 (18-89)	1.6 (1.0-2.2)	0.51 (0.14-0.88)

Abbreviation: NA, not applicable.

[a]Positive likelihood ratio ≥2.0;

[b]Negative likelihood ratio ≤0.5;

[c]For ordinal data shown from 0 planes to 3 planes, sensitivity and specificity do not apply. Results shown as serial LR to show the increasing likelihood of restricted movements from 0 to 3 different affected planes;

eTable 6. Combinations of Clinical Signs and Likelihood of Hip Osteoarthritis

Feature	Threshold	Sensitivity (95% CI)	Specificity (95% CI)	LR+ (95% CI)	LR- (95% CI)
ANY HIP OA					
Number of signs[2,a] *Age >60, pain lasting longer than 3 months, no pain aggravation by sitting, groin tenderness, decreased external rotation.*	Five signs	NA[b]	NA[b]	4.1 (1.3-13)	NA[b]
	Four signs	NA[b]	NA[b]	5.3 (2.6-11)	NA[b]
	Three signs	NA[b]	NA[b]	0.84 (0.56-1.3)	NA[b]
	Two signs	NA[b]	NA[b]	0.61 (0.37-1.0)	NA[b]
	One sign	NA[b]	NA[b]	0.26 (0.10-0.71)	NA[b]
	No signs	NA[b]	NA[b]	0.26 (0.01-5.0)	NA[b]
SEVERE HIP OA					
Number of signs[2,a] *Age >60, inguinal ligament tenderness, decreased external rotation, decreased internal rotation, decreased adduction, bony restriction in one of the directions using passive hip movement, hip abductor weakness.*	Seven signs	NA[b]	NA[b]	38 (1.9-764)	NA[b]
	Six signs	NA[b]	NA[b]	128 (7.6-2156)	NA[b]
	Five signs	NA[b]	NA[b]	16 (5.1-48.1)	NA[b]
	Four signs	NA[b]	NA[b]	2.0 (0.88-4.3)	NA[b]
	Three signs	NA[b]	NA[b]	0.10 (0.01-1.5)	NA[b]
	Two signs	NA[b]	NA[b]	0.06 (0.004-0.86)	NA[b]
	One sign	NA[b]	NA[b]	0.16 (0.02-1.1)	NA[b]
	No signs	NA[b]	NA[b]	0.28 (0.02-4.6)	NA[b]

Abbreviation: NA, not applicable.

[a]Positive likelihood ratio ≥2.0;

[b]For ordinal data shown as increasing number of abnormalities, sensitivity and specificity do not apply. Results shown as serial LR to show the increasing likelihood of hip osteoarthritis the number of abnormal findings increase.

eReferences

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